PAPERS

FROM THE

NOTES OF AN ENGINEER.

FREDERICK GLEASON CORNING.

With Author's compliments

F. G. Canning

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PAPERS

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NOTES OF AN ENGINEER

BY

FREDERICK GLEASON CORNING, M.E.

DIPLOMIST ROYAL MINING ACADEMY, FREIBERG, SAXONY. MEMBER AMERICAN INSTITUTE OF MINING ENGINEERS, ETC.

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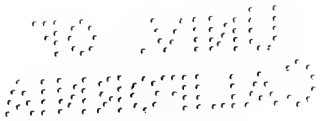

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I.

THE PANAMA CANAL.*

REVIEW OF THE FRENCH COMPANY, THE WORK ACCOMPLISHED, AND FUTURE PROSPECTS OF THIS GIGANTIC UNDERTAKING.

THE names of De Lesseps, Suez, and Panama, whatever may prove to be the issue of the latter venture, will always remain great among the chapters in the progress of civilization. To review the career of F. De Lesseps and fully appreciate the vastness of his projects is to become forcibly impressed with the man's extraordinary genius as the projector of startling undertakings and his unsurpassed ability as a successful promoter. A broad view of his achievements inspires a degree of admiration for this magnetic character only comparable with the intense interest felt throughout civilized countries regarding the success of his globe-remodeling projects and their important bearing on the interests of commerce and navigation. More minutely scrutinized, however—passing, as it were, from the poetic to the prosaic side of this talented Frenchman's schemes—we meet with some disappointment regarding the execution in detail and probable fate of his last great engineering and speculative undertaking at Panama. This concern for the future of the canal and for the prestige so long enjoyed by De Lesseps grows out of an impartial attitude toward the undertaking, in which the present condition of things on the Isthmus is contrasted with the original promises officially advertised by De Lesseps and his company.

In the United States it has become almost fashionable to cry down the Panama enterprise, and ridicule the efforts of the

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* From *The Scientific American*, New York, Oct. 8, 1887.

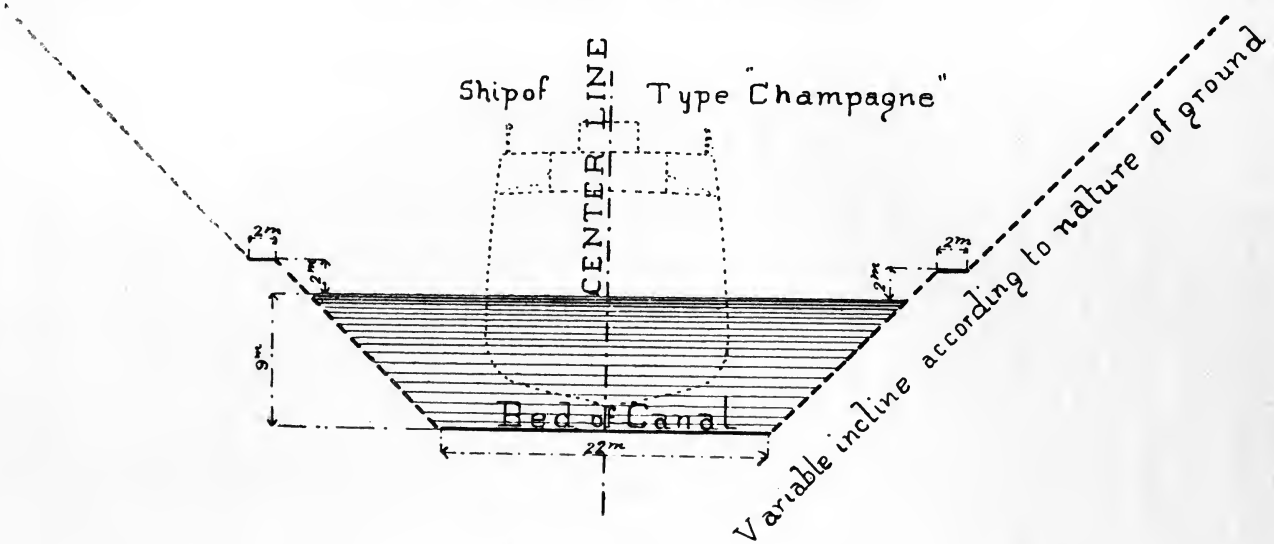
French company. It is hoped, however, that this small contribution to the already voluminous literature on the subject will not be taken as a blind indorsement of the many malicious adverse opinions heretofore rendered. It is only intended to be a compilation of the more important data affecting the success of the canal and a synopsis of the company's policy and management as observed on the isthmus and in Paris.

In spite of the indifference shown by Americans regarding the success of this special company, the interoceanic canal problem has nevertheless long been a subject of deep interest in the United States. For, although we have not as yet, to any great extent, actively participated in the construction of a canal, yet it is still fresh in the minds of the people that our government at one time expended a very considerable sum of money in reconnaissance surveys and preliminary work with a view to determining from an engineering, geographical, and economical point of view the most feasible route from the Atlantic to the Pacific. And when subsequently it appeared, as the result of careful estimates based on these accumulated data, that a sufficient amount of shipping could be relied upon to insure a volume of business for a canal through Central America to even justify an investment of at least double the amount of the cost of the Nicaragua route, the great attractions of a properly constructed canal to connect the two oceans by the most feasible line became manifest. At the same time our carefully and ably conducted investigations pointed strongly to the Nicaragua route as practically in all respects the preferable one. In the face of all this it is not surprising that the French company's choice of the Panama line should have incited a certain degree of adverse criticism and prophecies of disaster on the part of the Americans of the North. And now after quietly and patiently watching for six years the company's progress and prospects on the isthmus, the time is at hand when the nations pecuniarily and otherwise interested in the operations of the "Compagnie Universelle du Canal Interocéanique" are beginning to realize the correctness of the verdict of the United States scientists on the natural obstacles to the Panama route. At the same time it is becoming apparent that our exploratory engineering work, which showed the impracticability of the Colon-Panama line, was more thor-

oughly and intelligently executed, and the results more reliably made known to the public, than were the preliminary surveys and estimates of other countries.

At the so-called "International Congress," held in Paris in 1879, nominally for the purpose of discussing and deciding upon the best of the five projected canal routes submitted at that time, the Nicaragua route, after some comparatively superficial comment, was, with other plans, hastily set aside; and thereupon, in conformity with the wishes of Mr. De Lesseps, who substantially controlled the whole convention and framed its resolutions, it was finally decided: "That the cutting of an interoceanic canal at sea level was feasible; and that in order to secure the natural conditions essential to an undertaking of this character, it would be necessary to adopt the route from the Gulf of Limon to the Bay of Panama." More particular reasons for the choice of this line were stated on this occasion to be "the length of 45 miles," that would require but "one day for the passage." Following along in this impulsive, one-man policy, that may eventually culminate in serious reverses and disappointments to the De Lesseps following, as far as the dividend rate on the company's ultimate capital is concerned, came a long series of erratic announcements in the "Bulletin Interocéanique de Panama," the official organ of the company. Thus in the early "circulaires" and "bulletins" issued the management constantly proclaimed its ability to cut and complete the entire canal for 600 million frs., including expenses of every description and all fixed interest charges. For example, in an address by Mr. F. De Lesseps at the general meeting in January, 1881, we find, in his opinion, "the sum of 600 millions (frs.) will be required to open the Panama Canal to all classes of navigation." And in a February bulletin, 1884, by the same recognized authority, "The original estimate of the cost of the canal, namely, 1 milliard 70 millions (1,070,000,000 frs.), has been reduced to 850 millions; and upon the late arrival of contractors at Panama, the total cost has been still further reduced to 600 millions. The one hundred million cubic meters to be excavated will cost 500 millions, to which 100 millions are added for the *general expense account.*" About the same period a notice of similar import was circulated among the shareholders, by a large firm,

PROPOSED PROFILE



to whom had been assigned a considerable portion of the work, stating and indorsing that: "Mr. De Lesseps announces that eight years will be sufficient for the completion of the work, and that the estimate of 512 millions is considerably in excess of the real cost." Following these concise, business-like, official announcements, there appeared, about one year and a half later, in the bulletin of August, 1885, a report of the general meeting held in July, 1885, with the following extraordinary piece of incongruous news: "Contracts having been entered into providing for the completion of the canal to the bottom, we are now enabled to compute the further cost of finishing the same at 480 millions (frs.). This sum, added to the amount already spent, namely, 220 millions, gives 700 millions as the total cost of the canal on the opening day. To this figure must be added the expenses of administration and interest charges, to make up the total estimate of 1 milliard and 70 millions (frs.)."

The continued outpouring of dispatches of this character, proving the company's calculations and official reports to be inexcusably inaccurate, could not but give rise to much unfavorable criticism on the part of the United States, which the French attribute to jealousy. Already about 900 millions (frs.) have been sunk (realized from the marketing of various classes of securities whose aggregate face value is almost doubly as great), and, it may be said, without accomplishing much more than fairly starting the great work, now at the best not over one-fourth completed. Up to the end of December, 1885, the so-called *general expense account*, above referred to, amounted to something like 350,000,000 (frs.), and at this date cannot be far from the alarming sum of 500,000,000 (frs.). Furthermore, it is evident that should the company's operations continue for six or eight years longer, which would seem to be the least time required to finish the canal, these general expenses will swell to a sum closely approximating 1 milliard (1,000,000,000 frs.); because already they have reached the enormous sum of over 80 millions (frs.) annually and must continue to increase proportionately with the increase in the loan account, the limit of which is not yet in sight.

Some of the round sums of money which contribute *yearly* to swell this "*general expense account*" are interesting in the sig-

nificance they bear to the ultimate outcome of this system of financiering in the event of either a suspension of operations or a continuance of the actual work of construction beyond a certain limited number of years. They have been given to the public at various intervals through bulletins and annual reports, approximately as follows:

Interest on 250,000 bonds (5 per cent.)	6,235,000 frs.
Interest on 477,387 bonds (4 per cent.)	9,547,740 frs.
Interest on 600,000 shares of stock (6 per cent.)	18,000,000 frs.
Interest on 600,000 bonds (3 per cent.)	9,000,000 frs.
Interest on 458,302 bonds (6 per cent.)	13,764,000 frs.
Annual cost for services and miscellaneous acts	9,000,000 frs.
Central administration	1,500,000 frs.
Minimum local administration, Panama, (1,100 *salaried* employés in June, 1886)	10,000,000 frs.
For inspectors, engineers, opening new roads, repairs, hospitals, etc	3,000,000 frs.
General expense account	80,046,740 frs.

After the next loan or two shall have been placed, it is quite probable that the above general expenses will run closely to 100 millions yearly. Added to this account, it must be remembered, are the actual expenses of the machinery and the canal work proper—the excavations now under contract—which latter, together with the general expense account, make up the entire yearly outlay.

The total material to be removed in cutting the canal appeared in July, 1885, to be finally estimated at 128,000,000 cubic meters. By persons more familiar with the topography and surveys of the line than would be possible for one who has only paid four visits to the isthmus, it is claimed that this volume of 128 millions of cubic meters is a very considerable underestimate; and that in this figure, as in most others, a serious increase will eventually be met with. But however this may prove, the sad fact remains that, up to May 1, 1887, there had been excavated only a little over 36,000,000 cubic meters of the grand total Yet in the face of all these hard facts, which would appear to unavoidably retard the progress of the work, that sooner or later must come to the surface, it would appear that the company's policy has been to foster self-deception regarding the real state of affairs on the isthmus. In this connection we find in a September bulletin, 1886: "The work done per man per day now

exceeds 5 cubic meters." Then again, in a January bulletin, 1887: "The army of 12,000 to 15,000 laborers on the isthmus has the co-operation of machines representing an effective power equivalent to nearly 600,000 men."

It is surprising, in view of the transparency of these absurdly exaggerated dispatches, that their object of sustaining the company's credit should have been at all attained. The unsuspecting shareholder naturally concludes from such glowing accounts that the canal work is being vigorously pushed forward in accordance with the original assurances of the promoters, and quietly subscribes to new loans as fast as the opportunities are presented. His enthusiasm is too great and his mathematics too limited to reflect that, with "six hundred thousand men" handling "five cubic meters per man per day," the entire canal could be cut in less than two months. Again, the return to Paris of the Messrs. De Lesseps from Panama was the signal for some further authoritative utterances: and about this time we find an extract from one of Mr. De Lesseps' announcements published in the bulletins as follows:

"After having exhaustively studied all technical questions and examined every foot of ground along the line, I consider it within the bounds of truth to say that in 1887 the scale of the work as well as the amount accomplished will be three times as great (that is, more than 3,000,000 cubic meters per month)." As near as can be ascertained, however, this year's records do not show an average of much over 1,000,000 cubic meters per month.

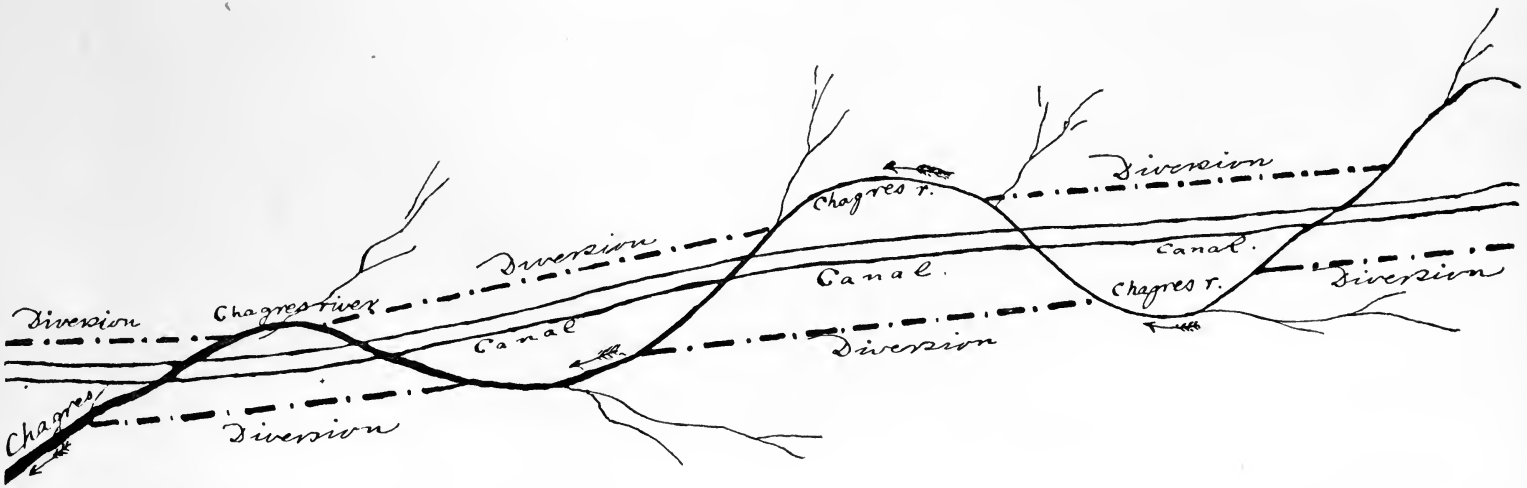
The rapidity of the work, generally speaking, is regulated by the labor supply and the ability of the local management, or the contractors, to gradually increase the working force, or at any rate to keep the same constant when once an adequate number of men has been secured. But their power to do this is in turn almost entirely dependent upon the ups and downs, the periods of relative salubrity and insalubrity, of the climate. The latter, without doubt, if not the greatest, is one of the most serious factors militating against the satisfactory, uniform progress of the work. With reference to this subject, about two years ago Mr. De Lesseps, with a promoter's enthusiasm, was published in the bulletin as stating: "The mortality is lower than in any

other excavations, not even excepting Europe." Notwithstanding, however, the opinion of one in a position to be familiar with the local climatic conditions, the incontestable fact remains that the canal happens to follow along one of the most unhealthy zones known on the planet, as proved by all statistics, personal observation, and in fact by the actual experiences of the company. Indeed, it is fully established that one of the first and greatest disappointments in the company's original calculations was the rapid doubling of the price of labor in consequence of the extra risks involved in living on the isthmus, particularly adjacent to the line workings; and now it has become so difficult to draw labor from Jamaica even at the advanced prices that it seems almost impossible to secure the adequate force for the rapid advancement of the work. In the rainy season the interruptions are incessant, while night work is hardly entertained. This climatic feature has proved a drawback to the Panama route, as far as the rapidity and cost of construction are concerned, little calculated upon originally; but already it has entered into the account, directly and indirectly, to the extent of many millions of pounds sterling.

This same fatal peculiarity of the narrow isthmus section in Colombia renders it difficult to see wherein lies the immense value of the company's land grant, already amounting to 500,000 hectares, gratuitously secured from the Colombian government in pursuance of a provision in the act of concession. Here again, in a May bulletin of this year, the vice-president, Mr. Charles De Lesseps, refers discreetly to the prospective value of the land, stating: "In addition to the revenue accruing from traffic, there are five hundred thousand hectares of land gratuitously granted by the Colombian government. How much these lands are worth I cannot determine; but what I do know is, that the lands at Port Said and Suez are worth from 100 to 120 frs. per meter." The Suez valuation here hinted at, applied to the Panama land grant, would lend a value to the latter of some 600,000,000,000 (600 milliard frs.). Even were this absurd comparison at all permissible, it would not indicate much of an asset, for it is plainly set forth in the Suez reports that the lands sold at Suez and Port Said in 1885 and 1886 collectively realized only about 670,000 frs. ($134,000).

But the threatening complications of the Panama company do not end with a diminution in the value of its land assets. Of far greater gravity are the old difficulties involved in the complicated *Chagres River diversions*, the *Gamboa regulating dam*, and the *great Culebra mountain cut.* On account of the numerous windings of the erratic Chagres across the path of the canal, as also owing to the heavy double drainage of the country on either side toward the river (the latter following with the canal practically the same synclinal axis), it has become necessary to provide two separate diversions for the respective river bends, together with the corresponding tributaries on either side of the canal. By this means it is expected to prevent the Chagres from running along the canal bed for long distances or from emptying into and repeatedly crossing the same back and forth. Thus in numerous places the work amounts to almost as much as three parallel canals, doubling, if not trebling, the cost of construction; and with all the occasional disturbances incident to the sudden freshets and rises so characteristic of this tropical region will probably not be fully eliminated.

Probably no division of this immense work of altering and regulating the natural drainage system of the isthmus remained longer obscured in uncertainty than the Gamboa dam, its feasibility, cost, and exact requirements. As early as November, 1883, it was announced through the bulletins in Paris that "the dam was very simple, and would cost eight millions." But in 1886, after some three years of pondering over its simplicity, less favorable reports began to appear; and, in a May bulletin of that year, the dam was announced to be "the greatest technical difficulty yet encountered." About this time, according to the company's annals, the estimates of the cost of this piece of work jumped from eight to forty, and then to one hundred millions (frs.). But now the plan is to control the drainage by the more extended system of Chagres diversions in process of excavation, which will materially reduce the enormous scale and cost of the dam as originally designed. Hence this piece of work and the Culebra cut are now looked upon as the most serious and costly divisions of the canal. With reference to the latter, at the general meeting in August, 1885, the Culebra mountain was qualified as "the culminating point and most knotty prob-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lem." But it was officially reported that notwithstanding the cut involved the removal of twenty-five millions of cubic meters, the contractors were "under agreement to finish the canal through Culebra mountain and open the same to all navigation by July 1, 1889." The February bulletin of 1887, however, showed plainly that of the twenty-five millions of cubic meters in the Culebra not much over two millions had been removed, leaving, according to the company's own statements, something like twenty-three millions yet to be handled in this job alone.

These and similar exaggerations directly from the management have inspired the frequent accusations of bad faith that have been made against the company. But notwithstanding the ambiguity and unwarranted favorable character of many official reports, it does not necessarily follow that the whole enterprise is a "barefaced swindle," as many have unjustly claimed. These sanguine reports are rather to be construed as an effort on the part of the directors to keep up the shareholders' spirits and sustain the company's credit. Having once embarked in so formidable an undertaking, and subsequently discovered that much larger sums of money would be required than originally anticipated, it is easily understood how difficult would be the task of protecting the shareholders' interests and floating new loans unaided by the infusion of a sanguine tone into reports from the seat of operations.

The work yet to be done may be roughly classified in the following six subdivisions:

1. The canal excavation proper; a *minimum* of say 90,000,000 cubic meters (in all probability greater), including something like 20,000,000 cubic meters falling to the Culebra section.
2. The completion of the Chagres diversions.
3. The Gamboa dam (on reduced scale).
4. The deviation of the Panama Railroad.
5. The turning out or passing basins.
6. The Atlantic and Pacific approaches and the canal entrances.
7. Numerous miscellaneous improvements, of secondary moment in point of cost as compared with the foregoing.

The magnitude of the Panama undertaking is so great, and the unforeseen contingencies arising to complicate and retard

the work have proven so numerous, with the probability in the future of at least a temporary suspension of the company's operations, owing to the difficulty in placing new loans, that it seems futile to presume to set a date for the inauguration of the canal. With the immense mechanical equipment and permanent improvements already paid for and in operation (valued at over 147,000,000 frs.), it would follow, theoretically, that in the future the work must progress more rapidly than in the first years of preparatory work. But this is the very point that has lately proved so delusive, for reasons already stated, although since the completion and working of the plant in all its branches along the line divisions, the work of excavation has become noticeably accelerated, though far from what had been expected.

With reference to the guesswork of determining the number of years that will still be required to finish the work, one formula is about as good as another under the existing circumstances. Perhaps as simple and safe a method as any (assuming the company's credit to hold out) is to reason that if in five years forty million cubic meters have been dug, it will take, on a basis of 90,000,000 cubic meters remaining to be cut,

$$\left(\frac{90,000,000}{40,000,000}\right)\times 5 \text{ years, less 40 per cent.}$$

The latter for the possible acceleration and increased efficiency of the work in the future over the past ratio. This would give about seven years more. A similar reasoning applied to ascertain the probable cost of the work gives something near 2,325,000,000 frs. as the total minimum cash cost and 3,750,000,000 frs. in various forms of securities as the total ultimate capitalization (capital stock plus bonded debt) of the concern. Up to 1887 the securities issued by the company represented a nominal value of 1,500,000,000 frs. (1½ milliard), that were marketed at rates which brought the treasury in cash about 930,000,000 frs.

It may be interesting here to recall the company's old figures, that show how far short were the most liberal calculations as to the amount of capital required.

Canal estimated to cost	1,070,000,000
The Panama Railroad purchase, about	94,000,000
	1,164,000,000
Now practically spent	930,000,000
Balance margin	Frs. 234,000,000

Should in reality at the expiration of five years (1892) the canal not be finished, as indicated by the facts here stated, serious legal, if not political, complications may arise with the Colombian government, involving the forfeiture of the company's grant and property. The act granting the concession provides that "The canal must be finished and thrown open for public service within 12 years from the date of the formation of the company that shall have as object the construction of the canal. But the executive power is authorized to grant an extension of six years in case of exigencies beyond human foresight."

As the shares of capital stock were issued in 1880, the work should be finished in or before 1892, or, with the extension, if secured, in or before 1898 at the outside. After either of these dates the Colombian government will have the right to force the law and declare the concession and the canal forfeited without indemnity, however near completion the work may be, to either finish it themselves or dispose of it to another company. In the event of such a fatal issue, the millions lost to France would fall most heavily on the small investors. It is principally this thrifty class of the great French public that has with unparalleled loyalty backed Mr. De Lesseps in his Panama scheme; and it is difficult to conceive how deep-seated and long of duration would be the depression and mistrust in new undertakings that would follow so sad a failure of the present canal company. Should, however, at such a crisis, the French people show the same admirable perseverance and fortitude that have characterized their liberal investments thus far, notwithstanding the increase in the amount of money required, it is quite possible, and sincerely to be hoped, that, after a scaling down of the capital and obligations of the old company, a liberal extension of time may be secured, and the government step in and complete the work of connecting the two oceans on a financial basis that will at least bring a fair return to a portion of the nation's good money.

This consideration suggests the all-important question of the earning power or incoming value of the canal and the equivalent average interest on the invested capital that may be looked for when the work shall have been completed and the highway opened to the world. The point of momentous interest in financial circles is: Will the traffic be sufficiently large at the

proposed tariff rate (15 frs. per ton) to yield a revenue that, after deduction of the expenses of maintenance and preservation (presumably unusually heavy, owing to the peculiarities of the climate), will still leave a fair interest on the total nominal capital? Officials in high standing at Panama speak confidently of an annual traffic of 10,000,000 tons, at 15 frs. per ton. And this appears to be the accepted basis for the argument that even if the capital swells eventually to 4,000,000,000 frs. (4 milliards), the gross income will amount to 150,000,000 frs. or $3\frac{3}{4}$ per cent. (without allowance for running expenses, to be deducted herefrom). The more exact figures are embodied in one of the recent official reports of Senor Nicolas Tanco Armero, canal commissioner for the Colombian government, as follows: "The committee on statistics of the International Congress calculates the tonnage that will pass the canal in 1889 (!!) at something less than 7,000,000 tons. But in my later calculations, taking into account the growth of commerce, the sum total comes nearer 9,000,000 than 7,000,000 tons, as is evident from the following abstract from the official statistical table published in England:

From Europe to American Pacific ports:	
England	1,426,852
France	573,922
Germany	360,000
From other European countries to American Pacific ports	210,000
Total	Tons 2,570,774
European trade with Australia, Oceanica, Philippines, etc., that will pass the Panama Canal	2,696,754
United States trade, excepting from San Francisco, with the same places, and also India, China, and Japan	1,619,440
From the United States, Western coast, with the Eastern section, for Europe and Eastern American States	1,500,000
Actual traffic per R.R. from Colon to Panama and *vice versa*	262,497
Total tonnage ready for canal first year	8,649,465

"Moreover, a few years hence, when the canal shall be opened to commerce, the available annual tonnage will have reached 12,000,000 to 15,000,000 tons." (!!) The bulletin of the com-

pany attempts to give more accurate figures regarding certain divisions of the traffic when it states that the trade from Antwerp that would have passed the canal in 1886, had the same been finished, may be taken at:

Peru	46,635 tons.
Bolivia	5,919 "
Chili	42,046 "
Australia	58,046 "
	152,646 "

Furthermore, in the same year the trade between Antwerp and the United States rose to 1,029,037 tons, of which 100,000 tons fell to American Pacific ports. Hence 250,000 tons are a more accurate estimate of this particular line ot traffic, included in the foregoing large and more general estimate of Mr. N. T. Armero.

By the very complicated nature of the subtile changes in the relations of navigation and commerce bound to be called into existence by the shorter lines of transportation that will follow the opening of the canal, the element of conjecture must necessarily enter largely into all attempts to solve mathematically this all-important traffic problem. But, to say the least in opposition to the canal company's figures, it is difficult to conceive how so high a rate as 15 frs. per ton can be consistently maintained at Panama, if the canal intends to monopolize the Australian trade, while at Suez the average rate is now about 10 frs. per ton. Then, too, in the matter of tonnage, everything indicates that a considerable reduction in the foregoing figures will, in all probability, be met with; for it should be remembered that the traffic at Suez after some fifteen years grew only to 5,767,656 tons in 1886, notwithstanding all brilliant predictions of a much larger volume of business. The Suez report for 1886 records 3,100 vessels, 5,767,656 tons, from which the receipts were 54,771,076 frs. Added to this are receipts from passenger traffic amounting to 1,714,115 frs., and revenue from miscellaneous sources of 313,093 frs., making the total gross income 56,798,285 frs. for 1886.

The economy in the principal lines of transportation to be afforded by the canal, expressed in "milles marins" of 1,852 meters, is compiled from official sources as follows:

	Via Cape Horn.	Via the Canal.	Economy of Distance.
London to San Francisco	13,795	8,135	5,660
London to Honolulu	13,915	9,556	4,359
Liverpool to San Francisco	13,678	7,897	5,781
Le Havre to San Francisco	13,627	7,949	5,678
Bordeaux to Valparaiso	8,675	7,239	1,436
New York to Valparaiso	8,550	4,574	3,976
New York to Panama	11,057	1,966	9,091
New York to Callao	9,791	2,333	6,488
New York to Guayaquil	10,441	2,808	7,633
New York to San Francisco	13,334	5,257	8,077

A not over-conservative weighing of the available statistics bearing on these points, leaving out of account a probable competition at Nicaragua in the near future, would indicate that in any event the Panama traffic at the start will fall considerably below present anticipations; while the 15 frs. rate appears too exorbitant to command the anticipated volume of business. Is it not more probable that the traffic will be about 5 million tons at say 10 frs. a ton, making 50,000,000 frs. as the revenue for the first year; *i. e.*, about 1½ per cent. on the probable cost of the canal?

Notwithstanding all rumors to the contrary, the work of excavation is being prosecuted at more points and with a larger working force than has generally been acknowledged in the United States. As the work is now almost entirely under contract, it is extremely difficult to ascertain accurately the number of men actually employed. The management claim between 15,000 and 18,000 men, while special contractors do not estimate less than 10,000. Under the efficient management of Mr. Pioch the company is learning at last to conduct its operations with economy; and the sums of money now spent are accomplishing relatively more than ever before. Setbacks are still caused occasionally by land slips, particularly in the rainy season. But the Culebra mountain is not "traveling into the canal on a bed of quicksand." Nor is the bottom of the canal, through some unheard-of tropical phenomenon, rising up even with the old surface of the ground.

The conclusion is, therefore, that while the canal can be built and operated with sufficient money, as far as overcoming all engineering difficulties is concerned, yet in the hands of the pres-

ent corporation, and owing mainly to the impracticability of the route, the enterprise has become handicapped in its infancy with an ever-increasing financial load, already of such formidable proportions as to threaten its credit and foreshadow a failure from a business point of view.

Not the least interesting in a detailed criticism of the company's internal affairs would be the unraveling of the contracts, sub-contracts, promoters' and others' commission interests that have swallowed up the large sums of money at Panama and in Paris. But this information is, of course, inaccessible to outsiders. Indeed, much of the complicated network of letting, subletting, checking, and settling of contracts on the line will probably never be generally known, even to the insiders. It is said that according to the original agreements, the promoters are to be allowed 15 per cent. of the net profits of the canal. For the convenience of allotment and transactions among the numerous participants in this promoting commission, the interest was split into 9,000 shares; and these shares are reported to have sold once as high as 10,000 frs. apiece, and were quoted as late as May, 1887, at 3,000 frs. The latter price values the entire interest at 27,000,000 frs., while at 10,000 frs. a share (the highest price) the valuation was 90,000,000 frs.

May the Panama Canal, contrary to all present indications, and the general opinion in the United States, turn out to be a happy disappointment and an unexpected bonanza to the French people. May its credit be preserved, may it be finished with less money and in less time, and may the undertaking bring in greater returns to the original investors, than now appears probable, thus once more defeating the skeptical and scoring another victory at Panama for De Lesseps only second to his well-earned triumph at Suez. No ultimate result less auspicious will gratify the well-wishes of all who appreciate the vastness of the undertaking.

II.

THE LAKE OF TITICACA, SOUTH AMERICA.*

A journal of South American travel would hardly be complete without a chapter on the famous Lake of Titicaca, which is spread out over widely extended table-lands, at a great elevation in the heart of the Andes.

At this latitude, the boundary line between Bolivia and Peru, the Andes are divided into the Eastern and the Western Cordillera, between which ranges the great plateaux are expanded to the enormous width of about two hundred miles. This depression, hanging gracefully between the two cordilleras, has an oval shape, and with an average width of one hundred miles, its area is about 15,000 square miles, forming one of the most remarkable terrestrial basins in the world. It appears to be of volcanic origin; blocks of lava are scattered along the shores of the lake, while igneous rocks are noticeable traversing the sedimentary strata.

The marvelous picturesqueness of the region, together with the signs of cultivation, furrowed plains, terraced hill-sides, and the numerous ancient relics of an historic civilization that are met with around the lake, upon arrival at Puno on its western shore, are refreshing in contrast with the dreary railroad journey of over two hundred miles from Arequipa, Peru, through a desolate, silent, barren, ashy waste, where the tired traveler pants for breath in chilly altitudes, rising from 8,000 to 15,000 feet above the Pacific Ocean, in full view of the gray volcanic domes of Misti, Urvinas, and Chichani.

Titicaca is an Aymará word, and by some historians is translated catrock; according to other writers, *Titi* signifies lead, and *caca* a chain of mountains. The exact elevation of the lake

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* From *The Engineering and Mining Journal*, New York, Oct. 9, 1886.

above the Pacific Ocean is given at 12,516 feet, according to railroad surveys made from Mollendo, on the coast, to Puno. With an area approximated at 4,000 square miles, it is about 100 miles long, and averages 25 miles in width.

During the rainy season, from December to April, the lake rises about five feet; and during the dry season, when it sinks to the lowest level, the principal influx of water comes from the ranges of perpetual snow on the eastern shore. Of more than twenty different streams that flow into the basin, the main feeders are the Azangaro, the Maravillas, and the Ramis—the latter rising near the source of a tributary to the Ucayali.

The Titicaca is partially drained by the Rio Desaguadero, which is the only known outlet; and after pursuing a southerly course for, more or less, seventy-five leagues, the river spreads over the marshy flats of Pampas Aullagas, where the waters disappear through absorption and evaporation, there being no flow either toward the Atlantic or the Pacific Ocean. The Indians believe the lake to be in subterranean connection, under the cordillera, with the Pacific Ocean, because of the finding on the coast near Cobija of a certain kind of lake-rush peculiar to Titicaca, differing essentially from salt-water weeds.

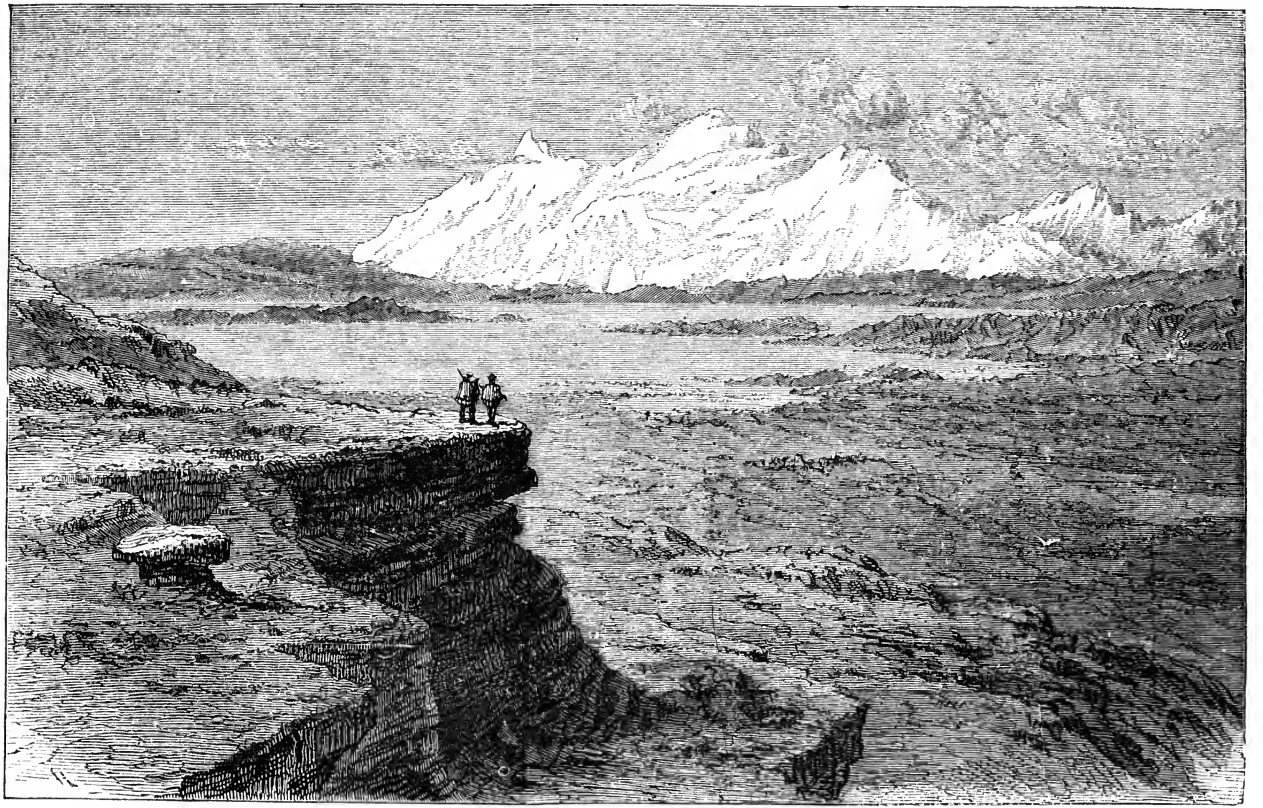
Although the basin is gradually filling up from the masses of soil and sediment, which are washed down its steep, barren banks, void of vegetation, tending to raise the water-line, nevertheless the surface of the lake is slowly but surely sinking. The meteorological conditions are such that the evaporation during the dry season and the precipitation throughout the rainy months are no longer equipoised, and the area of the lake is, in consequence, steadily shrinking. As far back as three centuries, the sparkling waters of Titicaca dashed against the ancient monuments of Tiahuánaco, standing to-day twelve miles away from the shore, and at an elevation of 130 feet above the surface of the water. But still it is by far the largest lake in South America, being about half the size of Lake Ontario, and the largest on the globe at so great an altitude.

The scenery is not of that miniature type characteristic, for example, of the Kœnig's See in Europe or of the Red Fish Lakes in Idaho; but the attractions of Titicaca consist in its vast expanse and magnificent Andean scale of nature's produc-

tions, combined with the poetry of prehistoric art. Looking across its crystal-clear waters over into Bolivia to the east, the snow-capped mountains of the Cordillera Real are seen rolling across the horizon like a succession of foamy waves—the loftiest mountains on the American continent. Here rise in majestic splendor the Nevado de Sorata and the Illimani, two groups of serrated snow peaks, fringed with glaciers, towering up to heights closely approaching 22,000 feet.

A scattering of beautiful islands is among the charms of this interesting sheet of fresh water. Of these, the island of Titicaca is full of historic associations and the home of many an Indian tradition. The narrow, winding passages formed by the islands and the mainland, where the blue water is deep and transparent, together with the monolithic monuments and ruins sprinkled over this classic soil of the Incas, lend a fairylike fascination to the scene.

The shores are dotted with the dingy, dusty huts of the Aymarás, whose past history is far more interesting than their present. Attired in sombre garb, with a silent, sullen disposition, reflecting nature's condition at this altitude and latitude, this strange tribe move about as if mourning their deterioration and fall from ancestral glories. They are indolent and poor; their occupation consisting in the cultivation of rice, potatoes, and barley. Along the shores of the shoaly coves, the Indians gather the lake-rush, which they suck the juice from or make into salad. This rush, which grows about seven feet high, in places so thick as to appear like a meadow, is known as *totora*. In this bleak, mountainous region, where timber is unknown, its stalk takes the place of iron, wood, and canvas. Besides being used to make boats (*balsas*), mats, sails, houses, and beds, this bayonet-shaped rush, it is said, was formerly woven into bridges by the Incas and Aymarás, over which whole armies were passed. But now the Aymarás spend their time chiefly in attending the numerous feasts and religious exercises, a national characteristic, amid the jingling of church-bells from dilapidated cathedral towers and the wild din of Indian music. The dances on these occasions are unique in their grotesqueness. To witness the droll reels at an Aymará *fiesta*, after suddenly awakening from meditations upon the grandeur of South American landscape, is



LAKE TITICACA AND THE SORATA.

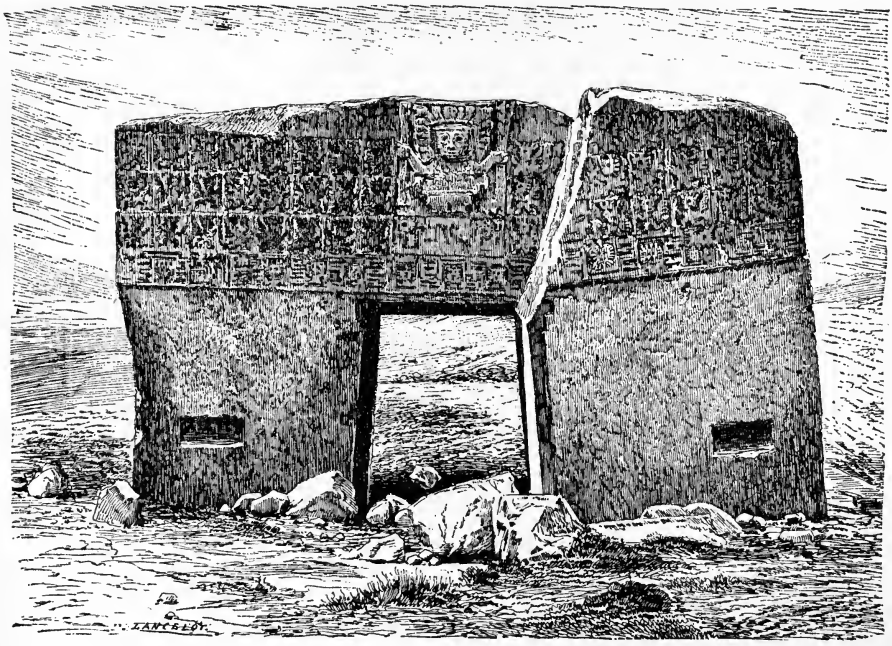
to fall from the sublime to the ridiculous. On these carnival days, the Indians wear the most fantastic costumes, showing, however, a decided preference for bright colors. In appearance they might be compared to a high order of scarecrows; and to see a procession of them rushing out of the church in wild confusion and rallying, with an image of their patron saint, for a grand *finale*, after a day of intoxicating revelry, is to be forcibly reminded of an insane asylum let loose. The favorite sport consists of a kind of tournament, in imitation of a Spanish bull-fight, that is carried on for hours at a time in all possible phases. They equip themselves with the heads, horns, and hides of cows, which are to be had at Puno, and, after drying them in the sun, they are suspended by their belts, and then, probably for propriety's sake, the animal is clad in skirts that hang modestly to the ground. Some play the *toros*, while others impersonate the *toreros* and *matadores*, and the whole population turns out on the *plaza*, to pay homage to the celebration. Throughout the greater part of these exercises, the Indians, old and young, are very grave and serious. A funereal solemnity reigns supreme, and no revelry is indulged in until they become too intoxicated to follow the leading chief in proper order.

The dress, manners, and general appearance of the Aymarás are about the same as those of the Quichua tribe. The women, however, are more thickly set, better looking, and apparently in a more cheerful frame of mind than the Quichuas.

Altogether, the lake region is healthy, and there appears to be but very little sickness. As night draws on, the cool winds sweep rapidly through the gorges and ravines of the great mountain ranges, oftentimes with the speed of a whirlwind, running the dust up into columns of immense height, and drawing up the water from the surface of the white-capped lake in spouts almost equally high.

At Puno, a Peruvian city of 5,000 inhabitants, the nights are often bitterly cold; and as llama-dung and *tola*, a variety of moss, are the only fuels in the land, the luxury of warm hearths is unknown. Early in the evening, the people wrap themselves in shawls and cloaks, or go to bed for comfort. The region adjacent to Titicaca supports a population of more than one million. Puno, the largest town, is mostly inhabited by Aymarás, although

there are a few Quichuas who form a set by themselves. The city owes its origin to the silver mines of Cancharani, in the neighboring hills, which are now comparatively abandoned, although claimed by some not to be exhausted. All the dwelling-houses are built of adobe, and are very low and uncomfortable; but the city boasts of a cathedral that dates back to 1757, a university (so-called), and several schools. It is the central point



MONOLITHIC GATEWAY AT TIAHUANACO.

for the alpaca industry; cocoa is also largely traded in, while sheep's wool and vicuña robes are among the chief exports.

The lake, which is the natural highway between Peru and Bolivia, is navigated by two small 100-ton steamers, which were transported from the coast over the mountains in sections, under great difficulties and at an expense far exceeding their cost. Steam is got up with llama-dung as the sole fuel, and the trip across to Chililaya, in Bolivia, is made in about twenty hours.

Among the intermediate places of exceptional interest, at

which the steamer touches during this memorable passage, the church of Copacabana deserves especial notice. This quaint old church of semi-cathedral, semi-monastic appearance, is to this section of South America in reputation and ecclesiastical importance, what Notre Dame is to France. It contains the famous *milagrosisima virgencita*, or little miraculous virgin, and, although the edifice has no definite style of architecture, but in detail is a combination of Doric, Corinthian, and Spanish Renaissance, it is nevertheless graceful and most picturesquely situated. Its high walls inclose a rare collection of precious jewels and choice gifts, valued at many millions, which have been offered up as grateful tributes to the supernatural powers and astounding miracles of the Virgin. At stated periods, great multitudes come from all parts of Bolivia, and assemble before the sacred shrines of Capacabana, to supplicate spiritual and not unlikely material blessings. It is a fact strange, but none the less true, that the most acceptable and favored prayers are said to be those of the women imploring deliverance from sterility; for it is well known that in these elevated barren regions and in this rarefied atmosphere of the Andes, people do not multiply in anything like the same proportion as the population of the deep, fertile valleys, surrounded by a greater amount of vegetable life and a more normal atmospheric pressure. And it is the ability to happily reverse this natural law that is claimed as the immaculate accomplishment of the *milagrosisima virgencita*. It has been irreverently suggested, however, by modern scientists of deep penetration, that the credit of effectually alleviating this affection is possibly more justly due to the altogether terrestrial supplications of the priesthood of Capacabana than to the more celestial influences of the *virgencita!*

The environs of this romantic and religious spot are strewn with the art relics of imperial Inca glories. These architectural and sculptural relics on the borders of Lake Titicaca are frequently cited by scholars as representative examples of what is called prehistoric art, by which we understand all art forms, irrespective of chronological order, that show human faculty at its best in this domain, before it has been touched by civilization. The extinct tribes that once inhabited this wild region have left to the world a museum of most interesting relics in

THE AYMARÁS AND QUICHUAS OF LAKE TITICACA IN BULL-FIGHT PARADE.

this important field of knowledge, whose lights are few and dim. Indeed, according to Humboldt and others, these innumerable abandoned towns, gigantic monuments, remnants of public works, and scattered cemeteries indicate that the basin of Titicaca was once the seat of probably the highest and most ancient civilization on the South American continent, whose vast population, forming an empire greater than that of Charlemagne, swarmed over the land and has left behind in these stone remains of hoariest antiquity, the evidences of superior power and skill.

According to tradition, the region of Titicaca was not only the home of the Inca race, but also of the great Peruvian law-giver, Manco-Capac, who diffused his influence throughout the land. An appreciation of the remoteness of this era may be had when it is remembered that the ancient Peruvians had only the vaguest ideas concerning the ruined edifices of Titicaca; and furthermore, that the eminence supporting the ruins of Tiahuánaco, today twelve miles from the lake and considerably over 100 feet above its surface, was formerly a beautiful island in the midst of deep water. This fact, coming so nearly within the historical period, and on that account of unusual geological interest, warrants the belief that the art-relics of Titicaca antedate all others known on the American continent. Authorities hold that the ruins of this desert island bear the same relation to the aboriginal monuments of South America as do those of Palenque to the old remains of the Central and North American continent. They indicate a much higher order of artistic attainment than existed anywhere in South America at the time of the Spanish conquests. They tell us the story of brave races of men, struggling after higher conditions; and their weird forms stand in the wilderness like the skeletons of prophets who looked far down the track of the centuries and foretold a better time. They are indeed achievements of intellect worthy to be commemorated in history.

III.

A SKETCH OF THE BOLIVIAN REPUBLIC, SOUTH AMERICA.*

The republic of Bolivia came into existence in 1825, the year of the Declaration of Independence of the region formerly known as Upper Peru. With an area of 450,000 square miles, about twice the size of Germany, more than double that of California, and more than four times the area of Colorado, the republic comprises the lofty plateaux of the Andes, including half of the basin of Lake Titicaca, 12,505 feet in altitude, the old province of Charcas, and a vast Amazonian region.

These sections of country lie mainly to the east of the Andes, where Bolivia's greatest length is 1,000 miles near the 68th meridian, and her greatest breadth about 700 miles.

The climate, in general, is healthy, and, with the exception of *terciana*, the much-dreaded fevers prevalent on the Isthmus of Panama, in Venezuela, Eucador, and Peru are unknown. For although nearly the whole of the republic is situated within the tropics, not more than two-thirds of her surface possess a tropical climate. The remaining area is occupied by high mountain ranges and valleys, table-lands of great elevation, and widely extended slopes, where it is cold and dry, with a clear atmosphere, similar to the higher portions of Colorado or North Germany in the autumn; while beyond the Cordillera, in the lower regions of the interior, it is disagreeably warm in the daytime and cool at night, in which localities malarial fevers are common during the rainy season.

The aggregate population numbers about 2,000,000, and is composed largely of the Quichua and Aymará Indians, the

* From *The Engineering and Mining Journal*, New York, Sept. 25 and Oct. 2, 1886.

former being direct descendants of the Incas. Their proportionate division is—

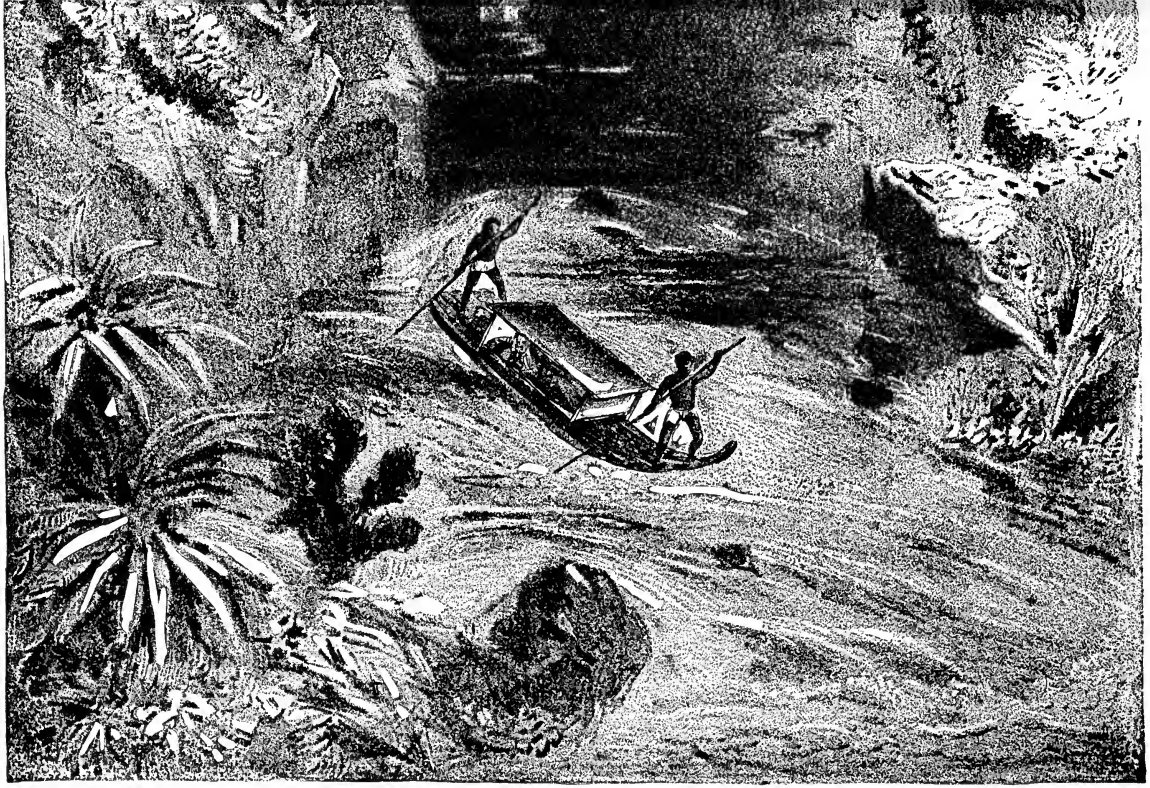
Quichuas	50	per cent.
Aymarás	25	"
Cholos (a Spanish and Indian mixture)	18	"
Whites and half-castes	7	"

Those constituting the Indian element are of medium size, massive build, thick-set and broad-shouldered, with the body relatively long, the legs short, the feet small, and the face beardless, with features frequently quite good.

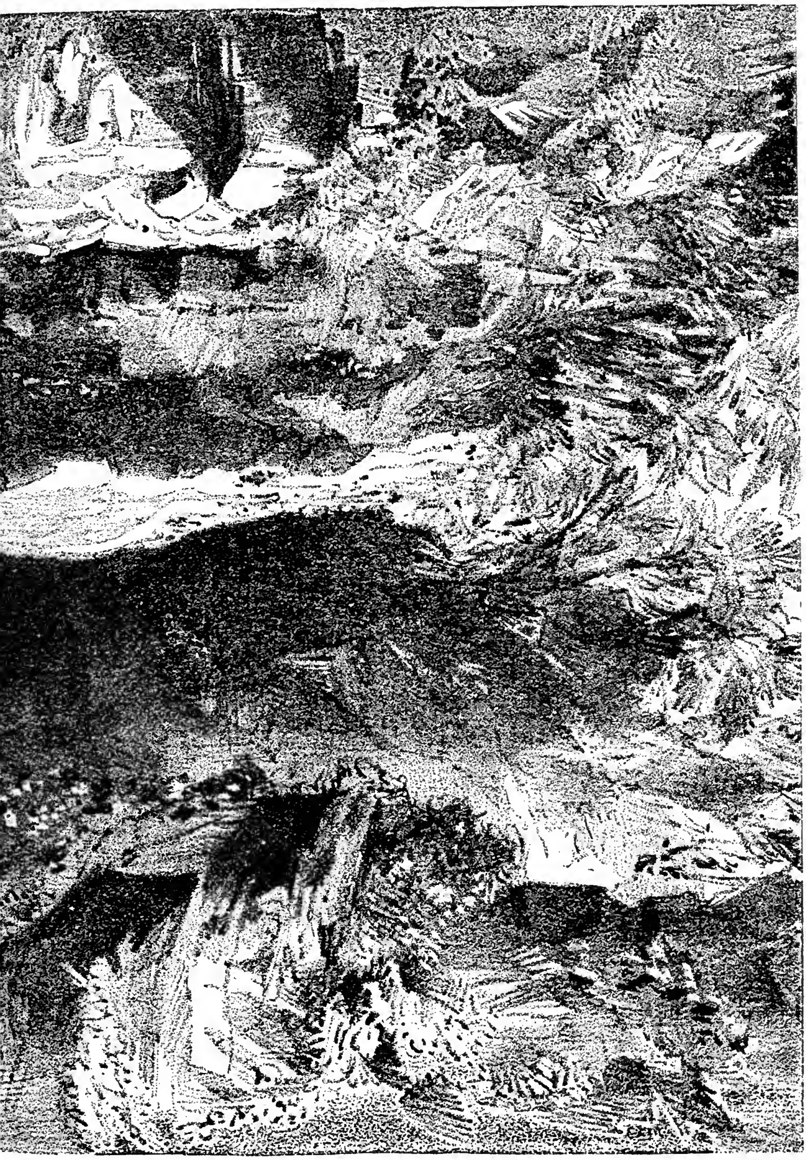
Their aliment is almost entirely vegetarian, consisting of *chuño* (frozen, soaked, and dried potatoes), corn (either boiled or roasted), and *chalona* (dried mutton). In addition to these articles of food, the better-to-do families consume, occasionally and in small quantities, rice, boiled plantains, coffee, cocoa, and pork—a diet that would hardly sustain any other race under similar climatic conditions and occupations.

The Bolivian Indian is a remarkable pedestrian, with legs and lungs of unusual strength and extraordinary powers of endurance. He will walk for weeks at the rate of 10 leagues or 30 miles per day, playing a reed fife and carrying on his back a weight of 100 pounds, consisting of a *carga* of from 75 to 80 pounds, and from 20 to 25 pounds of coca leaves, corn, and blankets, for his personal requirements *en route*. He endures surprising fatigue, nourished solely by small quantities of parched corn and coca leaves. In fact, by chewing the latter alone, the Indians are able to travel for days together dispensing with food and sleep, as the coca leaf is not merely a strong stimulant but also nutritious. For instance, the mail-carrier leaves La Paz on Thursday, and arrives in Sorata, ninety miles distant, on Saturday in time for distribution the same evening; and *propios*, or messengers, make the round trip of 180 miles in four days, receiving therefor wages at the rate of one boliviano (73 cents United States currency) a day. When resting during these long tramps, they have a habit of elevating their feet above their heads, the only national progressiveness I noticed that compares with Yankee invention.

The character, temperament, and habits of life of the Bolivian tribes are among the most interesting subjects for close



THE CAÑON OF THE TIPUANI : BOLIVIAN BALSA NAVIGATION.



study in South American travel. They are strong, bold, stubborn, serious, and reserved, yet harmless, submissive, generous, suspicious, and intensely superstitious. With a contented, unambitious disposition, they have few wants, a love for strong, intoxicating drinks being the only general vice. And, notwithstanding a large fraction of the year is spent in grotesque, carnival-like *fiestas*, none of which is without religious import, they wear a silent, sad, serious expression, everything about their apparel and manners having the same melancholy cast.

The Roman Catholic faith is professed, but in reality their religion is the old form of Inca worship, somewhat modified by the worst kind of Romanism. Not the least interesting of their peculiar ceremonies is the sad but none the less festive funeral—a procession composed of loud-lamenting, drunken mourners, headed by sprinklers of holy water, continuing a coarse revelry long after the corpse is laid away, as a sympathetic tribute to the departed spirit.

Travel in Bolivia is comparatively safe; for the Indians are not dangerous, and although the last trace of maliciousness toward the Spanish race has not entirely disappeared, they are grave and deferential to *caballeros*. A warm-hearted politeness, sincerity, and hospitality are among the national traits; and while there is dishonesty in small things, merchandise, money, and bullion are safely carried all over the country by unarmed, reliable muleteers, without heavy expenses for inadequate security.

This strange and interesting race lives in villages called *comunidades*, under a governor or *alcalde*, who is one of their number. They pay a tribute of from four to ten Bolivian dollars a year, those of age who can read and write, however, being exempt from payment and admitted to the ballot.

On the 25th of May, 1826, the first Bolivian Congress was installed at Chuquisaca. The constitution framed was by Bolivar, and, in conformity therewith, General Sucre was elected as first president of the republic. During the intervening years, she has had her share of tyrannical presidents, who have traded upon their official power for private gain and left behind the records of deceitful, jobbing careers. But fortunately there have been numerous exceptions, and among the men of talent

and education whose administrations have been marked with integrity and patriotic aims may be mentioned, besides General Sucre, Santa Cruz, Dr. Linares, Dr. Frias, Adolpho Ballivian, Señor Campero, and the present President, Gregorio Pacheco, whose recent election is regarded with general satisfaction, the feeling prevailing that the prosperity of the country cannot but increase, governed by so able and honorable a man.

The complications attending the late war between Peru and Chili have deprived Bolivia of coast and sea-ports, and likewise the great wealth of saltpetre and guano in the districts of Cobija and Tarapaca has been forfeited to the growing power of Chili. The exact course of a portion of her southern limit, separating the Bolivian from the Argentine Republic, has likewise been for some time in question. Hence, the main outlets for Bolivian trade are through Chilian, Peruvian, and Argentine territory. The most accessible port of the former is Arica, which involves a long and tedious land transit of two hundred and forty miles from La Paz to Tacna, which is in railroad connection with Arica—a distance of 40 miles. The traffic over this route, however, has of late years become reduced to the transportation of a portion of the mining products from the Department of Oruro, and to the mule-post from La Paz to Tacna, regularly performed in five days, while the great bulk of trade from the La Paz District is by steamer across Lake Titicaca, and through Peru via the Puno-Arequipa Railroad to Mollendo.

The third and longer route is southwesterly through the Argentine Republic to Buenos Ayres, and in pursuance of an existing treaty, whereby Bolivia reduces the import duty 50 per cent. on goods coming from the Atlantic, against the Argentine Republic, granting gratuitous right of egress through her territory, the larger part of the productions of the departments of Potosi, Chuquisaca, and Tarija, consisting almost entirely of minerals and metals, is drained through the Argentine in preference to Chili.

This shifting of trade from the Pacific to the Atlantic Ocean, and the consequent decrease of business on the former coast, promoted in a large measure by political spite, has been felt so keenly that a new impetus is imparted to the project of putting La Paz in railroad connection with the coast, the line running

through Oruro to Tacna, thereby recovering and controlling the entire trade from the Pacific side.

Besides La Paz and Oruro, Bolivia's leading cities and towns are Cochabamba, Sucre (the capital), Potosi, Tupiza, Santa Cruz, Trinidad, Tarija, Sorata, Corocoro, Belechuco, and Apolo—the copper of Corocoro, the silver of Potosi, and the gold of Tipuani being among her famous diversity of mineral deposits.

The republic contains toward the centre vast tropical forests of prolific vegetation, watered almost to an excess of fertility by a wide system of navigable rivers. The head-water tributaries to the Caca, Beni, and Madeira rivers, belonging to this system, have their sources in the extensive watershed lying on the eastern declivity of the Cordillera. These narrow, rapid rivers carry down the gold from the eastern spurs and foot-hills of the Andes, of which the Rio de Tipuani is the most celebrated for its placer mines.

This section of country is most picturesque and romantic. Looking into a clear blue sky above the cool shady gorges, where high precipitous walls pass over into steep mountain slopes, the floral boughs draped with fragrant orchids, ferns, tillandcias, and cactuses are seen drooping together from opposite sides, forming hanging-gardens in a natural Gothic arcade of ideal beauty. The hills and valleys are lined with forests of the greatest exuberance and variety of vegetation, whose tropical drapery droops into the rivers amid a brilliant profusion of feathery, fanlike foliage, the branches being often so closely interwoven and vailed with twiners that they appear like green walls shutting in the streams.

These comparatively unexplored virgin lands, shaded by a bewildering diversity of grand and beautiful trees, draped, festooned, and ribboned with an endless variety of creeping and climbing plants, yield, besides the most delicious fruits, the best coffee and chocolate in the world, of which hundreds of tons decay on the bushes every year, only a small amount being gathered for export. Amid luxuriant flora, of which the broad-leaved palms, bananas, and ferns form the most striking feature, more than sixty kinds of rare cabinet wood stand untouched in these immense forests. Also sugar-canes, cotton, and *gomales* (rubber trees) grow in abundance, but as yet only the latter two

have been turned to profit. While farther toward the interior, the plains extending over into Brazil to the east are covered with vast herds of cattle, millions of sheep, alpacas, llamas, and vicuñas roam over the high lands and lofty ranges in the western section of the republic.

The most important pursuit in the tropical or lowland districts, which has developed into a permanent industry, is the cutting and exportation of cinchona or calisaya bark, notably the richest in quinine, producing the purest and most efficacious fever antidote in the world. But of late years, the most accessible trees having become exhausted, the bark is no longer derived from the forests, and the business has merged into a systematic, scientific cultivation in plantation form. The credit of bringing this nursery culture to a very high degree of perfection is largely due to Mr. Otto Richter, who, besides being otherwise largely interested in Bolivia, is the leading bark merchant, his four *haciendas* or *quinales* in the Mapiri District, namely, Jarandillani, Bella Vista, San Agustin, and Santa Rosa, having grown already over 2,000,000 trees.

The bark business, however, has become very much depressed of late years, on account of the exceedingly low price to which quinine has steadily fallen.

Not of less importance are the coca plantations, from the leaves of which plants the mysterious cocaine is extracted. The great progress made in modern medicine in the use of this drug, not only in various medicinal forms, but also as an anæsthetic in severe surgical operations (concerning which subject there is probably no greater authority than Dr. J. Leonard Corning, of New York City, whose recent experiments, discoveries, and writings are well known to the medical profession), has created a demand for coca leaves that has lent no small impetus to the South American coca industry.

The plant only flourishes in moist climates, and is seldom found in the deep valleys of the Andes. It is cultivated in rows like maize; and after two years' growth, the bush attains its full height of from five to six feet, bearing green leaves about two inches long, with white blossoms and red berries. The leaves are gathered several times a year, and dried in the sun with great care before being packed for exportation. The bushes

produce for many years, when finally the planting of a fresh crop becomes necessary to preserve the good quality of the leaf.

Besides its local use by the Indians, who masticate it with or without slacked lime, a tea is made from the plant, and the miners also chew the leaf constantly for the soothing effect it produces. These sources of home consumption in themselves sustain many extensive plantation enterprises.

The development of Bolivia's mineral resources may well be claimed to be the most important of her national industries; for included in her prodigious mineral wealth, which numerous documents in European libraries prove to have influenced the political and monetary history not only of Spain, but of the entire commercial world, there are many gold, silver, copper, and tin ores, whose extraordinary richness gives a large profit margin, in spite of the excessive freight costs.

The name and fabulous riches of Potosi are familiar to every one. Its discovery in 1544 is among the oldest mineral records, and the products up to 1572 amounted to $250,000,000; from 1572 to 1627, $340,000,000; from the middle of the seventeenth to the eighteenth century, the records of Potosi show an annual average production of from $2,500,000 to $3,500,000; and, according to data contained in letters written to the king of Spain in 1627, the compilations of Friar Joseph G. De Acosta, and the Annals of Potosi, the Cerro Rico de Potosi or Rich Silver Mountain, has produced up to the present time upward of £400,000,000 sterling of silver.

Prior to 1825, the industry was erratic, and mining operations were frequently paralyzed by political troubles. Among the earliest interferences was the civil war in Spain in 1623, which extended to Potosi, causing abandonment and ruin. The war of independence in 1809, ending with the peace declaration of 1825, caused another suspension in mining and a general impoverishment of the country. Since the independence of the republic, however, mining enterprises have never been disturbed through political causes, and the irregularities occasioned by revolutionary movements have not extended to the mining regions or caused injury to corporations. On the contrary, the production of precious metals has never ceased to be encouraged and fostered; and while miners are not required to pay taxes,

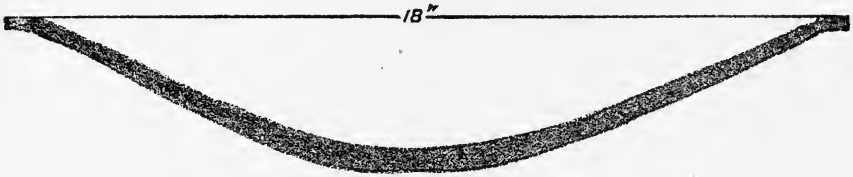
the export duty of silver is only one peso or eight reals per mark (58 cents per 0.5065 pound avoirdupois), gold being free, and machinery imported for exploitation entirely exempt from taxation.

The largest producing mines appear to be concentrated *par excellence* in the southern part of the republic, namely, in the departments of Potosi, Tarija, Chuquisaca, and Oruro. The former includes, besides the mines of Potosi, the Huanchaca and Quolquechaca groups, of which the controlling interests are owned by Señores Pacheco, Arce, and Ramirez, the bonanza kings of South American mining, who are reported to receive annually in the neighborhood of $3,000,000 as their share in the combined dividends of these properties.

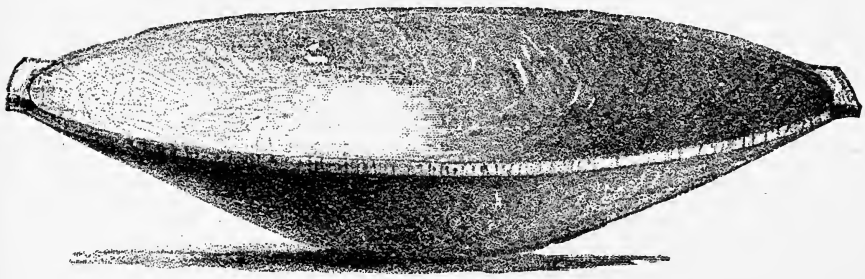
The growth of Bolivia's leading industry, however, is seriously retarded for want of more roads, proximity to accessible seaports, timber, and a better fuel than *taquia* and *yareta* (llama-dung and moss) in the silver lode districts. But these disadvantages under which mining has labored until within late years, of which the difficulty attending the transportation of machinery has been perhaps the greatest, have become somewhat diminished; for, by means of the Mollendo-Arequipa-Puno Railroad, connecting with the steam navigation on Lake Titicaca, and the stage-roads from Chililaya (or Puerto Perez) to La Paz, and from thence to Corocoro and Oruro, an extensive mineral territory is made easier of access; while the steady advance of the railroad system now extending westward in the Argentine Republic toward Southern Bolivia, is greatly facilitating the reopening of the Potosi Mining District that has lately been undertaken by a strong English-Bolivian company.

The gold of Bolivia is chiefly derived from placer mines along the rivers coursing through the section of country embracing the eastern slopes and foot-hills of La Paz Cordillera. At the present time, gold mining operations are carried on in a primitive way by the natives, who wash the richer gravel deposits in the *batea*. The *batea* is a circular, shallow wooden dish or bowl eighteen inches in diameter, for separating, through continuous use of water, the grains of gold from the dirt, sand, pyritic matter, magnetic iron, etc., and is to the South Americans what the pan is to the California miner. It produces the most accurate

and prompt separation, manipulated in experienced hands, and on many accounts is preferable to the North American pan. The gravity of the gold resists the centrifugal power of the water, and remains near the bottom of the vessel, forming the extreme point of a sector, while the lighter particles move forward toward the periphery, arranging themselves according to their specific weights, and spreading over successively greater areas in the sector. Where flat gold predominates (as in Tipuani), the *batea* is far superior to the pan, as the fibres of the



SECTION OF A BOLIVIAN BATEA. LARGE SIZE



BOLIVIAN BATEA

wood exert a maximum friction in contact with the smooth, flat gold surfaces, working against the escape of the metallic particles that adhere tenaciously to the sides and bottom of the wooden pan.

The government records show that the exports consist largely of the precious metals. For example, during 1883, for which year most accurate statistics appear to have been kept, they amounted to $21,988,729, of which $20,970,883.78 fell to the mineral production, $9,086,647 of which product was shipped

via the Argentine Republic to Buenos Ayres, the remainder passing over the mountains to Arica.

At one of the late national conventions, the mining laws were carefully revised, and the new Spanish Code substantially adopted, thus materially simplifying the tenor and title of property, with the view of favoring the development of the industry and inviting the investment of foreign capital. Among its fundamental provisions are:

1. On lands belonging to the public domain, and also on unfenced private property, minerals and mines may be sought, applied for, granted, and worked. Within fenced ground, the proprietor's permission or judicial license must be first obtained.

2. All individuals possessed of civil rights may apply for and obtain one or more *pertenencias* (one pertenencia = 100 m. square = 1 hectaréa) in one concession, not, however, to exceed 30 *pertenencias* (or 30 *hectaréas*).

= 10,000 square meters = 1 pertenencia = 1 hectaréa.

The *pertenencias* constituting one concession may not be scattered, but must border on one another (having common side-lines), forming a right-angular polygon.

A concession of 10 pertenencias may be:

1	2	3	4	5	6	7	8	9	10

or

1	2	3	4	5
6	7	8	9	10

or

1	2	3	4	5
		8	7	6
			9	10

etc.

3. Priority of application ("presentacion de la solicitud de concession") has the preference, however slight the difference in time.

4. Gold or tin deposits or other metallic minerals occurring in rivers, placers, pockets, irregular deposits, or bedded veins, on public or private lands, are subject to the same law applicable to all mineral concessions.

5. The claimant is owner of, and may work to an unlimited depth, all the ground, veins, deposits, and mineral occurrences within his surface claim and within the vertical planes passed through all the surface boundary lines of such claim.

His title and working privilege do not extend, however, to deposits and such portions of deposits, either in direction of strike or dip, or in any other direction, that are situated outside of or have departed from the ground inclosed within such vertical plane limits.

6. Parties exploiting in or into such adjoining ground, having passed the surface lines and vertical plane limits of their own claim, are compelled to return the minerals or an equivalent thereto to the party whose claim they have trespassed upon. And in the event of it being proved that such trespassing was carried on knowingly or with malicious intent, the offense becomes criminal, and the party committing the same is punished accordingly.

7. The concessions are perpetual in duration as long as the yearly *patente* of 5 bolivianos (5 Bolivian dollars) per *hectaréa* is regularly paid.

8. The *patente* must be paid in half-yearly installments in advance. It may, however, be paid several years ahead if preferred.

9. In case of failure to pay the *patente* for a period of one year, the claimant forfeits his right, title, and interest in and to the claim; and his property is sold out at auction to the highest bidder, when the claimant receives the surplus, after the amount of his indebtedness, plus costs and plus 10 per cent. of the entire amount for which the property was sold are deducted from such amount realized by sale. And in case no bidder appears, the land is returned to and becomes part of the public domain, and is reopened to location and exploitation.

With all the natural resources, however, that should combine to make Bolivia an extraordinarily rich and prosperous country, it must be acknowledged that, with exception of the calisaya

bark and coca plantations and the operations of a few of the better regulated mining enterprises, everything is in a surprising state of backwardness. And at first sight, one marvels at this condition of things in the midst of such boundless riches.

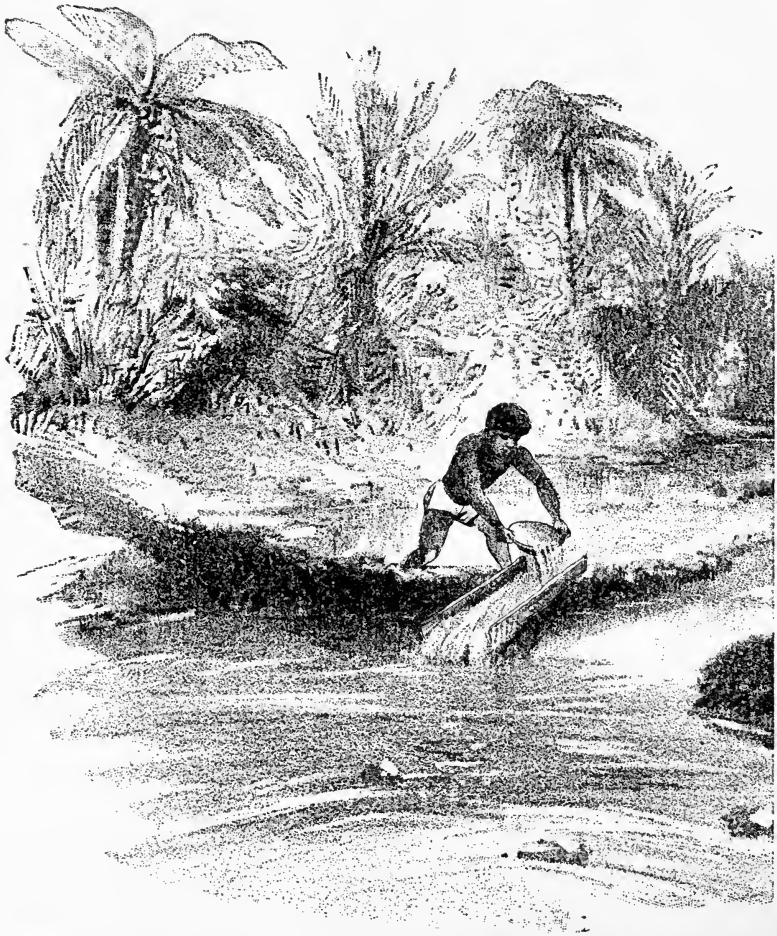
Each new administration has begun with strong endeavors to pursue a policy conducive to business activity and to the elevation of the country from its dull, torpid industrial condition to the rank of a thriving progressive state, commensurate with the variety and exceptional richness of her resources. Liberal and numerous concessions have been granted for roads and other public improvements; yet, for the greater part, nothing but trails connect the cities, traveled by mules, llamas, and Indians, the beasts of burden of the republic.

It is true there are navigable rivers to the east, and although there have been ably projected plans for their utilization, still their conversion into efficient fluvial highways remains unaccomplished. For instance, in 1868 a navigation company was formed with a large concession from the government, having as its object the opening up of a route down the rivers Mamore and Madeira to the Atlantic. The scheme was promising, and would have given easy access to half a million square miles of valuable land in Bolivia and Brazil, traversed by immense rivers, forming a natural canal system possessed by no other country in the world. But up to the present time there have been no active steps taken toward the realization of these designs, and the traffic in that direction, confined almost exclusively to the exportation of rubber and hides, is expensive and tedious, not to speak of danger from the more savage Indian tribes attending the back passage, up the rivers of the interior of Brazil.

Another project is now discussed, to continue the navigation of Lake Titicaca through Rio Desanguadero to Lake Poopó, and by means of a new railroad line from Chililaya to La Paz, in substitution for the present stage-road, and the navigation of other subordinate rivers farther south, to connect La Paz, Corocoro, Barca, Oruro, Cochabamba, Colquechaca, Sucre, Huanchaca, etc., with the view of diverting the Argentine-Atlantic and La Paz-Chilian trade northwestward through Bolivia and Peru to Mollendo. But, according to the writer's views, there are obstacles in the way of this scheme, to overcome which would involve

the solution of engineering problems at a cost entirely disproportioned to the advantages gained.

To an American traveling in Bolivia, the question naturally suggests itself: Why this backwardness and general stagnation?



SKETCH SHOWING METHOD OF SLUICE WASHING PRACTICED AT TIPUANI.

From a careful geographico-topographical study of the stupendous Andes chain, which has broken up and elevated to great altitudes the western part of the republic, forming a colossal barrier against the coast, it is evident that a peculiarly isolated, inaccessible position and great difficulty in building good roads

are the main causes that have operated in preserving the country's primitiveness. Added to this, it must be remembered that the development of the country has been in the hands of a people of whom by far the great majority are remnants of a nation doubly fallen. For even before the advent of the Spaniards over three centuries ago, during which time the Quichuas and Aymarás had been enslaved, persecuted, and forced into degeneracy, history tells us that the imperial glories of the Incas were but the last gleams of a civilization of a thousand years' standing, whose massive monolithic monuments, innumerable forsaken towns, ruined public works, terraced mountains, and crowded cemeteries, in the historic ground bordering the mysterious Titicaca, bear witness to a much higher scale of culture. And after a continued decline and free mixture with the Spanish invaders for more than three hundred years, it is hardly a matter for surprise that the resulting Cholos and half-castes should show little or no ambition for advancement, and the white constituency have absorbed in a high degree the phlegmatic, depressed disposition of the controlling Indian element, whose ignorance, utter want of purpose and life, and low standard of comfort, constitute the real secret of the characteristic stagnation not only in Bolivia, but in other South American States.

In a word, the consideration of the country's situation from a politico-economic point of view leads to the conclusion that, of the five factors that Lord Bacon and Bishop Hall have well said go to make a nation great and prosperous, namely, a fertile soil, busy workshops, easy conveyance for men and commodities, knowledge, and freedom, only the first and last are at all represented up to the present time in this beautiful and interesting republic, so appropriately called the Switzerland of South America.

IV.

THE GOLD DEPOSITS OF THE TIPUANI RIVER, BOLIVIA, S. A.*

The growing interest that is being manifested in the mineral resources of South America, and the importance attached to the revival of the mining industry in Peru and Bolivia, may justify the recording of some data concerning one of the historic gold regions of that portion of the continent.

During the past few years, the successful reopening of old Spanish mines and the discovery of several remarkable bonanza silver deposits in the Cordillera have developed an active but legitimate local boom, backed in its incipient stages almost entirely by Bolivian and Chilian resources.

As a general characteristic of the results attending these ventures, it may be said, in contradistinction to many similar enterprises in Mexico, that, in almost every instance where a lode mining enterprise has been provided with the necessary capital, expended under proper management, its efforts have been rewarded with profitable results; and this, too, in the face of such disadvantages as high altitude (from 13,000 to 14,000 feet above sea level), inaccessibility, scarcity of fuel and labor.

Among the more prominent of the permanently established paying silver properties may be noted the Huanchaca and Quolquechaca mines. Of these, the Huanchaca is at once the most celebrated and important enterprise in Bolivia, having already produced about $5,000,000 in silver bullion—the final outcome of a deep tunnel development scheme, nearly 3,000 feet in length, and requiring some ten years to complete. At the time of my visit to the republic, the company was paying 2 per cent. monthly dividends on a subscribed capital of $6,000,000, besides

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* From *The Engineering and Mining Journal*, New York, July 24, 1886.

adding monthly installments to a surplus fund that is now close on to $2,000,000.

But in point of historical magnitude, as also in respect to continuous ore-bodies actually remaining exposed to view, according to the mining reports of competent, reliable authorities, the mines of the Cerro de Potosí, Bolivia, are undoubtedly among the most phenomenal silver lodes, not only of South America, but of the world. Of the estimated total silver production of Bolivia, which, according to the Auditor of the Potosí Mint, is given at over $5,000,000,000, the Cerro de Potosí alone is credited with over $2,500,000,000.

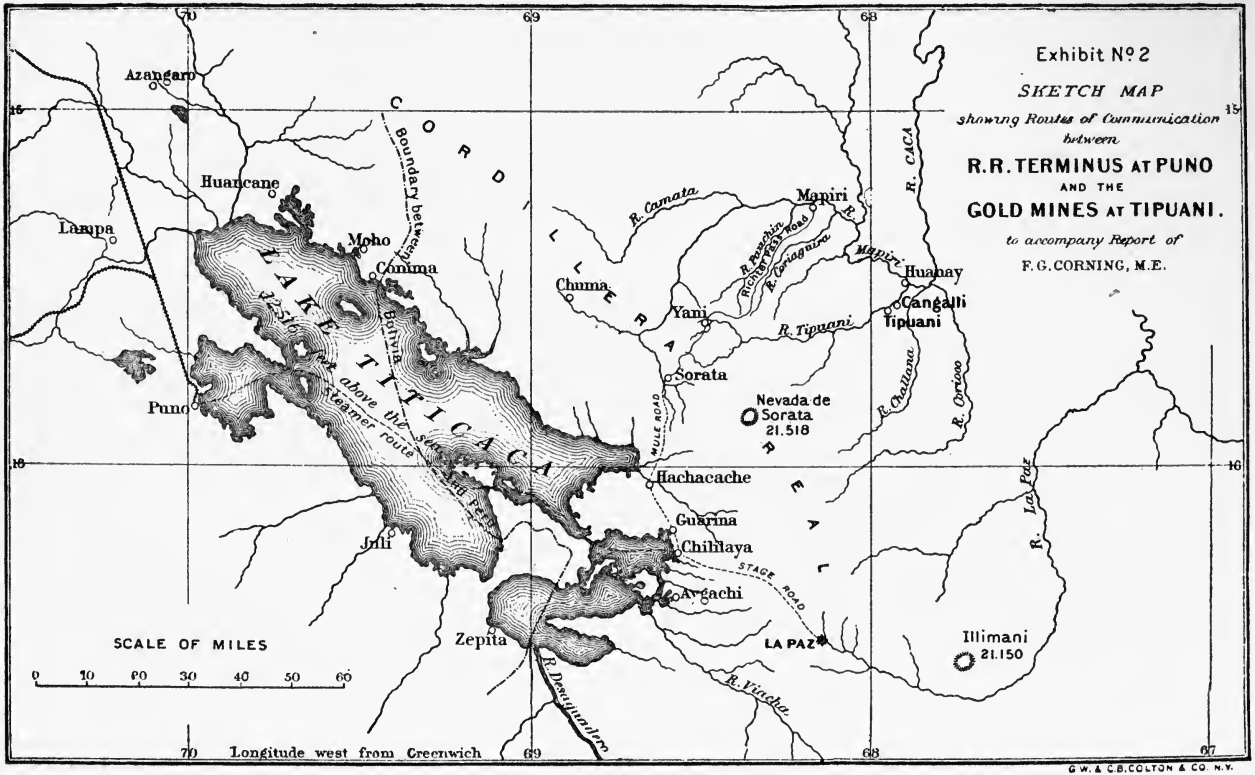
The resumption of operations in these mines, on a large scale, with all modern appliances, has recently been undertaken by a strong English company, whose shares are also largely held in South America. Judging by the conservative policy of the company and its efficient management, it would seem that a successful issue may be anticipated from the exploitation, on modern principles, of these vast bonanzas.

In Peru, a parallel scheme, having as object the extensive working of the Cerro de Pasco silver deposits, is at present entertained by prominent bankers in Lima and New York.

Such projects as these, not to speak of the regularly announced dividends from the noted El Callao gold mine in Venezuela, which aggregate to date about $9,000,000, have combined to enhance the enthusiasm for South American properties and for their possibilities upon more extensive development under improved systems of operation.

Although silver is the staple metal of Bolivia, gold has been found in considerable quantities. In lodes, it occurs in admixture with silver, in sulphurous, antimonial, and arsenical ores; but almost the entire amount is obtained from *lavaderos* or the washings of alluvial deposits in the beds and along the banks of streams and rivers; that is, from superficial, shallow, or modern placers of fluviatile origin.

According to Alexander von Humboldt and Professor Soetbeer, the gold production of Bolivia for 331 years, namely, from 1545 to 1875 inclusive, amounted to £41,013,000, which is about equivalent to the yield of the California placers after the first six years' work.



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The Andes, which skirt the bleak shores of Southern Chili, formerly Patagonia, rising higher and higher till they culminate in the gigantic porphyritic peak Aconcagua, and thence continuing through to the boundary-line of Bolivia in an undivided narrow sierra, depart from their meridional direction, and fork into two great longitudinal ranges, running nearly parallel, and known respectively as the Eastern and the Western Cordillera. They inclose the far-reaching table-lands of the Desaguadero and the mysterious Lago de Titicaca, which is at once the largest lake in South America and the highest in the world—covering an area of 4,600 square miles, with a surface lying level with the tops of lofty mountains at an altitude of 12,505 feet.

The eastern chain, locally termed La Paz Cordillera or Cordillera Real, separates from the Potosí mountain knot to the north of the Alturas de los Lipez, and includes, in latitude 16° 10′ S., and longitude 68° 47′ W., the Sorata or Illampu, a group of serrated snow peaks fringed with glaciers, rising in majestic splendor to a height of over 22,000 feet. The entire range shows a succession of sharp, jagged ridges with fiercely contorted strata, in contrast with the conical summits of the coast cordillera. It is built up of an extensive system of Silurian rocks (grouped by Forbes), running almost continuously for 700 miles, of which the principal lithological constituents are clay-slates, grauwacke, micaceous and talcose schists, broken, elevated, and metamorphosed by intruding igneous rocks, among which granites and porphyries prevail.

The whole of this geological formation is highly mineral-bearing, and the Sorata region of La Paz or Cordillera Real is eminently auriferous, containing everywhere and at great altitudes veins of gold quartz, generally associated with iron pyrites. And it is this section of country, especially on the eastern declivity of La Paz Cordillera, where an extensive development of Silurian slates and sandstones faces the Madeira Valley, that has contributed and continues to produce almost all the gold exported from Bolivia. It is everywhere met with on both sides of the mountain chain, although the accumulations on the north-eastern slope are far richer, both in quality and quantity.

The waters collected between the lateral ridges and high ranges of the Cordillera flowing to the northwest, swell the

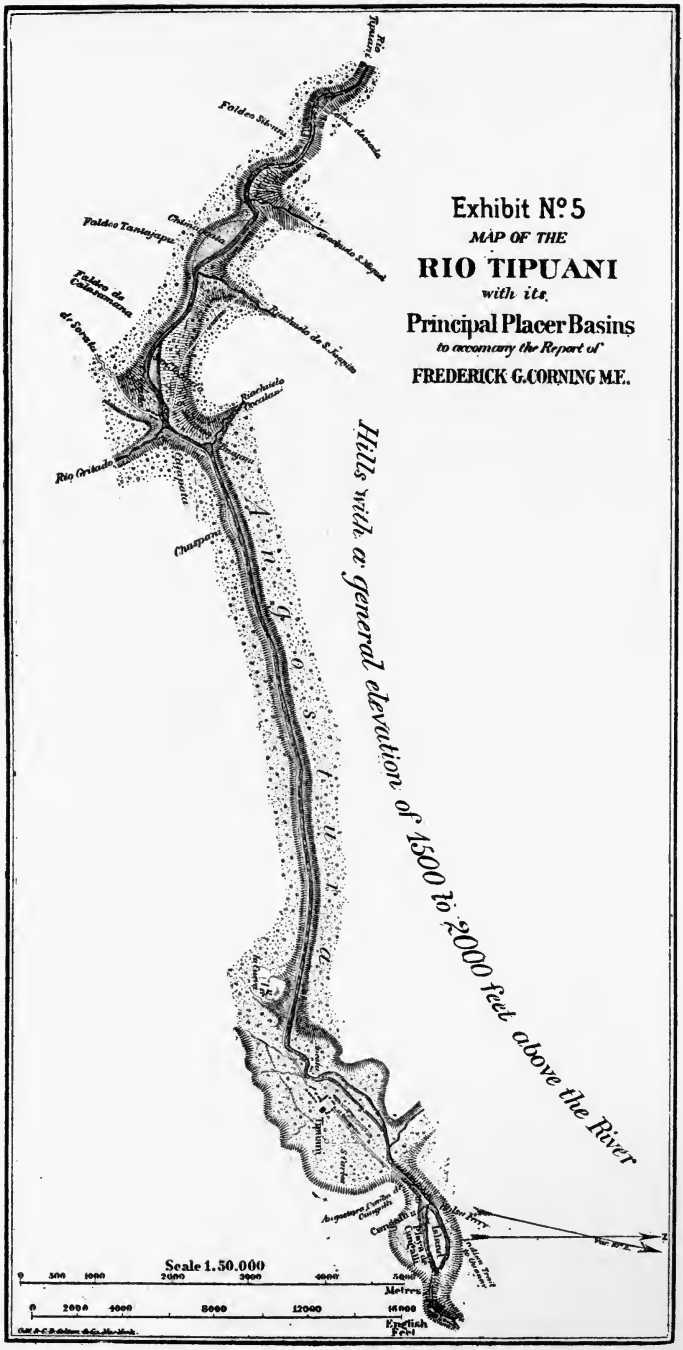
Exhibit N°5
MAP OF THE
RIO TIPUANI
with its
Principal Placer Basins
to accompany the Report of
FREDERICK G. CORNING M.E.
Hills with a general elevation of 1500 to 2000 feet above the River
Scale 1.50.000
Meters
English Feet

Ucayali, while the streams flowing eastward and northeastward descend to the foot-hills and plains traversed by the Beni and Madeira and their upper branches. The uncommonly powerful erosion caused by the *avenidas* or floods during the rainy season, to which the mountain sides and outcrops of auriferous quartz veins are subjected, disintegrates, transports, and deposits in the deep ravines and rivers flowing eastward enormous volumes of detrital material, through which are disseminated the liberated particles of gold. And although all the waters descending from this range that fall into the Beni carry down the precious metal, the Quebrada or Rio de Tipuani, which empties into the Mapiri, situated in the province of Larecaja, department of La Paz, is notably the most productive.

The Tipuani is best approached from the town of Sorata, which has an altitude of about 8,000 feet, and is 18 leagues (54 miles) distant from Chililaya and 9 leagues from Achacashe on the Lago de Titicaca.

The journey from Sorata to Mapiri, a distance of 32 leagues, is made in three days, namely, the first day, the summit of the main Cordillera spur called Llachisani, from 15,000 to 16,000 feet above sea level, is reached in five hours. At this elevation, the view is grand over a vast expanse of country, and one forms some slight conception of the huge scale on which nature has framed her productions in South America—"a sublime assemblage of mountains, plains, forests, and rivers, unparalleled and without rival in the works of creation." The air is so extremely rarefied that those who have not already become acclimated are likely to be attacked with *soroche*. The first symptoms make themselves manifest in the form of rapid breathing and dizziness, followed by palpitations of the heart and a general weakness and faintness—the least bodily effort causing complete exhaustion. Then sets in a stinging, smarting sensation about the eyes and forehead, which develops into sick-headache and, if the patient is fortunate enough, ends in violent vomiting, which is the only permanent relief. The general feeling is one of seasick misery, and is only slightly relieved by the smelling of ammonia.

The barren mountains once passed, the remaining 11 leagues to Mapiri are through the shady woods of the *quinales*, along

the crest of the hills sloping toward the Mapiri River. And here one meets with a novel feature in South American travel, namely, the *balsa* navigation of the narrow, rapid rivers tributary to the wide system flowing through the plains of the interior.

Twelve hours after departure from Mapiri, gliding and winding continuously over crystal-clear water, through 24 leagues of the most romantic country, lined with forests of the greatest exuberance and variety of vegetation, shut in by steep hills whose tropical drapery hangs into the very river, amid a brilliant profusion of feathery, fanlike foliage, Guanay is reached at the junction of the Mapiri and Tipuani rivers.

The source of the Tipuani River is at an elevation of 17,000 feet on the northeast side of the Cordillera Real, about five leagues to the northwest of the Sorata or Illampu, and ten leagues in a northerly direction from the town of Sorata. It pursues a northeasterly course for thirty-five leagues, more or less, measured along its winding path, and empties, ten leagues below the village of Tipuani, into the Mapiri River at Guanay. From the latter town, the combined waters flowing to the east as the continuation of the Mapiri, are known as Rio Caca, which farther down participates in the formation of the Beni River, a tributary to the Madeira.

The first five leagues of the Tipuani's development are through barren, desolate regions above the snow-line. Lower down, in the vicinity of Tipuani, and continuing to the mouth of the river at Guanay, it forms a tortuous chain of deep, delicious, transparent pools, from 200 to 700 feet in length, and with varying widths of from 30 to 70 feet, linked together by foaming rapids, alternately running between steep hills and through high cañons (angosturas), or becoming shallow and opening out into basin-shaped swells in the valley. The latter are the receptacles or repositories in which the transported placer-forming substances are sifted, spread, arrested from farther travel, condensed and built up in layers, accompanied with a partial bed-rock concentration of the heavier ingredients, and finally carved out into the *playas* as seen to-day. These benches or terraces of auriferous gravel—the placers proper—are from five to fifteen feet high, and run with the river for distances of from 200 to 2,000 feet, with width ranging from 100 to 700 feet, extending back toward the slopes

of the side-hills. Scattered along the banks irregularly and in groves are pine-apple, rice and coffee plants, orange, lemon, coca, cascarilla, rubber, cotton, cane, banana, and divers nut-trees.

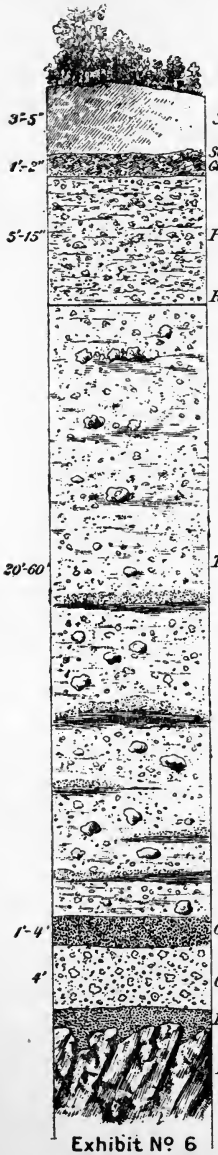

Exhibit No 6
Ideal Section of the Tipuani Placers.

The predominating country-rock throughout the river is hard, non-fossiliferous, slightly ferruginous blue clay-slate, the same as observed at great altitudes on the northeast slope of the Cordillera in violently upheaved beds hundreds of feet thick. Lower down in the foot-hills, they are overlaid with friable red shales or weathered mica-schist, on which are superimposed conglomerates, red clay, and thick deposits of brown soil of reddish hue. And although this order of superincumbent strata, which, collectively taken, is the gold-containing formation, is only noticeable in places, along the river, the slates appear often reaching prominently above the water. Here the formation is exposed to view in the cañons and narrow passages, where the contorted strata are abruptly elevated, presenting perfect stratification and the most varied structural forms. The beds maintain either a nearly vertical position, or incline with heavy dip toward the north and northeast, constituting with their upturned edges the bed-rock of the auriferous alluvial — *peña*. And this country formation is not only traversed by gold quartz

veins in the Cordillera watershed of the Tipuani, but must likewise be ribbed and seamed with auriferous lodes throughout that portion forming the side-hills; for, besides the actual river deposits, there are accumulations of gold-bearing alluvium in the side valleys of the main *quebrada*, and also high up in gullies and on

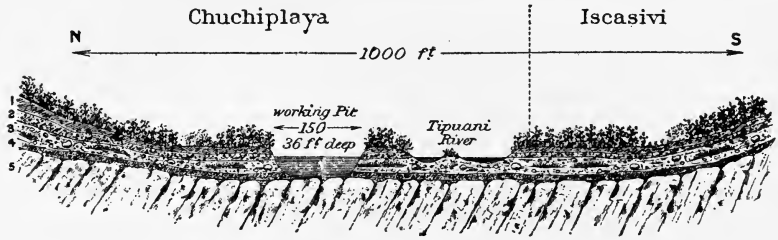

EXHIBIT NO. 7.—IDEAL SECTION THROUGH "CHUCHIPLAYA."

1, Top soil. 2, Soil and fragments covering gravel. 3, Playa and top gravels. 4, Auriferous blue clay stratum on slate bed-rock. 5, Reached by working-pit at depth of 36 feet.

shoulders of the bordering mountains, *falders* whose genesis is quite independent of the riverine agency below. Owing to this probable occurrence of gold in place in the immediate vicinity, the source of the Tipuani *playas* is not alone to be looked for in the region of its headwaters, but also in the country adjacent to the deposits. Vast quantities of soil from these steep slopes have

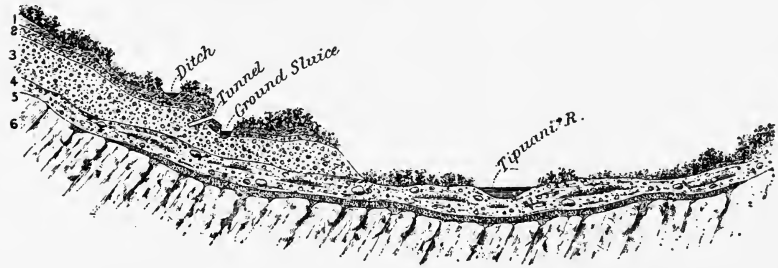

EXHIBIT NO. 10.—IDEAL CUT THROUGH "ANCOTA."

1, Top soil. 2, Soil and gravel. 3, Falder gravel. 4, Top gravels proper. 5, Gold bed-rock concentrations. 6, Slate bed-rock.

been emptied into the river through land-slides along the valley, as well as by torrents entering through cross-ravines. And at such points of combined gold contribution, some of the richest ground is found.

The periods of greatest geological activity at the present time re during the rainy seasons, from November 15th to March

15th, when rushing waters and a succession of powerful floods tear their way through the lode-incasing formations, gathering material from a wide area, conveying and subjecting it to the influence of the swollen river.

The ancient bed of the Tipuani lies from 20 to 60 feet below the present waters, and has been filled either gradually, or more probably spasmodically, by sudden flood-installments, as indicated by the stratifications of the ancient gravels, which appear to record different periods of deposition. And on the other hand, there is the strongest possible evidence, in the form of "pot-holes," as high as ten feet above the surface of the water, that the river has operated at higher levels with great power for long periods of time.

During and subsequent to the process of formation, the freeing of the gold, by attrition and disintegration of the auriferous vein-rock in transportation, has been succeeded by a sinking and concentration of the precious metal in the vicinity of the bed-rock or *plan*, as it is locally termed, in which zone the richest ground has always been found.

Resting on the slate *plan* or true bed, called in Tipuani *peña*, there is in many places a layer of "cement gravel," a hard conglomerate cemented with oxide of iron, termed *cangalli*, which forms apparently a new bed or false bottom. Deposited on the latter, is a rich pay stratum of gold sands and gravel, varying from one to four feet in thickness, and containing in places from one-eighth to one ounce of gold to the *batea* (two-thirds of a California pan).

The value and thickness of the *cangalli* stratum are not definitely known, as the records of workings that have sunk through to actual bed-rock are contradictory. It is highly probable, however, judging from the character of similar deposits, that not only the "cement" itself is pay material, never having been turned to profit for want of mining, crushing, and amalgamating machinery, but that below it, lying on the slate, there are deposits as rich as, if not richer than, the *cangalli* pay-streak.

Imbedded in the partially stratified top-gravels, lying in depths of from 20 to 60 feet over the *cangalli plan*, are found intermediate "false beds" of impure chalk or marl, which, like the cement gravel, are overlaid with thin strata of rich gold soil.

A section through the river formations shows the following geological order:

Dark and red surface soil	from 3 to 5 feet.	
Soil mixed with broken fragments and gravel	from 1 to 2 feet.	
Playa or auriferous gravel above river level	from 5 to 15 feet.	
Continuation of *playa*-gravel with partial stratification, extending below river-bed, and inclosing rich streaks	from 20 to 60 feet.	
Gold stratum (bed-rock pay-seam)	from 1 to 4 feet.	
Cangalli bed or cement	?	.6 feet
Bed-rock gold stratum	?	
Resting on slate bed-rock (or peña.)		

The detrital accumulations below the river-bed, and also composing the adjacent *playas*, consist of slate, syenitic granite with plain hornblende crystals, fine-grained granite, white quartz, and rusted cellular vein-quartz containing partially decomposed pyrites which occur in irregular fragments, but principally in lense and oval-shaped stones and small boulders. And the mineralogical constituency dispersed through this *débris* in small gravel, sand, and finer particles, consists of quartz, feldspar, hornblende, mica, hematite, titanite, magnetite, gold, and occasional grains of platinum.

The precious metal is diffused through the mass largely in the form of coarse flat scales, thin lenses, and oval-shaped leaves and angular plates of deep yellow color, which is the general character of Tipuani gold. Accompanied by magnetic and titanic sands, it also appears in small grains, fine particles, and dust. The coarse pieces are always flat, except the gold from the *falders*, or hill-slope deposits, which is more granular in appearance. Nuggets and wire gold are rarely met with. It is remarkably pure and constant in fineness, running not less than 22½ and generally 23½ carats, or about 980 fine. It is bought in La Paz at the rate of 27 pesos (21·60 Bolivianos, or $15.12 United States) per *onza*.

Besides the *cangalli* occurrence, the gold is distributed in rich and poor patches throughout the upper gravels, in accordance with the interruption of the current of the stream by diminution in its fall, by the entrance of tributaries, or by bars, reefs, eddies, etc.

Thus the gold deposits of the Tipuani may be divided into the following classes:

1st. *Cangalli* bed-rock, ancient or deep deposits.

2d. River-bed deposits, occupying the present wet and dry channels, and extending below to the rich pay-streak.

3d. *Playas* or placer benches above the water level—in point of origin the same as the latter.

4th. *Falders* or hillside deposits, which occur (*a*) in more or less well-defined auriferous strata; and (*b*) in thick hilly masses of alluvium, through which the metal is irregularly dispersed.

A long-continued, extensive system of *batea* sampling resulted in finding that the river-beds and upper gravels of the Tipuani formation may be counted to contain about 50 cents per cubic yard; while the bed-rock deposits, ranging from 25 to 40 feet below the river level, contain the precious metal in a much higher degree of concentration. This pay-seam varies in thickness from 3 inches to 3 feet, and is also variable in gold contents. But it has been made the basis of remunerative mining, in a small way as compared with the California scale of operations, under disadvantageous conditions in point of climate, location, and working methods. The records of Tipuani gold washings date back as far as 1533, and in those remote days thousands of Inca Indians were sent periodically to gather the gold as best they could, which was placed at the disposal of their heroes. Imbedded deep in the alluvial strata below the present river-bed, have been found gold ornaments, copper relics, hard-wood picks and hatchets of stone, bearing witness to the ancients' presence and equipment.

The remnants of these historic exploitations are quite numerous in places. The *falder*, or hillside gulch deposits, were worked *par excellence* in those periods, probably because the richer beds below the Tipuani were either unknown or of necessity neglected on account of the technical difficulties attending their working.

Later in the history of the country, the Spaniards, who appear to have been in sole possession of the river, carried on extensive workings of the hillside deposits at elevations of from 50 to 600 feet above the river level, where stone pits, basins, aqueducts, ground sluices, water-worn surfaces, excavations, and boulder dumps yet remain in comparatively perfect preservation.

The system they followed, known as *cochea*, was a variety of

booming or gouging; that is, the application of water in sudden rushes, in opposition to the use of continuous streams in ground sluices. The required quantity was conducted in an *acequia* from some convenient stream, and stored near the terminal point in a capacious reservoir, at a suitable height above the soil to be washed. The dam or side of the receptacle was provided with a flood-gate, through which the whole contents could be poured out in a torrent at pleasure, and the previously loosened soil carried off in the rush, while the gold remained behind in a concentrated product, arrested by the larger stones and boulders. The latter were thrown to one side, and the path of the stream successively shifted, until a large amount of ground was caved, and a certain patch washed, when a clean-up was made of the remaining gold sands, which were subsequently treated in stone sluices, and the metal finally separated after this long, laborious, wasteful process. They do not appear to have had any bed-rock floors or apparatus at the end of the flood in which to save the tailing gold, and the force of the flow must have been so sudden and powerful that more metal was carried into the river than was saved in the channels formed by this method of surface denudation.

Many millions' worth of gold from the Tipuani region are accounted for by the numerous legends so commonly associated with the records of old Spanish mines.

The most conspicuously successful of the more modern enterprises, however, distinguished for intelligent, energetic management and methodical working plans, are the operations of the late Don Ildefonso Villamil, who devoted himself with great perseverance to the development of Tipuani property for many years previous to his death in Sorata, some seventeen years since. The records of his estate show that over $2,000,000 were gained by his mining operations in and below the Tipuani river-bed. The system he followed was the excavation of a large open pit with sloping sides, pushed vigorously to bed-rock, where the rich gold stratum was rapidly mined and washed. In sinking, great numbers of Indians were employed, who conveyed both dirt and water to the surface by passing in leather aprons and buckets from one tier of men to the other.

Although Villamil and others have already worked, with more

or less thoroughness, many placers for miles along the Tipuani, there still remain relatively large *playa* tracts that could be mined profitably. Since the suspension of the more extensive operations, the natives alone continue the *batea*-panning of the upper gravels, producing annually not to exceed $20,000. The causes operating against the success of some of the attempts to work these deposits more continuously and systematically, besides consisting in the natural peculiarities of location, that is, concealment and depth below the drainage level, are also to be found in the crudeness of the methods followed in mining and washing. Owing to a very limited familiarity with the mechanics of mining, the main obstacles—water and exploitation in gravelly formations—were only partially overcome, and success, in consequence, oftentimes curtailed. The *Quebrada* abounds in timber suitable for purposes of placer mining; but for want of the necessary tools and machinery to convert it cheaply into lumber, it has not been used to secure and accelerate drifting in loose ground, nor to construct effective sluices. Thus the Bolivian miners were debarred from working through shafts and drives, substituting therefor the open pit-stripping method, which required much more time, labor, and expense, its chief drawbacks consisting in the large surface offered to the percolation of water, the reduced bottom area caused by the sloping sides, and a constant danger of filling up, by slides, floods, and silt. And as the pumping plants were extremely deficient, the draining of a comparatively shallow excavation was a formidable undertaking of doubtful success. The grade, topography, and dumpage facilities of the river preclude the possibility of applying the principles of hydraulic mining on a large scale, or of driving a bed-rock tunnel to tap and drain the lower pay zones. The only feasible method is the mining of the bed-rock deposits through shafts and drifts, and the careful washing of the wash-dirt and gravel in comparatively short, properly adjusted sluice systems, for which sufficient grade can be secured along the banks, and in these operations, water-power can be utilized to operate the necessary pumps. Mines of similar character are known in California, Victoria, and Western Australia, where millions of tons of wash-dirt have been profitably mined, the pay-streak underlying the top strata having

been in many instances much lower in grade than in the Tipuani region.

In view of this fact and the results already attained, and in view of the advantages of richness and cheap labor to compensate for the disadvantages of a somewhat remote situation and occurrence below the drainage level in a wet formation, the Tipuani field may be pronounced one in which, with the application of the improvements indicated, profitable operations on a limited scale could be carried on for some years to come.

The reputation of the *Quebrada* for unhealthiness is not altogether undeserved, as tertian fever prevails at times. And although I have no personal experience to relate as to its frequency and gravity, having enjoyed better health while examining the river than at any time in my South American travels, and having only noticed one case in Tipuani, I was told that *terciana* was common during the wet season.

These intermittents are confined, however, to those portions of the river where, besides a glowing midday sun, preceded and followed by a chilliness of air mornings and evenings, accumulations of decaying vegetation are hidden by dense masses of foliage from the ventilating influence of the breezes, which cannot penetrate at a sufficiently low level to carry away the malarial emanations from the rank grounds and their occupants adjacent to the river.

V.

THE GOLD QUARTZ MINES OF GRASS VALLEY, NEVADA COUNTY, CALIFORNIA.*

The name of Grass Valley has become classic in the history of American gold mining. For some thirty years, remunerative operations have been quietly but continuously carried on in that famous region, until finally, the economic merits of its phenomenal belt of auriferous, pyritous quartz lodes, and the conservatism of management and business success that have attended mining in that part of California, have won for Grass Valley a reputation as a permanent, legitimate gold mining centre, second to none of the mineral districts, either in the United States or in foreign countries.

Besides being situated in the midst of the largest, the most important and prosperous gold quartz mining district in California, in the heart of the great auriferous zone extending along the western flank of the Sierra Nevada Mountains, the town of Grass Valley numbers about 7,000 inhabitants, and a healthy activity pervades all business, with every indication that the place has come to stay, and has yet to reach the zenith of its growth. It is most picturesquely nestled in the fertile, fruit-grown foot-hills of the beautifully wooded range, distant from San Francisco about 160 miles by rail, of which 144 miles are on the Central Pacific, from San Francisco to Colfax, and 16 miles on the Nevada County Narrow-Gauge, from Colfax to Grass Valley.

It would be hard to find a "camp" (if indeed this term be at all applicable to that pious old rural town) that, in proportion to its size and importance, has been freer from the speculative craze and disasters that are sometimes connected with the working of

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* From *The Engineering and Mining Journal*, New York, Dec. 11, 1886.

claims adjacent to ore-deposits of exceptional value in our Western States and Territories. Nor would it be easy to find in the annals of American quartz mining a group of mines whose working has been rewarded with more gratifying, more regular, and longer continued returns, and whose profitable operation is more assured for many years to come, than the Idaho, North Star, and Empire mines, which are at present the leading producers and dividend-payers of the Grass Valley belt.

The discoveries of gold quartz in place in this section of Nevada County in the year 1850, following the extensive opening of important placer mines that had begun at an earlier date, are among the first in California. This county contains in a marked degree every form of gold deposit known in California; and as an annual bullion producer of about $4,000,000 in gold and some $60,000 in silver, the latter contained in the sulphuret concentrates from the milling process, it outranks every other county in the State, with Amador, Placer, and Sierra following next in order.

The known lode-bearing area of the Grass Valley District is comparatively small for the number of veins it contains. Its outside limits are not over seven miles in length by four in width, which region is joined by the Nevada City Mining District to the north. But the most noted tract of great developed veins belonging to the Grass Valley District proper is embraced within a radius of about two miles, in which the number of lodes, and the qualitative and quantitative uniformity of the ore they carry, are peculiarly favorable to great productiveness and permanent prosperity.

For numerous reasons of business policy, the publication of mineral records and statistics of production have in many instances been only fragmentary; for it is notable that the miners, much to their credit, avoid the customary advertisement and devote their energies rather to the mineral resources of the region, trusting to their actual merits to earn for the mines the deserved celebrity. This loyalty to and belief in the Grass Valley lode system are amply attested by the numerous subscriptions of miners and local residents to the stocks of companies formed to reopen temporarily suspended and mismanaged properties; for Grass Valley, like all mining districts, has had its "ups and

downs," its tribulations and set-backs, which, however, it should be noted, were owing more to irregular and unsystematic mining and milling and to an imperfect knowledge of local vein phenomena than to any other cause. But leaving the details of these subjects for later consideration, the following list of prominent mines, with their gold outputs, recently compiled from reliable sources, is deserving of mention as illustrating the rich productive character and possibilities of Grass Valley lodes:

Mine.	Depth on plane of lode. Feet.	Gold production.
Idaho, North Star, Empire } Present leaders.	2,500	$9,000,000
	1,600	3,000,000
	1,700	5,500,000
Eureka	1,200	5,700,000
Allison Ranch	700	4,500,000
Gold Hill	400	3,000,000
Rocky Bar	1,000	2,500,000
Massachusetts Hill	700	2,000,000
Pittsburg	....	1,500,000
New York Hill	1,200	1,300,000
Other smaller mines	....	3,000,000
		$41,000,000

A much larger estimate has been reached by including other mines not specified in the foregoing table, besides allowing for the large amounts of precious metal that have been wasted and stolen; but these figures will answer in support of other testimony embodied in this article as to the prosperity and lode wealth of this already celebrated district, and the inducements it offers for the further investment of capital under conservative guidance.

The lodes traverse various formations, occurring on the plane of contact between two dissimilar rocks, and also cutting independently against the planes of bedding. They run as parallel or companion veins, and also in cross systems. The Idaho-Eureka lode occurs on the contact between a metamorphic shale-slate (of coarse, schistose structure) and serpentine, while the Empire and the North Star cut through the slate; the Allison Ranch, through a granite formation; and the New York Hill courses in diorite (said to be!). The veins, as a whole, are exceedingly regular, only small, insignificant faults having been

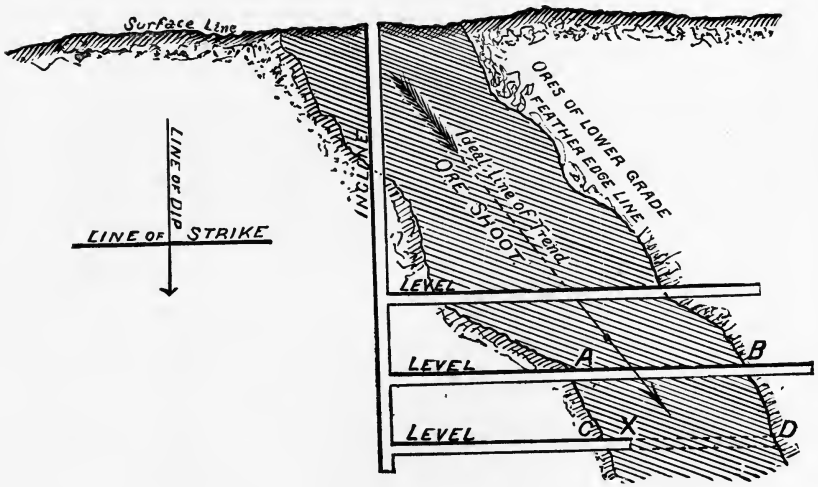
observed as yet in the principal mines. They are subject to violent waves on the strike and dip, which cause the drifts to twist and bend considerably. These waves, in certain mines, have a tendency to swing the ore-bodies into the hanging country, but they almost invariably come back into their normal courses, and are encountered in the drifts and inclines, which are regularly continued.

The ore occurrence is of the chute, channel, or chimney form, and throughout the mass of average grade ore (from $12 to $25) are sprinkled pockets and rich streaks of specimens, which are collected and disposed of as a separate division of mining. The feather edge or contour limits of the chutes form irregular, wavy lines, so that the point at which a new level running from the shaft toward a chute will come into ore does not always correspond with the calculation based on the average trend of the chute and the angle that such line of trend makes with the main incline-shaft. Frequently a chute will appear to be leaving the line of dip so fast, owing to the drift running into a concavity in its boundary, that as much as 200 feet will have to be drifted through practically barren ground, past the normal line of intersection, before the pay-ore is encountered.

But no anxiety is felt on this account; for sooner or later, the chute is surely met with, and the drift continues in ore across the same for the usual width. Indeed, so persistent are these ore-channels that, once the direction and width are clearly determined, by a series of levels at regular intervals, a new level run at a lower point in the mine when coming into the chimney at *X*, for example, puts practically the whole stripe *A*, *B*, *C*, *D* in sight, so infallible is the continuity of the ore ground in such mines as the Idaho, the North Star, and the Empire.

The gold is inclined to occur finely disseminated through the milk-white lode quartz, and is closely associated with pyrites and occasional spots of galena. The presence of the latter indicates rich ore, as does also the arrangement of the ore constituents in banded, ribbon structure. The proportion of pyrites is such as to yield three and a half tons of sulphuret concentrates in one hundred tons of milled ore. Where the pyrites occurs, however, impregnated in the fresh or stained country-rock adjoining the lode-filling proper, it becomes impoverished in gold contents.

The presence of calcite is likewise unfavorable to the quality of ore. In places, the metallic constituents disappear almost entirely, leaving the quartz in compact, pure white masses. Such apparently barren bodies will frequently mill from $8 to $12 per ton. Owing to the improvement that quartz mining has undergone within the past two years, much better results are now attained at Grass Valley in milling these grades of ore than was formerly possible. This closer working of the ores has been brought about by a reduction of mining and metallurgical costs, in consequence of—1st, the extensive application of water-power for hoists, for milling, and lastly, but not less important, for air-



drills; 2d, the building of mill plants with a greater regard for gravity handling and automatic action throughout, combined with a multiplicity of stamps. The gains resulting from these changes have begun to tell, and the bullion-producing industries in this section of California will now be steadier and longer sustained, backed by the large amounts of ore, formerly considered low grade, that are now susceptible of profitable exploitation. The appreciation of the advantages offered under the new standard of mining and milling is showing itself in the work of rehabilitating old and partially deserted mines in numerous parts of the State; and in certain districts where the size of the lode

is favorable to a large scale of operations, gold-bearing quartz is profitably worked with a yield as low as $5 a ton.

The career of the Idaho has, since its first opening, been followed with interest by the mining community; and its long-continued dividend record has come to be a matter of standard reference in government and other reports. Some of the salient features of this great gold property are always worthy of notice, even at the risk of monotonous repetition. Its gross yield approximates $9,000,000, of which about $4,000,000 have been paid in profit, in regular monthly dividends extending over a period of eighteen years. This is equivalent to nearly $1,300 a share on the 3,100 shares of capital stock of a par value of $100. The claim embraces 3,100 feet of the apex of the lode, which has a northeasterly and southwesterly course, a southerly dip of 70 degrees and a width of from three to six feet, being the first extension east of the old Eureka mine. The latter was an exceedingly rich, profitable property for many years, until the ore-chute finally pitched into the Idaho ground. This remarkably productive ore-chimney, which varies in width and value, trends downward to the east, ranging from 500 to as high as 1,200 feet across, and is the only paying one known in the Idaho lode. Its western edge, in the lower levels, feathers into a barren spar zone that runs for several hundred feet and appears to be unfavorable to the deposition of gold ore. The hanging-wall of the Idaho vein is marvelously even and sharply defined. It shows frequent striations, and is so smooth and straight that it presents the appearance of having been worked to order by some skilled stone-cutter. The foot-wall, though also quite regular, is given to swelling, which necessitates much heavy timbering, and increases the cost of mining as compared with the conditions prevailing in other neighboring mines. But this swelling peculiarity of the foot country is only found in the ground incasing the ore-chimney; outside of that zone, strange to say, the foot-wall does not show this tendency. Below the seventh level, all the levels are run to the east, to catch the main chimney that, in the lowest workings, is making rapidly toward the Maryland claim, in which property, it is generally believed, the chute will eventually be found to continue, but at a depth that may render its rapid, economical working greatly dependent on the right of way

through the Idaho, or other arrangements with that company. As the Idaho, like most other Grass Valley mines, has not been worked or trimmed to sell, it has happened once or twice in its career that, in consequence of the development-work having fallen behind, temporary exhaustions have set in, which, in conjunction with the encountering of lower grade bodies, and unusually heavy expenditures in the improvement account, have caused decreased earnings for a few months at a time. Thus, in 1883, the profits ran down to $34,100, as will be seen in the following table:

Year.	Tons.	Yield of rock.	Cost of mining and milling.	Product.	Dividends.
1881	27,945	$22 95	$9 51	$640,000	$271,250
1882	27,639	20 64	9 83	627,000	263,300
1883	28,572	12 76	8 70	362,000	34,100
1884	31,143	18 04	7 86	561,895	271,250

But from that year, the mine improved rapidly and returned in 1884 to its old-time prosperity. Since then it has continued to improve, until now, at a depth of about 2,400 feet on the incline plane of the lode (about 1,800 feet vertical measurement), the mine is producing a most satisfactory quantity and grade of quartz, considerably above the average, although not quite up to the highest of former years.

A great saving in running expenses has been effected by the substitution of water-power for steam. The Pelton wheel, of the "hurdy-gurdy" class, designed for relatively small supplies of water under high heads, is in general use, and gives most satisfactory results. This change cost the Idaho Company about $55,000; but the actual saving in fuel, labor, and repairs amounts to at least $30,000 a year, so that the interest accruing on the amount invested in this plant is all that could be desired.

At the present time there are some 220 men on the company's pay-roll, of which ninety are stopers (equal 45 men on ore in each shift); and the daily output, being about 95 tons, gives a little over one ton of ore per stoper per day, and something over two men on the pay-roll to the ton of ore mined and milled. Sinking at present depth costs from $25 to $32 a foot, and drifting $9 a foot; wages, from $2.50 to $3 a day.

The 35-stamp mill of the Idaho Company, with the exception

of the addition of self-feeders, has hardly been changed or improved since the early days, and belongs to the antiquated type. The stamps weigh 850 pounds; number of drops, 72; height, 9½ inches; capacity in twenty-four hours, 95 tons; proportion of sulphurets, one per cent.

While the Idaho is perhaps the most renowned mine in Grass Valley, there are other properties that in earning capacity are following closely in its wake, although, for various reasons, less has been openly said concerning their affairs. The Empire and North Star mines belong in this category. These are in some respects twin mines, having many features in common in point of vein geology and methods of working, besides being under the same administration; and as the Empire is the oldest working mine in California, it is, perhaps, entitled to first consideration. The claim embraces two companion veins only 100 feet apart, both carrying rich ore, so that the property is practically a double mine; and having only an average dip of about 30 degrees west and a north-northeast and south-southwest strike, it represents the flat veins of the Grass Valley region in opposition to the Idaho, which is a type of the practically perpendicular or straight veins.

For about thirty years the Empire has been worked nearly continuously, although for many years after its first discovery it was operated in a most desultory manner. But, notwithstanding the former crudeness and waste, the mine has always paid, as the ore is of high grade and exceedingly abundant. Several years ago the mill was entirely reconstructed and has since been enlarged, until now forty stamps, with self-feeders, are constantly in operation, and the mine is working to better advantage and yielding more regular and larger monthly dividends than ever before. The Triumph concentrators, used entirely by this company, give great satisfaction; and although the mill plant is not as perfect in detail as the new mill of the North Star, which is now nearing completion, nearly all of the latest and best improvements for convenient and economical working have been introduced by the manager, so that the cost of milling is only 64½ cents a ton. The sulphurets are much higher in grade than those from other Grass Valley mines, running from $100 to $250 a ton. They are sold to custom works at a reduction of $18 a

ton for working charges. It is claimed that the mill saves 95 per cent. !

At the North Star, an east and west lode, with a dip to the north of from 12 degrees to 21 degrees, ore averaging $20 (higher in places) is extracted from the east 5th, 11th, and 12th levels, and from the east and west 13th, 14th, and 15th levels, with large strips of stoping ground opened up ahead and the mine improving daily. The property will continue for a few weeks, pending the completion of its new 40-stamp mill, to supply the 10-stamp custom mill where its ores have been treated for the past year or two. The mine is so extensively opened that three times as many stopers as are at present employed can be put on ore without straining the property. Everything that expert designing and solidity of construction can do has been lavished on the North Star mill. It is being built by the Risdon Iron-Works, of San Francisco, and will be second to none in California. It will be operated by three turbine-wheels, which alone will save $1,000 a month in fuel. In general and in detail, the North Star plant will be the model mill of the State. It will reduce manual labor even more completely than the Empire, and the cost of milling will not exceed fifty cents a ton. In addition hereto, these two mines are soon to have their own chlorination-works, which will prove to be a further source of economy to both the Empire and North Star companies.

It is to be regretted that working maps are not generally kept up in the Grass Valley mines; for among other things, it would be interesting to compute the stope area corresponding to the production of a certain tonnage extending over a period of years; and from this to estimate the productive capacity of a given lode per square fathom. Such a unit would often serve, in one and the same mine, as a basis from which to gauge the sight tonnage of the irregularly blocked-out reserves, which, under the present circumstances, is a difficult problem. Also the compilation by the United States Geological Survey, for instance, of a general underground mining chart of the entire district, accompanied with a series of sections and a survey of the surface topography, would disclose many important relations existing between the lodes of the Grass Valley belt, in addition to solving many problems of extension-claims, lode parallelism, apex continuity, etc., in relation to surface claims.

As above intimated, the Grass Valley industry, as a whole, since the early days, has been somewhat erratic in character. At first, one property would loom into prominence, and, through the continuation of its profitable operation for a long period, an impetus would be imparted to the development of other ledges, which, in turn, would become paying properties. Then, after combined activity for a number of years, some irregularities would set in and cause one or more mines to suspend. Almost all of these stand-stills, however, may be traced to a change of ownership or administration, or to the encountering of water or some misunderstood and much exaggerated freak of vein geology; but these crippled enterprises were almost immediately succeeded by a new group coming into the field of active producers, until now the Idaho, the North Star, and the Empire happen to be the dividend leaders. And while the Idaho and the Empire have been almost continuously worked with large profits to the owners, the former for over eighteen years and the latter for nearly thirty years, each having paid several millions in dividends, the North Star mine remained, until within two years, inactive for quite a long period, notwithstanding its working has always been rewarded with gratifying returns. Lately this mine has been developed into a permanent paying property of greatly increased value, with ore-reserves surpassing in extent those of any other property in the district, thanks to the sagacity and able management of Mr. John Hays Hammond, the well-known expert of the Pacific coast. The other mines are either operated on a small scale or are lying idle. But the strong fact remains, significant of their prospective value, as well as bearing favorably on the economical nature of Grass Valley quartz lodes in general, that those mines that are properly worked are earning handsomely, while those that are now shut down and filled with water are known to have paid. Hence, many of these dormant enterprises were not disastrous failures, nor did their working incur losses to the owners; but, on the contrary, a number of them yielded profits, notwithstanding the crudeness, the waste, and the great expense attached to early mining and milling methods. Oftentimes, indeed, merely a lack of the necessary capital to put in suitable pumping and hoisting machinery was the sole reason for shutting down—intended at the time to be

only temporary. In other cases, the exploratory and development work was hardly carried a foot in advance of stoping, nor a dollar contributed from the profit account toward a fund to maintain a healthy proportion between the exploitation of ore and the opening up of new ground, to thus insure the mine's prosperity from year to year. Indeed, this hand-to-mouth system has only recently been radically changed by the advent into the district of Mr. Hammond, whose energy and influence have played an important part in the resuscitation of Grass Valley mines, and whose efficient management of the famous Empire and North Star have brought about a greatly needed reform, for which he has received much credit in San Francisco mining circles.

The most conspicuously favorable features of the Grass Valley belt are found in the facts that, first, the bottoms of all the active properties are in good ore, some quite above the average grade, which has given rise to claims of increasing richness in depth; secondly, that the occasional accidents and interruptions in the past working of the mines were not brought about, in most instances, by a giving out of the ore either in depth or in the direction of the strike (measured across the chimneys), for many of the at present inactive claims named in the foregoing list are known to have faces of pay-ore exposed in the extremity workings, on the strike and dip, and also standing in some of the stope contours. Some of these apparently forsaken ex-dividend properties combine, therefore, the elements that go to make good mines and insure for them an important part in the future, when a more general and vigorous development shall be resumed—a new era in Grass Valley that may be confidently predicted as not far distant. Then, too, it should here be considered, as having an important bearing on the future possibilities and probabilities of these properties, that many of their good records were made at a time when labor was $4 and $5 a day, instead of $3, as now, the thorough saving of the sulphurets on an economical scale undreamed of, and the standard of systematic mining, as well as the principles and practice of milling, much lower than nowadays, when ores of considerably lower grades are profitably worked.

The basis of the long-continued remunerative mining at Grass

Valley, which has stood up against many extravagances of management, lies in the remarkable continuity and persistency of the ore proper in the ore-bearing ground and in the liberal proportion of such ore ground to the total vein area. This ideal lode development in respect to the quantity of pay-ore, which is favorably distributed in chutes or chimneys of unusual width, as compared with the ordinary proportion of the width of a chimney to its extent on the trend, fairly assumes, in such properties as the Empire and the North Star, the appearance of continuous ore zones or sheets of ore running through the entire claim, and broken alone by occasional spots of lean ground; that is, the chutes appear to be about as extensive in a horizontal as in a downward direction. And this exceptionally liberal ore-deposition stands out so prominently in comparison with the average lode structure of quartz mines that it suggests some reflections in regard to mining experiences in general. A survey of the field shows that there is no scarcity of ore-deposits from which specimens and small lots of mineral can be obtained, which, in respect to grade and quality, are "pay-rock"; that is, the factor of *quantity* is found less frequently than *quality* of ore, in a degree sufficiently favorable to constitute a basis for a pay mine. And hence in the greater number of the failures of mining ventures, an insufficient quantity, rather than an inadequate grade of ore, is at fault, although it is not denied that a fading away of the precious metal contents and a transition into ore-bodies of too low a grade to work profitably are also frequently met with. The overlooking, in the examinations of developed mines, of the relations between these *natural essentials*, is at the bottom of many mistakes in mining judgment, and has caused not a few of the lamentable disappointments in the industry. Indeed, it seems almost impossible for some people to distinguish between *vein* and *ore*, which words, to the uninitiated, are practically synonymous. They do not stop or care to think that veins, even "*true fissures*" (!), exist without any ore in them, or that a vein may be true and satisfactory in all geological and mineralogical particulars with the sole exception as to the amount and dimensions of the ore-bodies it contains, the latter being often so aggravatingly distributed and limited as to always keep the mine in a most promising appearance for dividends, which, alas! are

doomed never to be earned, and assessment upon assessment is substituted.

The Grass Valley mines are not sustained by huge chamber bonanza ore-bodies, in point of thickness between walls, neither do they depend for their life on a thin, high grade, sensational pay-streak; for there is an abundance of lodes with as rich ore; but the district is supported by a lode system containing extensive, never-failing, and generous ore-channels, of which class of ore-deposits these mines are typical representatives.

Taking collectively the records of all forms of gold deposits in Nevada County, it is highly probable that no mining district of equal area exists that has produced as much gold. And while it is true that the annual production has recently become diminished, owing to the depression in placer mining following the sweeping legal decisions on the *débris* question, yet the flourishing condition of the quartz mining industry justifies the assertion that no known region has the promise of greater mining permanency.

VI.

THE MILL OF THE NORTH STAR GOLD MINE, GRASS VALLEY, CALIFORNIA.*

The recent erection of a 30-stamp mill and the introduction of water as a motive power for both the mill and hoisting-works give the North Star Mining Company in respect to design, equipment, and economical working one of the most complete and perfect plants on the Pacific coast.

The plant, which was built almost entirely by the Risdon Iron and Locomotive Works, of San Francisco, consists of the following machinery:

1st, hoisting engine; 2d, pumping plant; 3d, compressed air and drill plant; 4th, 30-stamp mill of the most approved California pattern; 5th, water-works and pipe system affording water power under 250 feet head to all the foregoing machinery.

With the exception of the mill, the entire plant can be run either by steam or water, and can be changed from one to the other in a few minutes' time.

The mill in particular, which is described in the following, is as near perfection as money and experience can make it. The buildings are of the most substantial nature, and are fitted with separate turbine wheels, thereby enabling each department to run independently of the other.

The tail water of the "original Empire mill and mine," the oldest going gold mining enterprise in California, is conveyed through a line of 24-inch wrought-iron pipe 10,000 feet long to the North Star mine, with a pressure of about 250 feet head. At the latter place, near the hoisting-works, the 24-inch pipe branches into one line of 16½-inch pipe running to the mill below the hoisting-works, while a 14½-inch branch runs into the hoisting-works.

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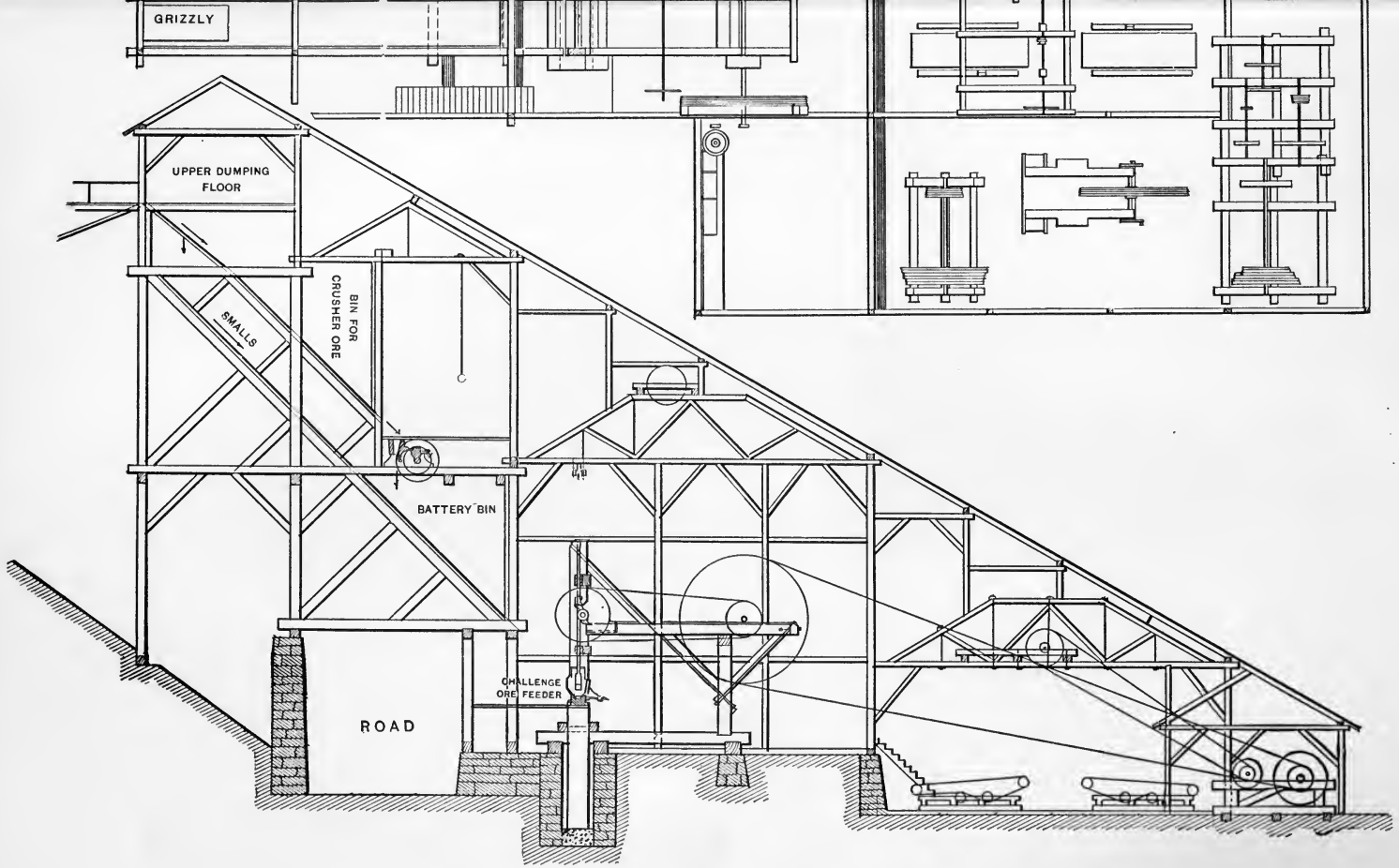
* From *The Engineering and Mining Journal*, New York, June 4, 1887.

The pipe line is constructed of the best material, and is hydraulic riveted throughout. It is carefully coated with asphaltum and coal tar, and, with a little attention, should be as good in twenty years from now as it is to-day. Heavy material is used throughout, to allow for deterioration, and the working strain on no part exceeds 12,000 pounds per sectional inch. The line is provided with air valves, blow-off and stop valves, and also with air chambers near the works to prevent shock or jar in the pipes.

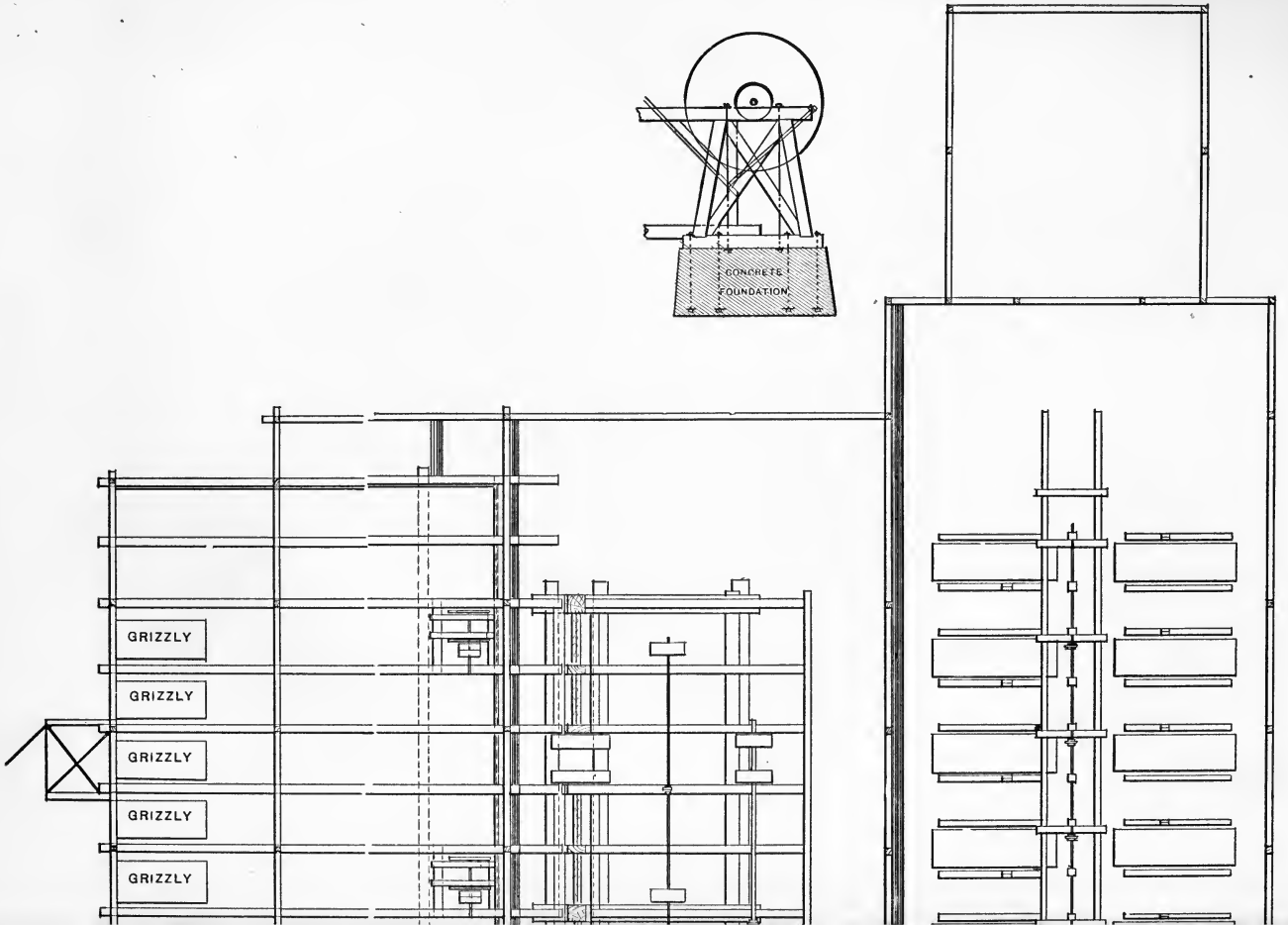
The branch running into the hoisting-works conveys the water for the motors of the hoisting and pumping machinery. These motors consist of one five-foot Pelton wheel for the hoisting machinery, equipped with deflector nozzle and a Moore's differential hydraulic gate (both being operated from the engineer's platform), and two Pelton wheels, of six feet and eight feet diameters respectively, both of which are mounted on the same shaft in a substantial framework, for the pumping machinery. This latter arrangement facilitates the changing of the pumping capacity at the shortest notice by increasing or decreasing the speed.

Below the hoisting-works and connected with the same by a substantial bridge is the thirty-stamp mill. The bridge referred to is on a level with, and is the extension of the landing platform of the hoisting-works, from which the ore is dumped into the upper part of the mill.

The ore, as it comes from the mine in cars, is trammed across the bridge and dumped over grizzlies into an ore-bin of 2,000 tons capacity. The coarse raw ore which passes *over* the grizzlies accumulates in a separate bin, and is fed to two improved Blake crushers. The ore thus crushed joins the fine ore which passes the grizzlies and accumulates in the main bins which supply the stamp batteries. The latter are six in number, carrying five stamps each, with single discharge mortars, and are fed automatically by six Challenge ore feeders. The dies, shoes, tappets, and cams are made of the best Pittsburg steel; and the cam shafts, each of which carry ten stamps, are of the best hammered scrap iron. Weight of Stamp, 870 lbs. Drop, 8 inches. Screen Frames, $56\frac{3}{4}'' \times 25''$, outside, with openings opposite each stamp. No. 30, Brass Wire Screen. One Iron Sluice Apron, $57'' \times 54''$. Two Iron Sluices, $25'' \times 77''$.



THE NORTH STAR GOLD MILL, GRASS VALLEY, CAL.—BUILT BY THE RISDON IRON-WORKS, SAN FRANCISCO.


CONCRETE
FOUNDATION
GRIZZLY
GRIZZLY
GRIZZLY
GRIZZLY
GRIZZLY

Provision has been made for ten additional stamps, for which the necessary space, power, and foundations are at hand. From the batteries the ore pulp passes through cast-iron sluice-boxes, provided with amalgamated copper plates, and thence on to shaking-tables. These shaking-tables, of which there are six (one for each battery), are 4 feet wide by 12 feet long; they are constructed entirely of wrought-iron, and are also provided with copper plates. From here the pulp is run through pipes on to twelve "Triumph" concentrators.

To facilitate and expedite cleaning up, the mill is furnished with a cleaning barrel, a batea, and a clean-up pan.

Extensions of the main mill building form the sulphuret and retort room on one side, the turbine and compressor room on another side, and a clean-up room on a third side. The clean-up room contains cast-iron cleaning tanks, covered with marble slabs, wash-stand, and clean-up pan. The compressor room contains a 14-inch by 24-inch duplex compressor and air-receiver, the latter being connected by pipes with an air-receiver in the hoisting-works, which supplies the compressed-air drills in the mine. The wheel-house contains the water-wheels (vertical turbines) which drive the different departments of machinery as follows:

One six-foot Pelton wheel, giving motion to battery line shaft by means of four two-inch hemp ropes;

One four-foot Pelton wheel, giving motion to rock breaker counter-shaft by one $5\frac{5}{8}$-inch wire rope;

One three-foot wheel of the same pattern, giving motion to concentrator counter-shaft by one $1\frac{1}{2}$-inch hemp rope;

One six-foot Pelton, driving 14 inches by 24 inches duplex compressors by four 2-inch hemp ropes with sheaves of different diameters for changing the speed.

The water-wheels driving the batteries and concentrator counter-shaft are each provided with hydraulic governors that are so necessary in securing the uniform operation required for efficient stamp mill and concentration work. Revolution counters are attached to the batteries and concentrators, and a hydraulic pressure gauge indicates the variations of pressure in the pipes.

The necessary mill water is drawn from a tank on the bridge

level. The water from the tail race in the hoisting-works is lifted to this tank by a centrifugal pump and heated to a temperature of about 100 degrees by the introduction of a jet of steam from the boiler. From the tank, a 4-inch pipe leads the water to the mill, where it is distributed by a series of smaller pipes and valves to the batteries, concentrators, and clean-up machines. The roofs of the buildings are covered with corrugated iron plates and with a number of 2½-inch fire hydrants, thus affording an excellent protection against fire.

VII.

ANOTHER CONCENTRATOR.*

The process of ore-dressing or mechanical concentration, in the United States, is gradually reaching proportions only comparable in economic importance with the scale of operation and perfection of that art in almost all of the great mining regions of European countries.

Until within the past four or five years, the receiving-floors of sampling, milling, and smelting-works in the West have been stored almost exclusively with raw ores, coming directly from the mines, where waste-dumps were accumulated, rich in the lower grades of mineral ill-adapted in the natural state to profitable transportation and metallurgical treatment.

But of late years, the products of concentration make up a formidable proportion, sometimes the bulk, of the smelters' ore supply; and the reduction-works at Leadville, Denver, Pueblo, Durango, Omaha, Salt Lake, Wood River, and other metallurgical centers are now filled with the "concentrates" of ore-dressing mills, testifying to a greatly increased efficiency in the exploitation and turning to profit of ore-deposits. Indeed, the maintenance of many lucrative mining operations in such thriving districts as Leadville, San Juan, and Wood River is solely dependent upon the successful dressing of the lower grades of ore, which fact of itself goes to prove the growing importance of that branch of mining engineering.

But before we shall have completely attained in American mining the thoroughness and technical completeness characteristic of the industry in the old country, a broader appreciation must be had of the benefits to be derived from an extensive application of concentration, carried to a finer degree of economy

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* From *The Engineering and Mining Journal*, New York, August 28, 1886.

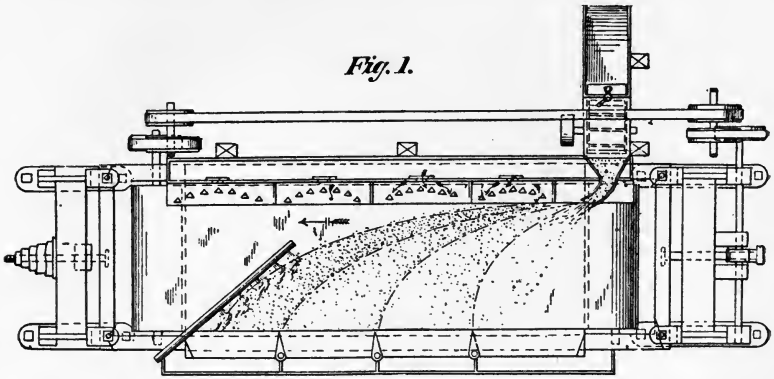
in point of a more general dressing of sands, coarse pulps, and slimes, which are too often inefficiently treated or allowed to go to waste.

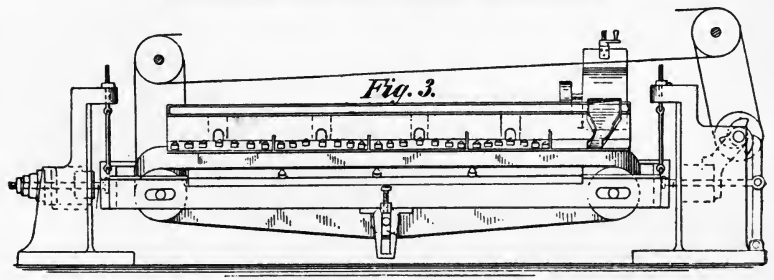
The process of concentration, sometimes ultra-expertly termed "dynamical metallurgy," has been vaguely construed and imperfectly understood in certain mineral regions of the West. This is, perhaps, in large measure, owing to the perplexity growing out of the fact that concentration belongs among the arts in which practical experiences often differ materially from the theoretical results of complicated computations developed under assumed ideal conditions; and on this account it is highly probable that, among the branches that command the attention of the specialists in the profession, there is none requiring so complete an understanding of both the theory and practice, and a familiarity with the business conditions involved in the various problems at issue, as does the concentration of ores. And while the value of the theoretical studies is not intended to be underrated, yet it is evident that if the ore-dressing specialist cannot be expert in all three requirements, he may better sacrifice the higher mathematical knowledge of the behavior of different substances in various mediums, under variable conditions, than be deficient in the experience and practical business sense necessary to a successful solution of the problems coming within the province of the art.

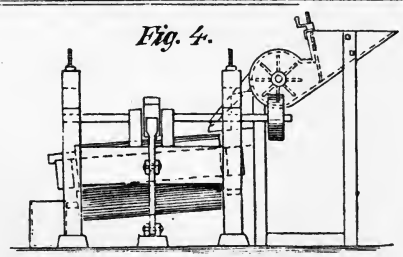
Ores are not infrequently met with in which the specific gravities of the valuable and worthless ingredients, although favorable to a fairly good separation, act, on account of other physical peculiarities, so nearly alike, subjected to mechanical treatment, that separation is rendered practically impossible. Hence the necessity for exhaustive experimentation as a preliminary in deciding upon the concentration properties of an ore.

However, not alone a neglect in making such preliminary tests is the cause of many of the failures of concentration schemes; for it has happened that all the laboratory work has been carefully done and the plant properly appointed; but alas! a thorough mining examination was not undertaken, and, after a few days' run, the source of the ore supply has proved inadequate to the capacity of the mill, and the prime requisite to the success of a formidable concentration enterprise is found want-

ing, namely, *large masses* of suitable low-grade ore exploitable at a cost sufficiently below its net metal value to leave a margin for profit over and above the expense of hauling, dressing, and the unusually heavy losses involved in the mechanical process, be-







THE CORNING CONCENTRATOR.

sides the *pro rata* cost of transportation and treatment of the concentrates according to the concentration proportion attainable.

The investigation of this fundamental requirement is quite as much a matter for underground inspection and mining judg-

ment as it is a question demanding the subjection of the ore to panning and other decisive tests; and as a general rule, which, truth to tell, is too little adhered to by enthusiastic Eastern companies, the erection of costly plants should invariably be preceded by satisfactory developments insuring a constant ore supply.

Among the conditions under which Western mines are operated, in mountainous and somewhat inaccessible localities, the expense of transportation is an important item in swelling the cost of production. And in such districts, other things being favorable, the chief advantage of dressing is to be looked for in the saving of freight consequent upon effecting a certain concentration proportion of the valuable metallic constituents. Here it may be mentioned that the disasters of custom ore-dressing works are frequently to be traced to the placing of mills at points, perhaps central as far as accessible situation goes, but at such distances from the mines that yield the bulk of the mineral that the cost of hauling the raw ore to the works is just heavy enough to absorb all the profit of the process and defeat the main object of mechanical treatment. Owing to this mistake and to the unsuitable, scattered occurrence of low-grade mines in one and the same district, custom concentration, generally speaking, has not proved very successful.

The most difficult part of ore-dressing is notably the washing of the sands, coarse pulps, and slimes. The processes followed in the mechanical treatment of these fine products involve at once a disproportionate amount of time, trouble, expense, and loss, besides an intricacy of management, as compared with the concentration stages of coarser-grained material.

The realization of these complexities and of the imperfections attending the treatment of the pulverized products, which suggest the necessity for improvements in the automatic action and capacity of buddles, percussion-tables, and vanning machines with the object of increasing the purity and efficiency of pulp-washing, is evidenced by the many machines and devices toward the patenting and introduction of which inventors are directing their efforts.

The vanning principle, in its various modifications, has apparently predominated, and earned the most important position

in the United States among the machines that handle crushed products below a fineness suitable for concentration on jigs.

Although it must be acknowledged, practically if not theoretically, that a complete separation cannot be continuously produced in one operation (for, in attempting to make pure "*heading concentrates*," free from the worthless gangue material, "*tailings*," there will always be a transitional zone of intermediate richness, "*middlings*": and in general any attempt to eliminate the latter product will result in either making *lean headings* or *rich tailings*), still the most popular of the modern dressing-tables have in view the effecting of a perfect, continuous separation, that is, to do clean work with a minimum loss; and in the construction and operation of such vanners, little or no account has heretofore been taken or provision made for the middling grades of material.

The concentrator that is the subject of this article, recently patented by the writer, not only separates the heavy and valuable metalliferous particles contained in ore pulp and mill tailings from the gangue or waste material, which is the light and worthless portion, but the concentration is carried to a finer grade of perfection in that the machine also effects a separation of the several kinds of valuable ore particles into different classes, according to the metalliferous-mineralogical constituency of the ore under treatment.

The peculiar advantages derived from the operation of this machine are the following:

1st. Middling products can be made.

2d. Such intermediate or transitional zones can be regulated as may appear necessary to preserve the purity of the headings and the leanness of the tailings.

3d. The middlings from these machines can be continuously and automatically drawn off and subjected jointly to another dressing on a "middling" vanner, to extract the remaining valuable product, from which second operation the tailings and middlings will be sufficiently impoverished to be thrown away.

4th. The subdivision produced by this vanner, in certain zinc and pyritous ores, renders the compositions of the several classes of concentrates better adapted to subsequent metallurgical treatment.

In ore-dressing *parlance*, this machine might be termed a Rittinger side-percussion vanner. Its superiority over the old Rittinger table consists in the banded shape of the apron, namely, the shortness of the table, measured in the direction of the incline, which is made possible to use under the peculiar order of arrangement and combinations of the machine. By means of the movement imparted to the pulp particles by the traveling belt, in addition to the forward propulsion characteristic of the Rittinger percussion, the parabolic zones are elongated and their respective discharges from the table are more easily regulated by variable quantities of clarifying water led on to the apron in flows of varying width and power. These ore parabolas on the old Rittinger table, with fixed, solid bottom instead of a comparatively narrow belt, whose line of travel is horizontal as peculiar to the machine in point, are more closely crowded together; and from their shape and narrow course down the table, with only small diversion from the line of the table's dip, these parabolic stripes are exceedingly sensitive and easily diverted from their normal paths by slight irregularities in feeding and in the pulp composition.

The modification of these features and the more advantageous drawing out of the pulp are among the distinguishing marks of this concentrator.

Fig. 1 is a plan view of my vanner, showing the parabolic curves formed on the traveling apron or belt by the particles of the ore-pulp fed thereon and separated in the order of their specific gravities during the progress of concentration and separation. Fig. 3 is a plan view of this side-percussion vanner, showing the rollers over which the traveling apron is carried and also the roller for tightening the same. Fig. 4 is a cross or end view showing the lateral inclination of the belt with a pulp-mixer.

In the preliminary working out of this machine, which was experimented upon by the writer for a long time prior to its publication in patent form, a very complex ore in one of the celebrated mining districts of Europe, consisting of galena, arsenical pyrites, iron pyrites, and zinc-blende, with a quartzose, calc, and fluor-spar gangue, was successfully worked.

The pulp from this ore, which passed through a one mm.

stamp-battery screen, was first graded into five classes in an ascending stream classificator. The first class, or coarsest pulp, was worked on a continuous four-compartment jig, while the remaining classes of the pulp were dressed on plain, longitudinal percussion-tables involving much hand-labor and many washings before a marketable product was produced. The diversion from these percussion-tables and the treatment of the second, third, fourth, and fifth divisions of the pulp on my machine gave, continuously, pure market products, corresponding to the grades of concentrates produced by the automatic jigging of class No. 1, referred to above.

The extreme delicacy of this concentrator, and the striking perfection with which the comparatively speaking infinitesimal amounts of the different minerals were actually made to walk out from the impure pulp mass, were thoroughly proved, and should insure a successful future for this machine.

VIII.

UNPROFESSIONAL OFFICE AND LABORATORY MINING REPORTS.*

A PRACTICE injurious to the mining engineering profession, or, more collectively expressed, to all those professing to be mining engineers, has long existed in the United States.

Not to become too personal, some recent manifestations of these malpractices have appeared in various forms in our Eastern cities, which deserve to be strongly denounced through the interesting and influential columns of your valuable journal. This frequently recurring evil consists substantially in the writing of reports and indorsements of mining and metallurgical properties and ventures, based, not on direct personal investigation of fact in the field, but on such indirect, incidental evidence as hearsay reports, designing correspondence, friendly corroboration of represented facts, census statistics, specimen assays, etc.

All these sources of information, not to speak of being generally unreliable and misleading, are at the most only of secondary importance as compared with conscientious, expert sampling, surveying, thorough investigation of the actual qualitative and quantitative ore occurrence, conditions of commercial situation and all other essential economic features which are only to be ascertained on the ground and capable of being judged in their bearing on the questions at issue, after careful detailed inspection and weighing, from a business and expert point of view.

During periods of prosperity when a better, or at least a more charitable, feeling toward mining operations prevails in business circles, and the failures and disappointments so frequently attached to ventures of this class begin to be forgotten, the public,

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* From *The Financial and Mining Record*, New York, July 10, 1886.

waking up to the money-making inducements afforded by legitimate mining, and considering the numerous schemes which are at short notice created to meet the first indication of a revival of the speculative interest, are at once confronted with documentary recommendations of this worthless kind. And strange to say, these so-called "Reports" are over the signatures, not alone of men of pretended engineering qualifications; but the names of well-known assayers, chemists, metallurgical and mining engineers, who might naturally be expected to have reputations at stake, are sometimes found as willing expert indorsers.

Whether intentional or not, the style in which such documents are written, is calculated to deceive the casual reader into believing that the writer is submitting a verdict based upon individual examination and experience, *i. e.*, an unbiased, final, and authoritative judgment to the best of his professional ability.

The superficiality of such reports is often so daringly disguised that there is not even a slight reference to the source of the information, much less an admission of inadequate evidence on certain salient points. Indeed, the wording is so cleverly arranged that the detection of their true character and worthlessness is difficult even to other engineers subjecting the documents to close analysis. Everything is stated in most positive language, and no encumbering "ifs" or conditional clauses are allowed to enter in to weaken the style and force of these convincing reports.

While the casual observer, however, may not detect their emptiness, a second reading by one on the alert discloses the fact that the author is only giving the gist of some one else's pretended belief, and as a matter of fact, has not thoroughly investigated into the conditions of the case under discussion, but merely indorses blindly a second party's opinion who, by the way, has almost always a pecuniary interest in the ultimate results gained by his "expert's affidavit."

It is self-evident that the great defect in this kind of office work is the fact that the element of individual mining and business judgment, which should be the pith and main object of a professional report, is almost wholly excluded from opinions rendered under these circumstances. It naturally follows, however plausible the tenor of the document, that owing to the uncertainty of the accepted premises, the recommendations will be

one-sided and theoretical — worthless as a decisive basis for action.

Now in regard to experting and what is ordinarily meant by that much-abused term, no claim is made to clairvoyance and kindred fanciful accomplishments, sometimes erroneously claimed by, and more commonly expected of, the profession. But it is firmly believed, whatever be the proper appellation, that there is such a thing as successful discrimination and choice in the recommendation of mining properties and metallurgical projects; and moreover, other things being equal, that the best judgment to follow as a guide for the promotion and prosecution of such industries is that of a man educated in the scientific branches involved in the finding, exploitation, and treatment of ores, balanced and rounded off with business and professional experience in the field. With honesty and the ordinary amount of natural adaptation and talent necessary to achieve success in other departments of professional life, the work of the expert mining engineer is entitled to a high position of authority, and is just as valuable and safe to follow as is the advice governing the ventures and operations in other lines of industry.

It is not denied that in consulting practice, questions will be asked and information must be given concerning certain important points, forming part of the main problem; but the adviser in such cases should be cautious in committing himself, and not be deluded into twisting and broadening his work to an unwarranted limit, merely to further the ends of his enthusiastic client.

The intensely speculative character of the people by whom mining engineers are often employed, brings to bear many influences to warp professional judgment. And it behooves engineers to guard against such a disposition on the part of promoting employers; and in avoiding the pernicious phases of expert work, the profession will become elevated to the dignity becoming its importance and requirements in point of capacity, training, and education.

IX.

THE CHOICE AND LEGITIMATE OPERATION OF MINES.*

In replying to "Subscriber's" request for some enlightenment on the question of *selecting mining property* and the possibility of profitably operating desirable mines on *legitimate principles*, I take pleasure in supplementing my last communication with the following brief remarks:

The consideration of this subject is especially appropriate in relation to mines of the precious metals which, for the most part, are made the bases for the irregularities and abusive speculative transactions which so frequently cloud the mining industry of the United States; while, on the other hand, the operations of coal, iron, and copper properties have, generally speaking, long since settled down into comparatively steady enterprises, and are no more questioned as to their legitimacy or classed among the so-called "extremely hazardous gambles."

But it should be noted that the exhaustive discussion of these questions might properly constitute the subject for an entire volume, for the publication of which it is not to be presumed your valuable journal could allow the necessary space. Such elaborate treatment would involve at once a review of precious-metal mining in the United States, and would also embrace a somewhat comprehensive synopsis of mineral deposits and vein phenomena, in their bearing on economic mining—more especially with respect to the influences of such natural conditions on the business chances of mining ventures.

A mere cursory analysis, however, of the records, facts, and ultimate issues of various mining operations, from the standpoint of their pertinency to the theme under discussion, leads

* From *The Financial and Mining Record*, New York, July 24 and 31, 1886.

undeniably to the conclusion that the accumulated data of experience in the United States, from the early working of the famous Comstock lode in Nevada down to the present time, constitute a store of practical field knowledge inestimably valuable to those administering the gold, silver, and lead interests of the Western States and Territories, in furthering the accuracy of professional decisions upon the numerous questions pertaining to the degrees of valuation to be placed on mineral properties during progressive stages of their development.

On the other hand, mines that pay to work are characterized by certain favorable features in the qualitative and quantitative mineral occurrences, in the distribution and continuity of ore bodies, proportion of stoping ground to barren vein matter, degree of profit yield or the credit balance under a given scale of operation,—*i. e.*, with the maintenance of a fair, healthy proportion between dead work and stoping ground,—the returns left after deducting the total expenditure and interest involved in such exploratory development work and exploitation from the revenue accruing from the ore or bullion production, are a criterion of the remunerative capacity of the property under the peculiarities and conditions of location. And on the other hand, the characteristics of unremunerative properties, considered as a whole, are equally pronounced to the educated engineer of capacity and experience, the chief distinguishing mark being generally the absence of all the principal features essential to pay mines; and if such qualities are not totally missing they are, at most, present in a very weak, indefinite, and unsatisfactory degree, precluding, if not the possibility, at all events the business probability, of paying.

It is not claimed that the dividing line between these two extreme groups of mines is sharply defined; nor is it denied that there is a gradual transition or merging into one another of the economic and uneconomic features; for, broadly speaking, Nature has created mineral deposits of all degrees of worthlessness and profitableness.

But to the intelligent capitalist, who operates on conservative principles and avoids dealing with mere mineral indications and other prospects of uncertain character, a classification of mines into three kinds presents itself, namely:

1. Pay Mines of determined character and computable value.

2. Transitional Mines, in an unremunerative condition, but bidding fair to develop into paying properties.

3. Undeveloped Miscellaneous Claims and Prospects of uneconomical nature.

The first of these divisions comprises only rare exceptions, while classes 2 and 3 include the bulk of all mineral discoveries and claims; and their indiscriminate, blind development on exaggerated representations largely for speculative purposes, has caused the frequent lamentable losses and disappointments in mining enterprises.

But infallible success can no more be expected of mining than in other lines of industry; for in the same measure that Nature has irregularly, and, it must be acknowledged, somewhat disappointingly, distributed ore bodies of variable grades and dimensions, there will be in mining ventures, even when conducted under fairly favorable auspices, corresponding uncertainties and failures. While, therefore, the masses during periods of inflation and wild speculation on the apex of a cycle of prosperity must necessarily lose, as will also be the experience in all lines of industry for those "buying in recklessly at the top," nevertheless, the efforts of corporations equipped with an honest, able guidance, can meet with success, if operating alone with first-class mines; and under these circumstances, the capitalist will be found *to win in the average of his ventures and reap a profit*, if not on the par capitalization of his company, at least *on the actual cash investment*, far greater and less hampered by the influences of competition than in any other business.

This selfish policy of only choosing the "cream" in mining, it may be argued, would lead to a dangerous stagnation in the development of the country's mineral resources; and in consequence of such a serious limitation, many good mines would go undiscovered for want of the co-operation of capitalists in sustaining vigorous prospecting. To this it may be replied that the intoxicating fascination, almost inseparably associated with mining, will, in a country like our own, whose people are fairly saturated with speculative enthusiasm to the extent of being natural risk-takers, always prove an irresistible attraction to visionary people who, with a superficial knowledge of mining and an

erroneous conception of the real nature of a "mining risk," will spend their time and money romancing through the mountains and "assessment holes" in search of the much-dreamed-of Bonanza mines. These prospectors are a good-natured, warm-hearted class of mining adventurers; but in face of the fact that only in very rare instances are their efforts crowned with financial success, it is self-evident that a most imaginative, sanguine temperament is necessary as an incentive to such a vocation. And after much weary labor and repeated disappointments in "hunting for a lead," serious disputes, conflicts of title, and not infrequently the total expenditure of hard-earned savings, the prospector, with his restless, roving disposition, is wont to become discouraged, sometimes when his claim is on the point of developing into a property of merit.

This crisis in the affairs of the discoverer and early worker of mineral claims, is the most propitious time for the entrance of capital into the field of mining, because the primary risks having already been taken by the original owner, and "generous" ore exposures of profitable grade and dimensions having been "put in sight," it is a matter of common mining experience that such a valuable find has much better chances of continuing good and even improving, than a poor showing has of ever opening out into a paying mine. And at such a period the prospector, who has not the means, skill, and executive ability to conduct systematic operations under organized labor, can be treated with on terms favorable to both seller and purchaser.

How, then, is it that so much money has been lost in mining?

In answering this query, many unprofitable expenditures may be traced to one of the following sources: First and foremost, the *inevitable losses;* these are inherent in the nature of the mining business and are largely to be accounted for in the extreme phases of the eccentricities and irregularities of mineral deposits, such as faults, unexpected limitations of ore chutes, pinching, treacherous occurrence of the pay ore, pockety formations, etc. The latter class of anomalous deposits includes a great variety of mines, among which are found some of the most noted permanent and profitable properties in the history of the industry; although, as a whole, enterprises based on the working of a pocket property, as ordinarily understood, are wanting in continuity and have generally resulted disastrously.

The more conspicuously successful of these irregular pockets or so-called abnormal mines, however, are distinguished for a bonanza form of ore occurrence, consisting either of one body of unusually large dimensions, or they are made up of a continuous chain of pockets and ore chambers more or less connected and traceable by lode material and stringers along a certain geological plane or mineralized zone. The Leadville and Eureka deposits may be cited as types of this more regular and reliable class of pocket mines.

The undesirable variety of irregular properties, the working of which has caused many of the notorious losses connected with this group, consists of those deposits which are made up of ore bodies of limited extent occurring almost entirely disconnected with one another, or totally isolated; and in these mines the discovery of new ore-reserves is a pure gamble, with the chances against the miner, as there is no lead or other indication to follow as a guide to new ore ground.

But a second and most prolific source of disappointments and losses in the ventures of mining companies is to be looked for in what may be termed the *inexcusable or avoidable causes.* Here may be mentioned the purchase and working of uneconomical properties, under inferior advice and poor mining judgment; also the conducting of mining operations on bad financial principles, over-capitalized and inefficiently managed.

Every engineer and experienced mining operator knows that for years past the Eastern markets have been deluged with prospectus reports of properties which never warranted the attention of capitalists, much less being incorporated into companies of heavy capitalization under the guise of valuable mines. In innumerable cases groups of such mines (so-called), while hardly meriting the risk of further expenditure in their development, are not even entitled to the rank of fairly promising prospects.

It is one thing to open a prospect in an inexpensive way to the extent of a few thousand dollars, but quite a different business venture to work the same property under an expensive system involved in a corporate scale of operations. The first case may not result in material losses or great disappointment, because the "prospect risk" is fully understood; but in the latter case the community at large suffers serious financial losses combined

with dissatisfaction and a general cry against mining. Claims of this kind should not be presented to capitalists or placed on Eastern markets as "mines." In any event, if worked under corporate management, the risk attached to their development should be thoroughly understood to be a prospect chance and not a mining venture in the best sense, while the capitalization under which they are incorporated should be reduced to a minimum.

The method followed in promoting mining companies is also to a considerable extent responsible for many of the mistakes and failures in the prosecution of mining enterprises. The policy of the management is too often controlled by motives of personal interest, and the directors' efforts instead of inuring to the benefit of their company, in making ample provision for a liberal working capital and surplus fund, are frequently directed toward securing and disposing of bonus stock.

It is eminently proper that liberal interests should be allowed and commissions paid to parties through whose facilities and good judgment valuable mining interests have been acquired at prices which render their purchase exceptionally safe; and for similar reasons, under these circumstances, it is proper that a mine should be capitalized at a greater rate than the actual cash price paid in consideration for the property. But the promoters' commission interests, as well as the stock capitalization with which the property is loaded, should be consistent with reason and with the mine's value and business probabilities upon more extensive development.

There is a peculiar obscurity about mining which cannot be fully comprehended or judged by the public at large, in the same sense that other industries, admitting of more thorough investigation, can be grasped. Hence it becomes necessary that promoting firms and syndicates, who make a specialty of the business, shall be intrusted with the floating of good mines and with the financiering and management of mining companies. The position of these firms and parties is one of trust, and mutual confidence and good faith should be the foundation of their relationship with the speculative class of investors.

The elimination of many of the false methods of incorporation, inflation, and management, injurious to the successful prosecution of mining, rests with the promoters to effect.

But it sometimes happens that mines which have proven fairly successful are spoken of as "failures," when in reality they have returned the entire purchase price and working capital expended plus a speculative profit of, say, fifty per cent. or more; and as there is, perhaps, no market for the stock, owing to a temporary exhaustion as far as dividends are concerned, the ventures are described as swindles by a class of lambs who bought the shares at high prices during the dividend stage of prosperity.

And this leads to some erroneous conceptions of the nature of mining dividends with which the public mind is imbued. Mines, generally speaking, are not permanently paying producers; but frequently the profit return is so sudden and large that, although the dividends only extend over a few years, their aggregate amounts to as much, if not more, than in certain lines of industry which yield a smaller and more regular interest on the money invested. In so far, however, that mineral deposits are exhaustible, and the careers of mines are limited to a variable number of years, every dividend produced is in reality the subtraction of just so much value from the property; and on this account mining profits are not to be regarded as dividends in the ordinary manufacturing and railroad acceptance of the term. We may, therefore, properly speaking, regard a mine as a "big specimen," whose exploitation will yield a probable aggregate product which may be considered as a varying annuity lasting a certain number of years. Graphically represented, a mine's life is something after the fashion of a crescendo with a corresponding decrescendo: At first a small product, increasing to a maximum as the mine becomes extensively developed, and finally decreasing as the point of exhaustion is approached. These variations must be allowed for and will naturally influence the stock quotations. Too commonly, however, no account is taken of the fast approaching decline in the property's prosperity; and the dividends, though they may have been declared to the extent of several hundred or a thousand per cent. on the first subscription price of the stock, have been spent as liberally and with as much assurance of continuance as the proceeds from the coupons of Government bonds. Apparently, at the brightest moment, a decline sets in which carries the price of the stock, relatively speaking, out of sight. Dividends are spent and the capital

originally invested has disappeared, and mines in consequence are strongly denounced.

To counteract this disparaging influence the stockholder should set aside regularly a share of the accruing dividends to eventually reimburse himself to the amount of his investment. Or, mining companies might, after first devoting their earnings to the accumulation of a surplus fund for bridging over periods of temporary exhaustion, cut down their rate of dividends say one-third, devoting only two-thirds of the mine's earning capacity to stockholders and depositing the remaining one-third in trust to be eventually divided out *pro rata* on the stock in amounts equal to the original subscriptions, so that each certificate would carry a right to a share in such a subscribers' sinking fund. Stripped of all incumbering defects in the methods of acquiring and managing mines, by compassing exact facts through honest and intelligent investigation and the *devotion of the same careful attention as is necessary in other departments of business, mining becomes a most attractive and relatively safe speculative pursuit.*

Already signs of improvement are discernible. The number of mistakes and wild-cat schemes is yearly diminishing; at the same time, all divisions of the precious-metal industries are fast settling down into legitimate employments.

The West is no longer dependent upon Eastern resources for the development of its mineral lands to the same extent as formerly, as the capitalists of San Francisco, Salt Lake City, Omaha, Denver, Leadville, and other prominent commercial centres, having implicit faith in their home industry, deal in mines at cash prices and work them liberally and intelligently. The regular profitable operations of many companies, never heard of on the Eastern markets, attest the success of Western ventures, and their regularly divided profits would be a matter of surprise to some of our skeptical business men of the East.

This steady progress and improvement at the fountain head, practically uninfluenced by long periods of depression in general trade, is bound to make itself felt in the near future; and the signs of the times point to a growing belief in the recognition of mining in its proper position. It is fair to presume that in the next boom mining enterprises will be better thought of and more intelligently conducted than has been their reputation in the past.

Since historic time mining has never ceased to occupy an exalted position in foreign countries where it has been favored with marked disposition to foster its interests in every way; and, moreover, those who are officially identified with the prosecution of the industry are envied in their positions of trust and authority.

In our rich and prosperous country the mineral resources, in their vastness and adaptation to economical working, are in proportion to all other natural advantages of this wonderful continent. And, being at the disposal of an energetic, rich, and venturesome people, there is every reason why the development of the mining interests of the United States should rank among the most legitimate and inviting pursuits.