1892.
NEW ZEALAND.

THE GOLDFIELDS OF NEW ZEALAND:

REPORT ON ROADS, WATER-RACES, AND OTHER WORKS IN CONNECTION WITH MINING.

Presented to both Houses of the General Assembly by Command of His Excellency.

Mr. H. A. GORDON, F.G.S., Inspecting Engineer, to the Hon. R. J. SEDDON, Minister of Mines.

SIR,— Mines Department, Wellington, 28th July, 1892.

I have the honour to submit my annual report, for the year ending the 31st March last, on the different works undertaken and constructed, either wholly by the Mines Department or by subsidies paid to local bodies, also on water-races under the control of the department, Schools of Mines, and generally on the development of the mining industry throughout the colony.

The different subjects are classified under the following headings: "Subsidised Roads and Tracks;" "Grants for Construction of Roads;" "Schools of Mines;" "Gold-mining;" "Quartz Workings;" "Alluvial Workings;" "Dredging;" "Locks at Outlets of Otago Lakes;" "Scheelite;" "Manganese;" "Discovery of Granite in the King Country;" "Mining Machinery;" "Limestone and Coal, Alford Forest;" "Hydraulic Pipes;" "Spontaneous Ignition of Coal;" "Explosions in Coal-mines;" "Last Examination Papers for Mine-managers' Certificates;" and statistical tables showing the value of works constructed.

SUBSIDISED ROADS AND TRACKS (NORTH ISLAND).

BAY OF ISLANDS COUNTY.

Road, Tamarere to Puhipuhi.—A subsidy of pound for pound, to the extent of £241, was authorised for the construction of a road across the Terehunga Gorge, and on towards Puhipuhi, to give communication between the mines in that district and Kawakawa. Out of the amount authorised £110 has been paid.

Road to Puhipuhi.—This is a road from the Whangarei–Kawakawa Road through the Puhipuhi Forest to the place known as "The Mast-head," where the hotel is erected, and where, if the field warrants it, a township will be laid off, the distance being about seven miles. The road is not metalled, and in winter-time it is very boggy and soft, but it will make a good summer road, and stand a fair amount of traffic. Its cost has been £1,396 17s. 9d.

COROMANDEL COUNTY.

Track, Coromandel to Kuaotunu.—For a distance of about fourteen miles between the end of the horse-track leading out of Coromandel towards Kuaotunu no work had been done until recently. The County Council estimated the cost of constructing a horse-track, so as to avoid the worst portions of the swamps and hills, at £750. A subsidy was accordingly authorised to the extent of £375. This money has been well expended, the road having been greatly improved, and the unexpended balance of £370 of the estimated cost will be sufficient to make a passable road for the whole distance.

Road, Sea-beach to Kuaotunu.—This road is partially constructed by subsidy of pound for pound to the extent of £300, and partially by a direct grant of £500. An expenditure of £900 has already been made; of which the Government have paid £700, leaving a balance of £100 yet to be paid as subsidy. The whole of the fuel for the different steam-engines has to be carted on this road, and it is also used to cart the quartz to the crushing-batteries. Only portion of it is metalled, and during wet weather the road becomes a perfect quagmire, and will, during the winter months, become impassable unless it is metalled. The estimated cost of widening and metalling this road is £800.

Road, Just-in-Time to Pumpkin Flat.—This is a dray road from the Just-in-Time and other mines to Mr Curtis's crushing-battery at Pumpkin Flat, to enable the claim-holders to send their quartz to the battery. Its estimated cost was £300, of which £150 was authorised as a subsidy; of this amount £120 has been paid.

Extension, Just-in-Time Road, Coromandel.—This road was required, as machinery had to be placed on Blagrove's Freehold to enable mining operations to be carried on. The estimated cost of the extension is £300, of which amount £150 was authorised as a subsidy.

Track, Kapanga to Paul's Creek.—This portion of the track completes the road between Coromandel and Cabbage Bay. Its cost was £200, of which £100 was paid as subsidy.

Track, Mercury Bay to Kuaotunu.—This is a horse-track between the end of the sea-beach dray-road to the mines and Mercury Bay, and opens up a good line of communication between the two places. The cost of the work has been £360, of which amount £180 was paid as a subsidy.

Thames County.

Subsidies on ten different roads and tracks in this county have been authorised, but the County chairman, on my recent visit to the district, informed me that the financial affairs of the county would not admit of nine of these works being at present undertaken. The estimated cost of these is £1,902, on which subsidies are authorised to the extent of £951, but it is expected that some of the works will be undertaken at an early date.

Road, Upper Tararu to Sylvia Mine.—This road was formed several years ago, but never metalled. As mining operations have, within these last two years, extended greatly in this vicinity, the traffic cut the road up to such an extent that it become impassable, and had to be metalled at a cost of £750. A subsidy was authorised to the extent of £375; of this amount £342 3s. 6d. has been paid.

Ohinemuri County.

Road to Waitekauri.— A new dray-road is in course of construction to avoid a steep hill on the road leading from Ohinemuri Valley to Waitekauri. The estimated cost of the work is £360, of which a subsidy of £180 was authorised; of this amount £166 17s. has been paid.

Road, Karangahake Hill.—This work consists of widening and metalling the hill-track between the site of the new bridge across the Ohinemuri River, at Karangahake, and the old Hauraki Mine. The cost is estimated at £200, of which £100 was authorised as a subsidy; of this amount £16 9s. has been paid.

Road, Karangahake through Gorge.—This road was completed early last year, but it has not yet been metalled. There seems to be a good deal of traffic on this road, as it is now greatly cut up, and will be very bad this winter unless something is done towards metalling it. A direct grant of £1,000 was given towards its construction, and afterwards a subsidy of pound for pound to the extent of £100, all of which has been paid.

Road, Owheroa to Waihi.—This is for the construction of a deviation to avoid the steep hill between the Ohinemuri River and the Waitekauri Creek. The road is in course of construction, and will cost, when completed, about £600. A subsidy of pound for pound has been authorised to the extent of £300, none of which has yet been paid.

MIDDLE ISLAND.

Waimea County.

The County Council applied for and obtained two subsidies on pound for pound principle to the extent of £110 for repairs to track between Baton River and Karamea, and for constructing a track from Dove River to Baton Saddle, and from Rolling River to Wangapeka Saddle, but none of these subsidies have yet been paid.

Inangahua County.

Road, Globe to Merrijigs.—This was at first constructed as a horse-track, and is now being widened for dray-traffic. It may be said that the whole of the ground on the line of reefs between Rainy Creek and Merrijigs is held in claims, some of which are giving fair returns. This road will give a means of communication with the whole of the claims. The estimated cost of the work is £1,500, of which £750 was authorised as a subsidy; of this amount £698 13s. has been paid. It is now found that the balance of the money will not be sufficient to complete the work.

Track, Larry's Creek.—A horse-track was constructed some years ago between Larry's Creek and Coal Creek, and last year this track was extended, and is still in course of construction. The total cost is estimated at £1,220, of which £610 has been authorised as a subsidy; of this amount £530 17s. 6d. has been paid.

Road up Mangles Valley.—This is a road up the valley of the Mangles River from its junction with the Buller River to McGregor's station. The estimated cost of the work was £1,200, of which £600 was authorised as a subsidy; of this amount £300 has been paid.

There are four other roads on which subsidies have been authorised, namely: Horse Terrace to Hunter's station, £640; Golden Lead to Battery, £150; extension of road to Cumberland machine-site, £200; and extension dray-road to Boatman's, £50. Some of these works are said to be in progress, but no subsidies have yet been paid.

Buller County.

Road, Waimangaroa to Sea-beach.—This is a road to give the miners working on the sea-beach means of communication with the Township of Waimangaroa. The cost of the work has been £390, of which £195 was authorised as a subsidy; out of this amount £120 has been paid.

There are three other roads which are subsidised on the principle of pound for pound, namely: Cedar Creek towards Coalbrookdale, £50; Basin, Charleston, to Ballarat Creek, £50; and from the county road to United Alpine low-level, £50; but none of these subsidies are yet paid.

WESTLAND COUNTY.

Road, Hokitika Borough Boundary to Shallow Rush.—This work is completed, at a cost of £120, of which amount £60 was paid as a subsidy.

Track, New Rush, Back Creek.—This is the continuation of the horse-track constructed by direct grant, and also for the extension of a track to join the track from Rimu to New Rush with the track constructed up the valley of the Hokitika River to Back Creek. The cost of the work was £100, out of which a subsidy has been paid to the extent of £50.

Road, Rimu to Seddon's Terrace.—This is for widening the horse-track into a dray-road, to enable the miners on this field to get their supplies brought in by drays. The estimated cost of the work is £150, of which £75 has been authorised as a subsidy.

SOUTHLAND COUNTY.

Roads, Waikaia to Whitcombe, and Waipapa to Six-mile Beach.—The former road was completed at a cost of £161 6s. 8d., of which a subsidy of £80 13s. 4d. has been paid; and the latter road has been completed at a cost of £175, of which £87 10s. has been paid as subsidy.

Repairing Bridges, Waikaia Bush.—A balance of subsidy authorised for road, Waikaia to Whitcombe, amounting to £19 6s. 8d., was transferred towards repairing some bridges in Waikaia Bush; but this amount has not yet been paid.

ROADS CONSTRUCTED FROM DIRECT GRANTS.

Road, Thames to Manaia.—This is for completing the road between Thames and Coromandel. Portion of the work is in course of construction under the supervision of the Thames County Council, and portion under the supervision of the Coromandel County Council. The estimated cost of the work was £500; of this amount £77 10s. has been paid.

Track, Aorere Valley to Karamea.—This track has been in course of construction for the last nine years, and still requires about thirty miles to be made to complete it. During last year five miles of the track going down the Heaphy Valley was constructed under the supervision of the Collingwood County Council. The total cost of this work, including the contracts now in progress, has been £27,860 17s. 3d., of which amount £27,588 10s. 11d. has been paid.

Repairs to Nile Bridge, Charleston.—This bridge has been erected for the last fourteen years, and the cribwork foundations for the piers were giving way. These are being replaced with concrete. The cost of the work is estimated at £600, of which amount £300 has been paid.

Road, Cobden to Seventeen-mile Beach.—A dray-road has been constructed for some time between the Grey River and the Seven-mile Creek, but as this is a tidal creek it cannot be forded for about two hours both before and after high-water. A bridge across this creek is in course of construction under the supervision of the Grey County engineer. The cost of the work is estimated at £400, of which amount £250 has been paid.

Bridge over the Mahinapua Creek.—This work is being constructed under the supervision of the Resident Engineer of the Public Works Department, Greymouth. It is estimated to cost £500, but none of this has yet been paid.

Road, Rimu to New Rush.—This is the construction of partially a dray-road and partially a horse-track between Rimu and the diggings near Back Creek. The cost of the work was £829 17s. 9d., all of which has been paid.

Great South Road.—A portion of this road is being widened and metalled on the south side of the Waitaha River. This is the main line of road between Hokitika and Jackson's Bay, and there is a dray-road constructed from Hokitika as far as the Waitaha River, but from there southwards it is only a six-foot horse-track. Contracts have been let for widening and metalling about six miles of the road, which is estimated to cost £1,500. Of this amount £37 5s. 6d. has been paid.

Track up Waiho Creek.—A track is in course of construction up the valley of the Waiho River to give facilities to the miners to get inland. The estimated cost of the work is £100, of which £18 12s. 6d. has been paid.

Track, Jackson's Bay to Gorge River.—A horse-track has been constructed from the Arawata Valley to the Duncan River, and the survey of a road has been completed from the Duncan River to Lake McKerrow, and plans prepared. The total cost of the work up to the 31st March last was £5,310 10s. 11d.

Track, Haast Ferry to Gluepots.—A track is in course of construction between these points, under the supervision of the Westland County overseer. Its cost is estimated at £120, but none of this amount has yet been paid.

Repairs to Victoria Bridge.—This bridge is on the road between Cromwell and Queenstown, over the Clutha River. The wooden piers are becoming greatly decayed and unsafe for heavy traffic. The cost of new piers is estimated at £250. This work will be done under the supervision of the Lake County engineer.

Road, Arrowtown to Macetown.—There is a dray-road constructed from Macetown to within about one mile of Arrowtown, where the drays have to come down the bed of the river. This river is frequently flooded, which stops all traffic. A road is now being constructed up the side of the gorge, and £250 was voted last year for this purpose, but this amount will be insufficient to complete the road.

Road, Wakatipu to Milford Sound.—The survey of the first twenty miles from Lake Wakatipu was completed previously to the work done last year, but it is yet a question for further trial-lines to be made to see if the end of the surveyed line can join on to a road from the mouth of the Clinton River. The surveyed line goes up the valley of the Greenstone River and on to Lake Howden. This was undertaken after a report was received from Mr. Holmes, Resident Engineer in the Public Works Department, who was sent to make a reconnaissance survey of the route. Mr. Holmes reported in favour of a line up the Hollyford Valley to Homer's Saddle, and thence down the Cleddau Valley; but this route was, after further investigation, found to be utterly impracticable. The survey of the Lake Wakatipu end had been completed to near Lake Howden before this became known, and a reconnaissance survey was then made from Lake Howden to the head of the Te Anau Lake, which proved that a road could be constructed in this direction, but the line is not a good one.

At the Milford Sound end the road has been surveyed for four and a half miles up the valley of the Arthur River and the side of Lake Ada; and at the time of my last visit to this locality, in March last, about forty chains of a dray-road on the Milford Sound end had been constructed by prison-labour. It is intended to construct only a horse-track in future, but it will take a long time to connect the Sound with the head of Lake Te Anau. The cost of the work up to the end of March last has been £3,251 7s. 8d.

Road, Garston to Nevis.—This road was constructed over a range about 3,000ft. above the level of the sea, so that in winter time it is always blocked with snow. The construction of the road has, however, been the means of reducing the cost of carriage of goods to the Nevis by about one-third. This road passes through two counties, neither of which would for some time take it over, necessitating the cost of maintenance by the department before the Lake County would take charge of the road. The total cost of the work has been £1,545 18s. 8d.; of this amount £1,469 17s. 2d. has been paid.

Deviation of Road, Pleasant Creek Terrace.—The dray-road is constructed from Queenstown to the bridge across the Shotover River at Pleasant Terrace, but at the other side of this bridge there is an extremely steep zig-zag track. A deviation was proposed by the County Council to avoid this steep portion of the road, at a cost of £130, which was authorised. It was, however, found, after inspection of the work by Mr. Gow, the Inspector of Mines, that the deviation was being constructed with unnecessarily steep grades, and the department accordingly refused to give any money towards the work.

Road, Waiau to Preservation Inlet.—A survey has been completed for nine miles on the Preservation Inlet end, and the bush felled for a distance of six miles and a half to a width of 30ft., with clearing in the centre, so as to form a good foot-track. The total cost of the work to the end of March last was £356 13s. 4d.

SCHOOLS OF MINES.

Thames School of Mines.

The attendance at these schools shows that the benefits derived are better appreciated every year. During 1889–90 the average number of individuals who attended the classes at the Thames School was 33; for 1890–91 the number was 93; and for the last year the average number was 111. This included the Saturday classes; but independently of these classes the average number attending the school was 33, 45, and 58 for the different years respectively, or the number last year was $1\frac{3}{4}$ times as many as the attendance in 1889–90. When this school was first started many of the miners were under the impression that very little good would result from technical teaching beyond enabling them to distinguish the different classes of ores met with; but during my recent visit to this district every one spoke with well-merited praise on the good work being done. Students from different parts of the colony attended the classes last year, some of whom are men well advanced in years, showing that not only is the school appreciated in the Thames District, but that the results of the teaching are becoming known throughout the length and breadth of the colony. Indeed, one of the late students of the School of Mines attached to the University of Dunedin, who had gone through his course of mining training there and got his diploma as associate, was employed last year for some time at the Thames School as an assistant, and he informed me that he was perfectly surprised at the high class of teaching, the different subjects taught, and the progress made by the students attending the classes. The advantage of this school over any other in the colony is that many of the students are men well acquainted with the practical working of mines, and those who have not that knowledge can visit any of the mines and see for themselves by actual demonstration the different methods adopted in working a mine; this, together with a theoretical training, will indelibly imprint on the mind of a student a clearer knowledge of the subject he is grappling with, and in less time than it could possibly take were his education confined entirely to book-knowledge.

During the past year six different parcels of ore—as shown by the accompanying statement—were treated at the experimental plant, two of these being from Puhipuhi. One parcel of 84lb., from the Luminary Mine, having an assay-value of £1 8s. per ton, yielded bullion to the value of £1 3s. 4d. per ton; and the other parcel of 1,900lb., of an assay-value of £9 9s. 11d. per ton, yielded bullion at the rate of 91·5 per cent. of its assay-value. Both of these parcels were crushed dry, and afterwards treated by hot-pan amalgamation. Other three parcels of ore—two from the vicinity of Waitekauri, and one from the Thames—were crushed wet and treated by hot amalgamation, yielding 85 per cent. of the assay-value. In treating parcels with this test-plant the students have to do the actual labour themselves.

TABULATED STATEMENT of the PARCELS of ORE tested at the THAMES SCHOOL of MINES' Experimental Plant during the last Year (percentage saved not given).

Name of Mine and and District.	Quantity of Ore treated.	Assay-value of Ore per Ton.				Treated by Wet Crushing and saved on Copper Plates.			Treated by Hot Amalgamation and Chemicals.				
		Value.	Gold.	Silver.	Bullion.	Gold.	Silver.	Percentage saved.	Gold.	Silver.	Percentage saved.	Value of Bullion per Ton save .	Total percentage saved of Bullion.
	Lb.	£ s. d.	Oz. d. g.	Oz. d. g.	Oz. d. g.	Oz. d. g.	Oz. d. g.		Oz. d. g.	Oz. d. g.		£ s. d.	
Luminary, Puhipuhi	84	1 8 0	0 2 12	5 18 12	6 1 0	..	..	..	..	..	83·3	1 3 4	83·3
Waipu* „	1,900	9 9 11	1 5 1	33 5 3	34 10 4	..	..	..	1 4 12	22 19 12	91·5	8 14 0	91·5
Burtham, Waitekauri†	2,240	34 8 8	7 16 2	22 9 0	30 5 2	3 9 15	3 8 2	41·9	3 5 20	12 2 1	43·5	29 8 4	85·4
Dixon's, Thames ..	2,000	3 14 0	0 2 12	21 6 0	21 8 12	..	..	..	..	..	..	not given	..
New Find, Komata ‡	2,360	23 2 0	4 11 0	32 12 11	37 3 11	2 12 10	1 10 10	39·	2 3 14	18 0 5	46·2	19 5 0	85·2
Great Mercury, Kuaotunu§	95	..	..	..	..	..	..	..	..	..	..	..	..

* The percentage saved was 96 per cent. of gold and 68·4 per cent. of silver.
† 89·5 per cent. of gold, and 69 per cent. of silver saved.
‡ 90 per cent. of gold and 60 per cent. of silver saved.
§ Nothing in the ore. All silica.

The following is a report by James Park, F.G.S., the Instructor and Director, on the state and progress made at the Thames School of Mines for the year ending the 31st March, 1891:—

"I have the honour to report that the year just ended has been the most successful the School of Mines has seen since its inception, both as regards the efficiency and usefulness of the work and the attendance of students. The average number of registered students for the whole year was 58, as against 45 in 1890 and 33 in 1889, a result which must be considered highly satisfactory and encouraging. The practical character of the instruction has attracted students from all parts of the colony, and many miners have come to the Thames and secured employment in order that they might be able to attend the school and qualify themselves for certificates as mine-managers.

"It is now freely admitted throughout the Hauraki Goldfields that the practical and theoretical work of the Thames School has exercised a most beneficial influence on the mining industry, and I have much pleasure in stating that the jealous ignorance which has hampered scientific mining and stifled progress in many mining centres in New Zealand does not exist in this peninsula, where the practical miner eagerly embraces the opportunities which the School of Mines affords of learning the technical branches of his occupation, where the students of the school find ready and profitable employment, and where the latest scientific processes for the extraction of the precious metals are readily tried and as readily adopted when they have been proved successful. It is this progressive and enterprising spirit which has placed the Thames Goldfields, in the matter of gold- and silver-saving appliances and processes, so far in advance of the southern goldfields, and has enabled her low-grade ores to be profitably worked on a large scale.

"The attendance at the different classes during the past year is shown in the following table:—

"TABLE OF ATTENDANCE, Thames School of Mines, for Year ending 31st March, 1892.

Name of Class.	1891.			1892.
	First Term.	Second Term.	Third Term.	First Term.
Practical assaying and metallurgy	29	35	43	34
Practical chemistry and laboratory practice	22	20	24	25
Theoretical chemistry	22	24	24	25
Mineralogy and blow-pipe determination	5	7	7	11
Geology and geological surveying	5	7	7	9
Mining	29	22	17	15
Land and mine surveying	27	24	23	20
Mechanical drawing	11	11	11	12
Saturday Lectures.				
Theoretical chemistry	61	55	51	46
Total attendance at all classes	211	205	207	197
Total number of individuals	112	112	115	105
Registered students exclusive of Saturday classes...	51	57	64	59

"*Practical Assaying and Metallurgy.*—The attendance at this class was very large throughout the year, and severely taxed our accommodation and appliances for instruction. Much valuable work is done in this class, as it is here that most of the students first obtain their knowledge of the numerous complex ores found in the peninsula, and the different methods of treating and valuing them. Several of the students have obtained good appointments in Australia, and quite recently Mr. Edwin Banks has been reappointed assayer to the Waihi Gold- and Silver-mining Company, succeeding the well-known metallurgist Mr. James Napier. A great many miners and battery-

hands have qualified themselves as reliable assayers of bullion, of ores, of gold, silver, lead, tin, antimony, &c., also of tailings and concentrates; and, although there is only a limited demand for assayers, the fact has now come to be generally admitted that an accurate knowledge of assaying and valuing different ores, particularly those of gold and silver, is a necessary qualification in those engaged in the extraction of gold and silver in batteries and reduction-works. The complex character of the up-country ores has also forced upon miners and prospectors the necessity of possessing at least an elementary knowledge of assaying and metallurgy. It is a well-known fact that the great bulk of the valuable ores from the Waiomo, Hikutaia, Komata, Waitekauri, Waihi, and Karangahake districts seldom afford even an approximation to their true value by the prospector's method of rough crushing and panning. This can only be ascertained by thoroughly sampling a bulk parcel of the ore, and then subjecting it to a fire-assay.

"In the beginning of February of this year the Hon. R. J. Seddon, Minister of Mines, engaged Mr. A. Purdie, M.A., of the Otago University, as my assistant for three months. Mr. Purdie began his duties in the middle of February, and for two months took charge of this class as well as the ordinary and Saturday chemistry classes. He expressed surprise at the large number of students and the thoroughly practical and advanced character of the instruction. He conducted his classes with zeal and all his ability, and left for an appointment in Victoria on the 21st April.

"*Practical Chemistry and Laboratory Practice.*—The extraction of the precious metals from the complex low-grade ores of these goldfields, as well as those of Australia and Tasmania, presents a number of scientific problems, involving not only an acquaintance with mechanics and hydraulics, but also an intimate knowledge of the reactions of the different metals under varying conditions, and of the laws which regulate their combinations. The different operations of the metallurgist should be governed by the chemical affinities and reactions of the ore he is treating, either with fluxes or chemicals, and the successful treatment of low-grade ores will in the future demand an extensive practical knowledge, backed by skill in chemical manipulation and processes.

"The class devoted to practical chemistry has been already productive of much good, and many of the advanced students are competent to analyse coals, soils, waters, complex ores, and slags. Some of the more interesting analyses performed in the laboratory during the past year are as follow:—

"*Brown Coal, Waitakururu, Thames Firth, analysed by Mr. J. Robinson.*

"*Upper Seam, 13ft.*

"Fixed carbon	49·01
Hydro-carbons	30·15
Water	15·72
Ash	5·12
	100·00

"Evaporative power, 6·38lb; sulphur, 0·95 per cent.

"*Middle Seam, 7ft.*

Analysis.	Fixed Carbon.	Hydro-carbons.	Water.	Ash.	Sulphur.	E. and P.
J. Sheppard	45·12	34·50	15·41	4·97	...	5·86
J. McPeake	44·02	36·80	14·10	5·08	...	5·72
Geo. Fleming	44·61	36·41	13·78	5·20	1·02	5·79

"*Remarks.*—These are valuable coals, well adapted for steam or household purposes. Friable, ash-grey to buff colour.

"*Bituminous Coal, Coromandel, analysed by Mr. J. Shepherd.*

"Fixed carbon	62·25
Hydro-carbons	30·14
Water	5·02
Ash	2·59
	100·00

"This coal is from a thin irregular seam, imbedded in the auriferous tuffs near Paparoa. The coal is suitable for smithy or steam purposes, but the seam is too thin to be of any value. Bright, shining, crumbling, ash-grey; evaporation power, 8·09lb.

"*Ferro-manganese, Waiheke Island, analysed by Mr. W. O. Bell.*

	No. 1.	No. 2.
"Manganese-oxides	45·92	60·12
Iron-oxides	32·17	28·86
Alumina	10·31	3·94
Silica	9·64	6·15
Water and loss	1·96	0·93
	100·00	100·00

"These are valuable ores for the manufacture of manganese steel, and if found in large quantities in places accessible to deep water could be exported with profit to Great Britain.

"*Limestone, Coast, north of Coromandel, analysed by W. O. Bell.*

"Silica	3·36
Iron and alumina	7·08
Carbonate of lime	86·12
Carbonate of magnesia	2·35
Water and loss	1·09
	100·00

"This is an excellent limestone for burning into lime both for mortar and agricultural purposes, and will in the future be a valuable asset to the Coromandel and Cabbage Bay districts, where calcareous rocks are scarce.

"*Marble, Takaka Valley, Nelson.*

Analyst.	Silica.	Iron and Alumina.	Calcium Carbonate.	Magnesium Carbonate.	Totals.
A. T. Day	2·24	2·18	94·86	Trace	99.28
Bain Hogg	1·98	1·95	95·13	Trace	99.06
W. Shepherd	2·20	2·10	96·02	Trace	100·32

"This is a very pure form of marble or crystalline limestone of Silurian age, from the Takaka Valley, where it covers a large area. It is eminently suited for a building-stone, also for burning for mortar and agricultural purposes.

"*Garden Soil, Parawai, Thames, analysed by Mr. W. J. May.*

"$Si O_2$	68·13
$Fe_2 O_3$	9·96
$Al_2 O^3$	3·50
$P_2 O_5$	Trace
$Ca Co_3$	2·10
$Mg CO_3$	Trace
$K_2 O$	Trace
$Na_2 O$	Trace
Organic matter, Water	16·60
	100·29

"This is a black, loose, loamy soil, somewhat siliceous, and deficient in lime and alkalies; fairly well adapted for the growth of cereals, but would require liberal manuring for root-crops.

Tui Ore, Te Aroha, analysed by W. O. Bell.

"Silica	26·17
Iron	8·61
Copper	3·24
Zinc	24·38
Lead	12·16
Cadmium	Trace
Silver	0·14
Sulphur	25·16
	99·86

"This is a complex sulphide ore, composed of iron- and copper-pyrites, blende, and galena. It contains 37oz. 5dwt. 7gr. of silver, and 1oz. 10dwt. of gold per ton.

"*Copper-ore, South Australia, analysed by Mr. W. Climo.*

"Silica	1·000
Iron	19·600
Antimony	2·150
Arsenic	3·040
Copper	35·280
Bismuth	17·300
Sulphur	17·460
Gold	·004
Silver	·013
Carbon dioxide	3·970
Water and loss	·183
	100·000

"This was a very complex ore, consisting of a number of base metals combined with sulphur, arsenic, and antimony, the sulphides predominating. A small percentage of the copper existed as the blue carbonate. The gold and silver exist at the rate of about £17 per ton, but the extraction has proved a very difficult problem.

"Zinc-ore, Aclare Mine, South Australia. Analysed by Mr. W. Climo.	
"Silica ...	11·50
Iron ...	12·03
Zinc ...	32·01
Lead ...	13·64
Sulphur	30·71
Loss ...	0·11
	100·00

"This was also a very complex low-grade sulphide ore, which the owners so far have not been successful in smelting on account of the high percentage of zinc present. This sample contained about 25dwt. of gold and 24oz. silver to the ton.

"*Theoretical Chemistry.*—This very important and essential branch of chemistry was started last year for the benefit of the members of the practical chemistry class. I have treated the subject most exhaustively throughout the whole course; indeed all my lectures have been illustrated with numerous experiments. The attendance has been large and regular, among the students being a number of teachers from the State schools. The results of the instruction have been most gratifying, and have amply repaid me for the extra work which this class has placed on me.

"*Mineralogy and Blow-pipe Determination.*—The attendance at this class has always been small, as the instruction is given only during the day, on account of the difficulty of recognising the colour-reactions of the different minerals by gaslight. The subject is, however, one of great and growing importance, and I should like to extend the instruction to the night students, many of whom have expressed a wish in that direction. At present this is impossible, as my time during the evenings is already fully taken up with other classes.

"*Geology and Geological Surveying.*—This is also a day-class, attended principally by the members of the mineralogy class. The lectures in this subject are devoted chiefly to the study of general geology, including the study of faults, lodes, and geology as applied to mining. One forenoon every week is devoted to a field-excursion for the study of natural sections, mapping geological formations, collecting rock and mineral specimens, and instruction in taking the strike, dip, and inclination of strata and lodes. The different mines on the field are also visited for the purpose of noting the behaviour of lodes, character of country, different methods of timbering; also the machinery used for pumping, winding, and rock-boring. The batteries are also examined in order to study the various appliances and processes used for extracting the gold and silver from their ores.

"*Mining.*—This class was largely attended by students qualifying themselves for certificates as mine-managers. The syllabus of instruction is very wide and comprehensive, being intended to cover the whole of the subjects of examination for certificates under "The Mining Act, 1891," except surveying, which is taught in a separate class. During the year I sent up seven candidates for the Government examination, and six of them successfully passed the examination for first-class certificates as mine-managers, the other failing in one subject only, making a total of sixteen students of my mining and surveying classes who have succeeded in passing the Government examination during the last two years and a half. This is in every way an eminently satisfactory result, considering the very technical and exacting nature of the papers set by the Board of Examiners. It also reflects great credit on the industry and abilities of the candidates themselves, none of whom, at the time they joined the classes, possessed any knowledge of the subjects of examination, excepting the practice of mining acquired in their ordinary occupation.

"*Land- and Mine-surveying.*—This class is mostly attended by the members of the mining class, as well as others who wish to qualify themselves as mine-surveyors and engineers. The instruction is imparted by field practice with the theodolite, miner's dial, and level, once, and sometimes twice, every week; and by lectures on the use of logarithms, solution of triangles, calculation of areas, &c., and instruction in plotting, map-drawing, &c. Most of the students have taken a deep and intelligent interest in this subject, and many of them have found the instruction of immediate value to them in their work as mine-managers, contractors, &c.

"During the last two quarters I gave lessons in practical astronomy, dealing principally with the different methods for the determination of azimuth, latitude, and time. With a very superior 6in. transit theodolite, belonging to one of the students, I carried the standard meridian of Mount Eden to a prominent permanent station on Mount Pleasant. With the same instrument I took a number of observations for azimuth at the sun and several circumpolar stars, making an angular difference with the standard meridian, after making the necessary correction for convergency—varying from 7 seconds to 40 seconds of arc—the average difference being 36 seconds. Observations for time, extending over a number of consecutive days, gave very close results. One of the students has made excellent progress and will soon be able to fix his own meridian.

"While I was at Coromandel, in December, I fixed a station close to the School of Mines there and connected it by triangulation with the standard triangulation. Since that date, Mr. Wm. Horne has made a number of observations for time and azimuth with his 6in. transit at this station, and the results have been fairly good. An urgent necessity of our surveying class is a good serviceable 5in. theodolite in place of the old worn-out 4in. at present in use.

"*Mechanical Drawing.*—This class is still under the able supervision of Mr. E. F. Adams, M.E., and is attended chiefly by young mechanics and artisans. Many carefully finished drawings have been executed by the advanced pupils during the year. The instruction is imparted by drawing to scale from copies and objects, and the examination in December showed that most of the candidates possessed an intelligent understanding of the method of delineating on paper the construction of objects by section and elevation drawn to scale. The attendance should be much larger, and would doubtless be so if the Committee could afford to reduce the present guinea-fee per quarter to, say, ten

shillings, which would enable many yonng miners and apprentices, whose earnings are small, to take advantage of the class.

"*Saturday Science Class.*—Throughout the year I have given weekly lectures on theoretical chemistry, illustrated by experiments, to show the properties of the elements and their compounds. As the course of study has advanced the attendance of the smaller boys has fallen off, the remaining pupils being now mostly High-school boys, with others in the higher standards from the State schools.

"In the third term of 1890 I gave a course of lectures in agricultural chemistry to prepare the pupils to compete for the prizes offered by Professor Thomas through the Board of Education. The Board examination was held last March, but the results became known too late for my last annual report. I am now pleased to state that Master George Fleming, who gained the School of Mines first prize, also carried off Professor Thomas's first prize in competition with several hundreds from all parts of the provincial district.

"*Annual Examinations.*—The examinations were held throughout the first week in December. The number of candidates for examination was 45, compared with 39 the preceding year, and of these 11 secured first-class, 20 second-class, and 13 third-class certificates. The work in all the subjects showed a great improvement on former years, the papers having been set with a view of finding out what the candidates actually did know of the subjects taught during the year.

"The honours for the year fell to Mr. W. O. Bell, of Auckland, who took first place in practical assaying, practical chemistry, theoretical chemistry, mineralogy, and geology. Mr. Bell did much good work in the laboratory, and his papers of examination were full, clear, and accurate, and an evidence of much careful preparation and hard work. His record of five firsts is superior to that of any other student who has passed through the school, and I regret to say that the Committee, from lack of funds, were unable to recognise and reward his well-merited honours with the usual medal and prizes. The annual presentation of a medal would be a great incentive to the students to pursue their studies with zeal and ardour, and perhaps something may yet be done to place Mr. Bell on the same footing as his successful predecessors.

"*Laboratory.*—The number of assays and analyses performed for the public during the year was 382, being an increase of 111 compared with the previous year. The most of these were determinations for gold and silver, all of which were done in duplicate, and as parting assays. These assays, &c., involved the writing of 114 separate reports by the Director; but the actual assays and analyses were performed by advanced students, except in special cases. A considerable decrease in the public assays may be looked for in the future, on account of the number of assayers who have been trained during the last few years at the School of Mines and found employment throughout the goldfields.

"*Appliances and Fittings.*—At the beginning of last year the Committee imported from London a large stock of chemicals, glassware, crucibles and apparatus, including a fine assay-balance and a large muffle-furnace. These were much needed, and formed a welcome addition to our scanty stock.

"During the year thirty-two new cupboards were fixed in the laboratory, also a new drawing-table and a quantity of shelving to store the imported goods. The defective ventilation of the lecture-room and laboratory received some attention, and a water-jet was fixed to draw out the heated air and gases, but so far it has proved only a partial success, and some more effective method will have to be adopted before the much-needed ventilation is obtained. In November a retorting furnace was built in the experimental battery, and since that date wooden handrails have been erected round the elevated platforms at the pan and stamper-box. At the present time, perhaps the most pressing need of the school is a small workshop, fitted with a lathe and a set of carpenters' tools, so that apparatus for experiments and the trial of new processes could be made on the premises by the students themselves, and thus add fresh interest to their studies. A technical school without a workshop is like a foundry without its smithy; but this need, like many others, would be speedily remedied if the money were available.

"*Coromandel.*—In August and December of last year I visited this place, and held classes in mining, surveying, practical assaying, and practical chemistry. As in former years, the greatest interest was taken in the mining and surveying classes, and very satisfactory progress was made by a few of the students who attended regularly. The average attendance was under ten, or about the same as the preceding year. There is little interest taken in the school, and but for the efforts of Captain Argil, Mr. W. Horne, and a few others, would fall through altogether.

Experimental Plant.

"During the year six separate parcels of ore were forwarded to the school for treatment, and the results of the working-tests obtained in each are given below:—

"*No. 1.*—This was a parcel of 84lb. of ore from the Luminary Gold- and Silver-mining Company's mine at Puhipuhi. It showed an assay-value of £1 8s. per ton, as under: Bullion, 6oz. 1dwt. per ton; gold, 2dwt. 12gr. per ton; silver, 5oz. 18dwt. 12gr. per ton. A sample weighing 80lb. was dry-crushed, and hot-pan amalgamated with chemicals, and yielded 4dwt. of bullion, valued at 4s. 2d. per ounce, representing a saving of £1 3s. 4d. per ton, equal to 83·3 per cent. of the assay-value. The silver existed in the form of the simple sulphide argentite, and was easily extracted, as shown by the high percentage of saving, but the ore is altogether too low-grade to be mined with profit.

"*No. 2.*—This was a parcel of ore from Waitekauri, forwarded by Messrs. Bentham and Mason for the extraction of the contained gold and silver. It weighed one ton, and consisted of hard splintery yellowish-brown finely granular quartz, quite free from base sulphides. It contained free gold and silver-sulphide (argentite), and showed an assay-value of—bullion, 30oz. 5dwt. 2gr. per ton; gold, 7oz. 16dwt. 2gr. per ton; silver, 22oz. 9dwt. per ton: value, £34 8s. 8d. per ton.

"The ore was crushed wet, and then passed over amalgamated copper plates, which saved 6oz. 18dwt. 3gr. of bullion, valued at £2 1s. 10d. per ounce, equal to a saving of £14 8s. 8d. per ton, or 41·9 per cent. of the assay-value.

"The sluices and tailings which had been collected in settling-pits were subjected to raw hot-pan amalgamation with chemicals, and yielded 14oz. 14dwt. 14gr. of bullion, 209·2 fine in gold, and 752·2 fine in silver, valued at 19s. per ounce; representing a further saving of £14 per ton, or 40·6 per cent. of the assay-value.

"The headings were treated in the berdan pan, which saved an additional 19s. 8d. of bullion, equal to 2·9 per cent. of assay-value, making a total saving of 85·4 per cent. of the original assay-value, as shown below:—

	Gold. Oz. dwt. gr.	Silver. Oz. dwt. gr.
From copper plates	3 9 15	3 8 2
From pan with chemicals	3 1 17	11 1 12
From berdan pan	0 4 3	1 0 13
Total saved	6 15 11	15 10 3

"Percentage of gold saved, 89·5; percentage of silver saved, 69·0; percentage of value saved, 85·4. The bullion was sold to the bank at the School of Mines valuation.

"The above working-test was highly successful and satisfactory, and showed that the ordinary battery process combined with pan treatment could extract a high percentage of the bullion.

"*No. 3.*—This was a parcel of 2,000lb. of ore from Dixon's claim, situated at the head of Shotover Gully, Thames Goldfield. It consisted of hard bluish-coloured cavernous quartz containing a large portion of iron-pyrites. It showed on its joints and surfaces a thin incrustation of proustite—the arsenical sulphide of silver—and was believed by the owner to be of great value. The ore was crushed wet and showed an assay value of—bullion, 21oz. 8dwt. 12gr. per ton; gold, 2dwt. 12gr. per ton; silver, 21oz. 6dwt. per ton: value, £3 14s. per ton. As the extraction of the bullion from the tailings could only be effected by subjecting them to a thorough chloridizing roasting before treating them in the pan, an operation involving some considerable cost, the test was not carried further, at the request of the owner.

"*No. 4.*—This was a parcel of 2,360lb. of ore from the New Find at Komata, which has recently been acquired by Mr. T. Russell, of Waitekauri. The ore consisted of wet brown-coloured mullocky quartz from the outcrop of the reef. It showed the following assay-value: Bullion, 37oz. 3dwt. 11gr. per ton; gold, 4oz. 11dwt. per ton; silver, 32oz. 12dwt. 11gr. per ton: value, £23 2s. per ton. It was crushed wet and passed over amalgamated copper-plates, which saved 4oz. 2dwt. 20gr. of bullion, 526·8 fine in gold and 468·4 fine in silver, or £2 3s. 6d. per ounce equal to a saving of £8 11s. 4d. per ton, or 39 per cent. of assay-value. The tailings were treated by raw hot-pan amalgamation, and yielded 20oz. 3dwt. 20gr. of bullion, 108·0 fine in gold and 852·0 fine in silver—representing a saving of £10 13s. 8d. per ton, or an additional 46·2 per cent. of the assay-value, making a total saving of 85·2 per cent, as shown below:—

	Gold. Oz. dwt. gr.	Silver. Oz. dwt. gr.
"From copper plates	2 12 10	1 10 10
From pan with chemicals	2 3 14	18 0 5
Total saved	4 16 0	19 10 15

"Percentage of gold saved, 90·0; silver, 60·0: value, 85·2. This bullion was also sold to the bank at the School of Mines' valuation. This was a very satisfactory result, and of great value as showing that this class of ore could be profitably and successfully treated by wet-crushing and subsequent raw pan-amalgamation with chemicals.

"*No. 5.*—This was a parcel of ore from the Waipu Claim, Puhipuhi. It consisted of hard greyish-white quartz, partly amorphous with a banded wavy structure, and partly finely granular or crystalline, and often cavernous. It contained silver in the form of argentite, pyrargyrite, and proustite. It was dried, and then dry-crushed, showing an assay-value of—bullion, 34oz. 18dwt. 4gr. per ton; gold, 1oz. 5dwt. 1gr. per ton; silver, 33oz. 5dwt. 3gr. per ton: value, £9 9s. 11d. per ton. The dry pulp, weighing 1,900lb. was then subjected to a chloridizing roasting with 7 per cent. salt, and a little ferrous sulphate added to make up for the deficiency of natural metallic base sulphides in the ore. The roasting was a good one, 91 per cent. of the silver having been chloridized.

"Of the roasted ore 1,854lb. was hot-pan amalgamated, with a small quantity of copper-sulphate, and yielded 24oz. of bullion, 042·0 fine in gold, and 898·0 fine in silver, equal to 6s. per ounce, representing a saving of £8 14s. per ton, or 91·5 per cent. of the assay-value. Percentage of gold saved, 96·0; percentage of silver saved, 68·4; percentage of value saved, 91·5. The presence of the antimonial and arsenical sulphides of silver rendered the treatment of this ore somewhat more difficult than previous parcels from Puhipuhi; but this working-test showed that when chloridize-roasted a payable percentage of the bullion can be extracted.

"*No. 6.*—This was a parcel of 95lb. of so-called concentrates from a new pan erected in the Great Mercury battery at Kuaotunu. They consisted of clean coarse quartz-tailings, and when subjected to a fire-assay were found to contain no gold or silver. The gold at Kuaotunu occurs in microscopic particles, and it would appear that the gold escaped from the pan in the overflow with the slimes, while only the larger particles of quartz accumulated in the pan.

"All the labour connected with these tests—the assaying, sampling, roasting, amalgamating, retorting, &c.—was supplied by the students of the school under my own immediate supervision, and the instruction and experience gained in our experimental plant has in several instances proved of immediate value to them. The percentages of saving have been much higher this year than in

former years, and the owners of all the parcels treated have expressed themselves well satisfied with the results.

"Syllabus of Lectures and Instruction, 1891–92.

"Practical Assaying and Metallurgy: Lecturer and instructor, the Director. Tuesday, Wednesday, Thursday, and Friday.

"Practical Chemistry: Lecturer and instructor, the Director. Tuesday, Wednesday, Thursday, and Friday.

"Theoretical Chemistry: Lecturer, the Director. Monday and Saturday.

"Mineralogy and Blow-pipe: Lecturer, the Director. Laboratory—Monday and Thursday; field—Wednesday.

"Geology and Geological Surveying: Lecturer and instructor, the Director. Laboratory—Monday and Thursday; field—Wednesday.

"Mining: Lecturer, the Director. Laboratory—Thursday; field—Wednesday.

"Land- and Mine-surveying: Lecturer and instructor, the Director. Laboratory—Monday; field—Tuesday and Friday.

"Mechanical Drawing: Instructor, E. F. Adams, M.E. Friday.

"*Practical Assaying and Metallurgy.*

"Fuels, appliances, fluxes, &c., used in the dry assay of ores of gold, silver, lead, tin, antimony, copper, &c. Assay of gold, silver, and lead bullion, and wet assay of ores of iron, copper, lead, zinc, antimony, bismush, arsenic, manganese, &c. Preparation of pure silver; litharge assay; melting and refining base bullion; amalgamation; retorting. Text-book, 'Berringer's Assaying.'

"*Practical Chemistry.*

"Chemical manipulation; acids; reagents; group reagents; separation of metals; properties of metals; testing solutions; testing rocks and minerals; solution of mineral substances; analysis of simple substances; analysis of compound substances; quantitative analysis of sulphides and complex ores, coals, soils, waters, slags, limestones, &c.

"*Theoretical Chemistry.*

"Principles of chemistry; atoms; molecules; vapour density; quantivalence; chemical formulæ; the elements—their history, occurrence, preparation, properties, and uses; compounds of the elements: their occurrence, preparation, properties, and uses.

"*Mineralogy and Blow-pipe Determination.*

"Systematic mineralogy; properties of minerals—their cleavage, hardness, specific gravity, &c.; optical properties—refraction, reflection, double reflection, polarisation, lustre, phosphorescence; chemical properties—the application of the blow-pipe, supports, reagents, flame reactions, colour tests with borax heads, &c.; isomorphism, pseudomorphism, and allotropy; distribution and paragenesis of minerals; classification of minerals—chemical system, economic system; descriptive mineralogy—non-metallic division, carbon group, haloids and salts, alkaline earth group, silicates, aluminates, with a description of the principal minerals of each group, aided by hand-specimens; metallic division—a description of the principal ores and compounds of the different metals, their occurrence, hardness, specific gravity, crystallographic form, colour, lustre, streak, composition, uses, distribution, &c.

"Crystallography: The six systems, their axes, typical forms, modified forms, holohedral and hemihedral forms, macles, reading of faces, &c.

"*Geology and Geological Surveying.*

"*Physical Geology.*—The earth as a planet, its form and motions; geological climate; the atmosphere; ocean; solid crust; the interior of the earth.

"*Dynamical Geology.*—Metamorphism; agencies modifying the crust of the earth—atmospheric, aqueous, chemical; weathering; sedimentation; classification of deposits—mechanical, aqueous, organic, and chemical; denudation and erosion.

"*Structural Geology.*—Stratification; jointage; contortion; faults, conformity, unconformity; dip and strike; cleavage; metamorphic rocks; intrusive sheets, bosses, dykes; fissures; formation of quartz-veins, lodes, and metallic deposits; dynamics of lodes; recovery of lost lodes.

"*Geological Surveying.*—The practice of running natural sections; noting dip, strike and inclination of strata and lodes; mapping geological formations; collection of mineral and rock specimens.

"*Stratigraphical Geology.*—Classification of plants and animals; fossils; blending of species; geological record; the study of characteristics, life, and distribution of formations from Archæan to recent times, with special reference to the geology of New Zealand.

"*Mining.*

"Shafts: Selection of site, size, modes of excavation in dry and wet rock, wet sand, and swamp; timbering of shafts; ladders; chambers—size, excavation, timbering; levels and drives—size, excavation, timbering; securing sets or inclines; mode of stoping, height and timbering of stopes; main passes, size, timbering, division; mullock passes—size, timbering, distance apart. Pumping and pit work—pumps and engines used in metal mining, force-pumps, plunger-pump, draw-lift, fixing pump pieces, bearers, friction-rollers, V-bobs, balance-bobs, main rods, flat rods, clacks, buckets, bucket-rod, catches, staples and glands; thickness of pipes; capacity of pumps. Ventilation—atmospheric pressure, vapour density; ventilation of drives and underground workings by natural and artificial means; furnaces, water-blasts, fans; division of air-courses; noxious gases met with in metal-and-coal-mines, their composition and detection. Explosives—their use in

quarries and mines, relative strengths, action, gases evolved, composition; charging bore-holes; firing explosives; quantity to be used. Hauling and winding—safety-cages; man-engines; strength of ropes; strength of timbers. Water-power—turbines, pelton-wheels, calculation of horse-power and flow of water from boxes and nozzles.

"Text-book used: Gordon's "Miner's Guide," 5s.; Government Printer.

"*Land- and Mine-surveying.*

"Adjustments of theodolite, dial, level; chain and steel tapes; traversing with theodolite and dial; connecting survey with standard meridian; ranging lines; division of land; computation of areas by latitudes and departures; reduction of slope-measurements; off-sets; chaining; computation of co-ordinates; balancing survey; plotting survey and off-sets. Mine-surveying: Different methods of connecting underground with surface meridian; magnetic variation; to reduce magnetic meridian to true meridian; conducting underground traverse with theodolite and dial; correcting magnetic survey by method; back- and fore-sights; holing. Mathematics: Equations; logarithms; plane trigonometry; solution of triangles; calculation of last or connecting line; of distance from working-face to nearest point on boundary of lease. Levelling: Recording levels; practice with level and staff; grading roads, tramways, and water-races; plotting and striking grades.

"*Practical Astronomy.*

"The ecliptic; equinoxes; solstices; meridians; longitude; latitude; altitude; declination; right ascension; azimuth; use of nautical almanac; polar distance; zenith distance; hour-angle; sidereal time; mean time; solar time; parallax; refraction; retardation; acceleration; convergency of meridian; determination of meridian by star- and sun-observations, by single altitudes, equal altitudes, greatest elongation of circumpolar stars; use of star-charts; calculation of hour-angle, azimuth, and altitude of celestial bodies; determination of latitude by meridian altitudes; determination of time by star transits and sun-observations.

"*Mechanical Drawing.*

"Use of scales; printing and lettering; shading; colouring; drawing to scale from copies and objects; portions of engines and other machinery; plans; sections; elevations.

"Scale of Charges for Assays and Analyses.

	£	s.	d.
"Bullion assays	0	5	0
Assay of quartz, pyrites, tailings	0	5	0
" gold and silver ores, with parting assay	0	5	0
Examination and determination of minerals, rocks, or fossils, each ...	0	5	0
Assay of lead- and tin-ores, each	0	5	0
" iron- and manganese-ores	0	10	0
" copper- and antimony-ores	0	10	0
Analysis of limestone {complete	1	0	0
Analysis of limestone {partial	0	10	0
" coals and fuels, each	0	10	0
" rocks and soils {complete	2	0	0
" rocks and soils {partial	1	0	0
" fireclays and slags	1	0	0
" waters {exhaustive	3	0	0
" waters {partial	2	0	0
" nickel-, cobalt-, chrome-ores, each	0	10	0

"*Class-fees.*

"Registration or membership, 10s. for a year; all class-fees, 5s. per quarter for each subject, excepting mechanical drawing, 21s. per quarter.

"Students are supplied with crucibles, glassware, apparatus, chemicals, &c., free of charge.

"*Experimental Plant.*

"Parcels of gold- and silver-ores up to three tons are treated and exhaustively reported upon at from £3 to £5 per ton, or part of a ton, according to the nature of the treatment required to extract the bullion. All expenses connected with the working-tests are paid by the school, and the bullion is returned to the owners.

"In concluding my report, I have to express my great obligation to the School Committee for their hearty co-operation in forwarding the interests of the school, and for the ready and generous manner in which they have at all times endeavoured to supply all the appliances and requisites for efficiently conducting the classes, so far as the funds at their disposal permitted. I have also to thank the different mine-managers for the facilities they have always placed in the way of myself and the students for visiting the mines under their charge; and also Mr. George Wilson, and many others, for rocks, minerals, and ores for the collection of the School of Mines."

Reefton School of Mines.

The Reefton School has been better attended last year, and the Instructor speaks more hopefully of the future results likely to be obtained. A very large attendance could not be expected, as most of the mines are situated some distance from Reefton, and the workmen do not have the same opportunities of attending the night classes as they have at the Thames School. The following

table will show the subjects taught and the average number of students attending each class at the school during last year :—

Subjects taught.	Average Number of Students attending Class.
Mining and mathematics	20
Practical assaying and metallurgy	15
Surveying	—
Practical and theoretical chemistry	14
Geology	8

At Boatman's School, where instruction is given once a week, the average attendance has been 25. The following is a report by Mr. R. Aitken, the Instructor, for the year ending the 31st March, 1892 :—

"I have the honour to report on the work and progress of the Reefton School of Mines and its branches during the past year ending 31st March, 1892, which, I am pleased to say, is far more satisfactory and encouraging than that of the previous year.

"The time-table was altered to suit the students, and the classes held with every regularity throughout the whole year, with the result that far greater interest was taken in the school, and the attendance largely increased, there being as many in some classes as could be accommodated comfortably. The increase is partly among the miners, and some students have obtained work in the district for the sole purpose of attending the school, which is evidence that the benefits to be derived from such an institution are appreciated. Samples of minerals, &c., are now sent from all parts of the coast, and other districts, for assay and determination.

"The mining and surveying classes are the most popular and best-attended. These classes are not only attended by those who desire to qualify themselves as mine-managers, but also by those who are mine-managers, and by others whose sole object is to extend their knowledge on the subjects taught.

"The classes in practical assaying and theoretical chemistry were well attended, but the progress was hindered owing to our limited supply of material and apparatus; this difficulty, however, has now been overcome by our last shipment from England; and these classes, together with practical chemistry just started, are making excellent progress, and are much appreciated by the students."

"A class was started on mining and mathematics in the Merrijigs district with over fourteen members, and was kindly conducted by Mr Southerland, one of our advanced students. It was discontinued after about five months, owing to a partial collapse in that district, and the removal of many of its members, but I am pleased to report there is every probability of the class being again reformed.

"The number of assays, tests, &c., are not so large as those of the previous year, which I attribute to the comparative dullness of the district, although many most important assays have been made.

"Following is a list of the subjects taught in the school during the past year :—

"*Mining and Mathematics.*—It is found necessary to take these two subjects together, as one is, to a certain extent, connected with the other. This class has over twenty members, the majority of whom are miners, and the number is gradually increasing. The instruction given is on arithmetic, logarithms, plane trigonometry, mining geology, and on the formation of lodes, besides hauling, winding, hydraulics, ventilation, gases, and the strength of materials.

"*Practical Assaying and Metallurgy.*—In this class the students are instructed in the assaying of ores of gold, silver, lead, copper, antimony, and tin, and in the use and composition of the fluxes and reagents used. The melting, refining, and valuing of gold and silver bullion, together with the dressing of copper plates, and cleaning and retorting of amalgam, also formed part of our work last year. The assaying has been principally by the dry methods, but this year, with our supply of chemicals, we shall enter into the wet methods, and also analysis. The number attending this class is over fifteen, and the students are of various occupations. The text-books used are Mitchell's and Aaron's. In this class assays by amalgamation are also taught, which give far more practical and correct results in assaying parcels of quartz than by the fire.

"*Surveying.*—This class is very largely attended, and instruction is given on the theodolite, dial, &c., together with the use and adjustments of these instruments; also in land and mine surveying, plotting by protractor and rectangular co-ordinates, tabulation of traverses, calculation of areas, and levelling. Several students have procured instruments and now do their own surveying. These with a little more practice will soon become competent surveyors, and some have already shown their competency by practical illustrations.

"*Geology.*—In this subject our text-book is 'Geikie,' and most of our work last year was purely theoretical. The instruction was on Book I. and parts of Books II. and III., comprising physical geography, composition of the earth and its envelopes, and dynamical geology; the average attendance being eight.

"*Practical and Theoretical Chemistry.*—These two classes are now held the same evening, so that the students in one class may attend the other. The latter class was held during last year with an average attendance of six members, and now, since the two are held together, the attendance has increased to about fourteen—as many as can be accommodated. The work done in this class is the reactions of metals and acids, and the schemes for the separation of metals, together with the principles of analysis; also the chemistry of the elements and their compounds, illustrated by experiments.

"*Boatman's School.*—Instruction is given at this school every Thursday evening, and the class has been held regularly throughout the full terms. As the attendance here numbered twenty-five students, I found it necessary to form a senior and junior class, and the latter class was conducted

by Messrs. Cavell and Lawn, two of the senior members, on another evening. I desire to thank these gentlemen for their valuable assistance. The only subjects taught were mathematics and surveying (including logarithms and trigonometry), in which excellent progress was made by some of the students. The same members are working this year at assaying and chemistry. Mr. Raithby has kindly offered a box of mathematical instruments to be competed for among the junior students in logarithms and plane trigonometry.

"*Laboratory.*—Over fifty assays for gold and silver have been made, besides numerous qualitative tests. The other asssays are as follow: antimony, six; clay, four; and tin, seven. Many of the assays were made by amalgamation in berdan, and the tailings assayed by the fire; and I have found by this that a large percentage of the gold may be saved, by grinding without an overflow, keeping the water from becoming acid, and amalgamating in a pulp. In this way it is impossible for fine gold to escape, and iron amalgam will not form so long as the water is not acid. I intend now to sample all the tailings on the field, and experiment with them in this way. Exhaustive tests were made on samples of stone taken from a belt of chert rock which traverses this district, and, although gold was found, it was not in sufficient quantities to extract, except perhaps on an extensive scale. We received from England lately a very fair stock of chemicals and apparatus, which were much required, and which has greatly improved our laboratory.

"*School.*—Many of the much-needed improvements to the school have been made. The water is laid on now in every room, which is a great convenience, as before all water had to be carried. The berdan is now placed in a small shed outside the assay-room, and is driven by water, the power being obtained from a small water-motor, made and given by Mr. Hufton, one of the students. Our surveying appliances have also been increased by a dumpy-level and staff, which, although not new, answers our purposes splendidly. I am now endeavouring to get the school lighted better, and also to form a scientific library, which I am sure would be a great boon, not only to the School of Mines but to the whole district.

"*Examinations.*—In December the annual examination was held for class certificates, on the same basis as those at the Thames School. These examinations proved most satisfactory, and were greatly appreciated by the students. For particulars of these papers set and the results I must refer to the copies forwarded, which show that splendid work has been done by students during the past year. The papers were set by myself on the work done during the year, and gave general satisfaction to all concerned. For mine-managers' certificates, two candidates sat from this school under the Coal-mines Act, in August, 1891, and passed; also four under the Mining Act, in February, 1891, passed. In the last examination, held in February, 1892, two students from the Denniston School presented themselves for examination under "The Coal-mines Act, 1891;" besides one student from the Boatman's school, and four from the Reefton School, under "The Mining Act, 1891." The results of this examination are not yet known.

"*Denniston School.*—Under your instructions I visited this school during January and part of February, 1892. There has been very little done there, although a great many persons appear anxious for instruction. The School of Mines is connected with the reading-room, and members of the one are members of the other. The classes were attended regularly by about twelve students, and instruction was given in ventilation, gases, pumping, and surveying (including logarithms and trigonometry). The limited time only allowed me to enter into the first principles of these subjects, they will, however, be continued on my next visit, in July. There is no doubt that with a little assistance a splendid school could be formed, as the men are all close to the town, and many are anxious to improve themselves.

"*Students.*—Many of our students are now receiving appointments as mine-managers, and are showing by their work that practical education, combined with the theoretical, is of the greatest service.

"In conclusion, I may state that the Reefton School is now in a fair way towards being one of the principal schools in the colony, and although the ores in this district are not so complex and refractory as in others, yet there is a large field to work on. I must thank the Committee for their assistance during the past year, and also our hon. secretary, Mr. Casley, for his untiring efforts in promoting the interests of this school."

Nelson School of Mines.

Although the principal Schools of Mines are at Thames, Reefton, and Dunedin, there are several small schools in different localities, where some of the members give lectures and teach the method of analyzing the different ores met with. Occasionally an Instructor visits these schools and gives for a short period elementary instruction. It cannot be expected, however, that such itinerary technical education is of great value, but it has the effect of raising a stimulus to gain more knowledge of the different subjects taught at the regular schools; and many of the miners in districts where these small schools are situated are now able to analyze some of the ores, especially those containing gold or silver, they have a fair knowledge of the different rocks in which certain minerals are likely to be found. At Nelson, Mr. W. F. W. Morley, the curator of Nelson School of Mines, and second master of the Bridge Street School, has been for the last two years holding a class in the school once a week, to teach mineralogy and blow-pipe analysis, and so far he has been very successful. The following is his report on the progress made last year:—

"I have the honor to lay before you a report of the work done at the Nelson School of Mines during the year 1891. I was appointed curator of the Nelson School of Mines at the close of the year 1890. Previous to that appointment I had conducted, for two years, a mineralogy class for boys belonging to the Bridge Street School, of which I have the honour to be second master. After taking full charge, I immediately began to try and make the school more popular than it had hitherto been. A class for the study of mineralogy and blow-pipe analysis was formed. Twenty boys joined this class, and continued to work steadily throughout the year. The class met once a week,

the average attendance being 17·3. At the close of the year these boys were examined in mineralogy and blow-pipe analysis, with very gratifying results. Eleven of the boys succeeded in getting 60 per cent., or more, of marks, and thus obtained a certificate of having passed the examination. Two boys, Ernest Kissell and Hardy Kitching, obtained 75 per cent. of marks, respectively, and were suitably rewarded with books. The examination, though an elementary one, was fairly hard, and great credit is due to the boys for the amount of attention which they evidently devoted to the subject. It must, however, be borne in mind that the boys who did best were those who, having belonged to my former class, had had a three years' course.

"A course of lectures on elementary chemistry was also given during the winter months of the year. These lectures proved highly interesting to many of the scholars in the State schools, but only a few, comparatively, availed themselves of the opportunity of attending them. Nine lectures were given, at which the average attendance was about thirty.

"In the month of April, arrangements were made with the Hon. R. J. Seddon, for Mr. Aitken, of the Reefton School of Mines, to visit Nelson for the purpose of delivering a few lectures on School of Mines' work. Mr. Aitken's lectures were well advertised, but only half a dozen persons thought it worth while to attend. An assay-class was formed, and six lectures on assaying were given. After Mr. Aitken's departure the class was conducted by myself for the remainder of the winter months. The members of the class, though few in number, proved to be very intelligent, painstaking students, whom it was a pleasure to teach.

"Past experience has shown that there are not many adults in Nelson interested in School of Mines' work, but that a great deal of good may be done by teaching the elements of mineralogy and blow-pipe analysis to the elder scholars of the State schools. Those boys who have been in my classes for two or three years are able to identify, either by inspection or by the aid of the blow-pipe, all the ordinary ores of commercial importance. But, what is of more value, their faculties of observation have been trained. They know that there are many valuable ores which have nothing specially inviting in their appearance; and they have been trained to examine every stone, however insignificant its appearance at first sight. These boys when rambling on the hills would be more likely to discover valuable mineral deposits than totally inexperienced persons; or, if this should not happen, the knowledge which they possess would, at any rate, greatly increase the pleasure of a country walk. My only regret is that there are so few who have thus studied the subject. If mineralogy could be studied during school-hours, many more boys would take it up; but to expect boys to study it after school, while their fellows are playing at cricket or football, is to look for too much. Only the more thoughtful and earnest boys will sacrifice their play, even for so fascinating a study. I hope the time will come when the elements of the primary industries of agriculture and mining, the industries from which all others spring, will be efficiently taught to the rising generation of this colony."

Minor Schools on West Coast.

During three months last year Professor Black's assistant, Mr. Goodlet, was employed giving instructions in some of the small schools on the West Coast, while Mr. A. Purdie, M.A., was employed for a similar period as assistant to Mr. Parks, at the Thames School. During Mr. Goodlet's visit to the Rimu School he found rubies in some of the boulders in that locality, and also some osmiridium. One of the rubies was sent to Professor Ulrich, of the Otago University, who is acknowledged to be one of the best mineralogists then in the Australasian Colonies, and he pronounced it genuine. The following are the Professor's remarks on this subject, and also on a specimen of tin-ore shown him from Humphrey's Gully by Mr. Goodlet:—

"I examined the mineral specimen you recently gave me as broken from a boulder of some 40lb. in weight, found in the gold-drift at the Back Creek, near Rimu, Westland, and I am glad to inform you that it is not only of great interest mineralogically, but the discovery may also prove of commercial value. The red mineral is true Oriental ruby, namely, a variety of corundum, as conclusively proved by its strong dichroism, crystalline form (hexagonal prism), and hardness, which exceeds that of the topaz—being nine according to Mohs' scale. The abundance in which the precious stone exists in the green matrix is really astonishing, and I can find no record of a similar occurrence from any part of the world producing true rubies. Although in the specimen I examined the crystals are rather small and of a dull purplish-red colour, still some appear in parts clear and of a fine carmine or magenta colour—a fact giving promise of larger and really valuable ores of the kind being found if looked for. You should certainly advise the owners of the claim in which the boulder was found to save and carefully examine the heavy sand resulting from gold-washing, and also look out for other boulders of the kind; because, irrespective of the chance of finding stones valuable as gems and for jewelling watches, the—as it might fitly be termed—"ruby-rock" could, I think, in small pieces be sold at a good price as mineral-specimens to collectors, or, if ground fine, would furnish polishing-powder superior in quality to the common emery-powder. The emerald green—in parts fine scaly—matrix in which the ruby-crystals are imbedded requires a quantitative analysis for determination of its species-name. According to blow-pipe trials it is an infusible silicate of alumina, coloured green by chromium oxide. Its comparative softness (3-4) no doubt favours the disengagement of the ruby-crystals and their dispersion through the drift. Regarding the piece of grey, minutely granular, tin-ore, which you showed me as found in the gold-drift of Humphrey's Gully, it bears the closest resemblance to the kind of ore found in such large masses at the celebrated Mount Bischoff Mine, Tasmania. There is, I think, great probability of prospecting in the ranges the drift is derived from being some day rewarded by the discovery of a rich parent deposit (lode or stockwork) of this ore."

This shows that there is a fair prospect of finding both rubies and tin-ore on the west coast of the Middle Island. With such knowledge the miners will be more careful in examining the boulders and small stones found amongst the gravel-drift, for if larger samples of the rubies can be

obtained they would be a valuable product, and would tend to make comparatively poor auriferous ground payable for working.

On my last visit to Kuaotunu the miners on that field were desirous of getting a school of mines, with some person to visit it occasionally and give a few lectures. There are some of the late students of the Thames School on the field who would be of great service in giving elementary instruction. As there are about 274 miners on the field, and the mining claims all adjoin one another, a small school here would be well attended and would be likely to produce good results.

Expenditure on Schools.—The following statement shows the expenditure by the department on the different Schools of Mines since their inauguration, exclusive of subsidies given towards the school in connection with the Otago University :—

Financial Years.	Subsidies towards the Erection of Schools of Mines, and Maintenance.	Chemicals and Apparatus, also Mineralogical Specimens, supplied to Schools of Mines.	Salaries of Teachers, and Travelling-expenses, &c.	Total Sums paid by the Department towards the Schools of Mines.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1885–86	Nil	36 19 9	1,223 9 10	1,260 9 7
1886–87	257 16 6	409 1 4	2,716 9 3	3,383 7 1
1887–88	253 15 9	253 14 1	1,714 9 6	2,221 19 4
1888–89	42 10 0	6 12 9	1,139 4 1	1,188 6 10
1889–90	142 2 0	181 14 10	716 3 10	1,040 0 8
1890–91	217 6 6	54 8 0	620 9 9	892 4 3
1891–92	181 14 0	Nil	689 5 9	870 19 9
Totals	1,095 4 9	942 10 9	8,819 12 0	10,857 7 6

In addition to the expenditure of £10,857 7s. 6d., there has been a yearly subsidy of £500 paid for the last seven years towards the School of Mines in connection with the Otago University, making a total of £3,500 which has been paid towards the maintenance of this school. Taking the whole expenditure on all the schools in the colony—namely, £14,357—it gives an average of £2,051 per annum, but the annual expenditure for the last two years has only amounted to £1,392 4s. 3d. and £1,370 19s. 9d. respectively. This is money well spent, and the colony will reap in future years the advantage in having trained men, both practically and theoretically, to carry on the mining industry. Not only men actually engaged in mining pursuits, but also boys and young men, some of whom are following other avocations, are attending these schools. Great credit is due to Mr. Morley, of Nelson, who has a class of boys studying mineralogy and blow-pipe analysis, the average attendance at his class being over seventeen last year. Similar classes would give the youths an impetus in searching for any rock likely to contain minerals, and this technical training will eventually lead to the mining industry being conducted on a more scientific basis.

WATER-RACES.

Waimea Water-race.

The upper portion of this water-race has been constructed since about 1875, or about seventeen years, and some of the flumes are still standing, very little repairs having been done. A large portion of the trestlework and stringers have been replaced; but wherever silver-pine and rata are used the work is as good yet as when first erected. Small portions of the flumes have had to be renewed, but the most of the original boxing is still sufficiently good to last for some time yet.

During last year a survey of a branch of this water-race was made to Callaghan's, with the view of having an extension to that place, so as to be able to dispose of all the water in the event of it not being used in the vicinity of Goldsborough and Stafford. When this survey was made great expectations were formed with regard to a rich deposit of auriferous wash-drift said to be discovered by Hyndman and party in the flat. On further prospecting this ground it was found there was no possibility of bottoming it without proper pumping-machinery; and until this is accomplished, and the ground thoroughly tested, very little water could be disposed of at this place; but if the deep ground should turn out payable for working, pumping and winding will be done by water-power. The length of this branch race will be 4 miles 62 chains, and the estimated cost is about £4,500.

It is not intended to construct the whole of the race to Callaghan's at present, but merely to construct the first 2 miles and 10 chains to bring the water on to the ground at the head of the Waimea Valley, where there is a considerable area known to be payable for working by hydraulic sluicing. This portion of the race is in course of construction, and is estimated to cost about £1,700.

The sales of water from the Waimea Race are getting less every year. Last year the average number of men employed was seventy-six, while for the previous year the average was eighty-eight. The following statement will show the sales of water and cash received, together with the cost of maintenance and the approximate quantity and value of gold obtained by the miners using water from this supply :—

Month.	Sales of Water.	Cash received for Sales of Water.	Expenditure.	Outstanding Moneys at the End of each Month.	Number of Men employed.	Approximate Quantity of Gold obtained.	Value of Gold.
1891.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		Oz.	£ s. d.
April	110 3 0	122 9 10	61 3 5	59 0 5	74	238	928 4 0
May	115 18 10	120 10 9	63 5 9	59 2 11	74	244	951 12 0
June	96 12 9	82 14 8	57 17 5	57 2 11	72	187	729 6 0
July	71 17 6	69 0 4	63 14 4	58 12 11	61	190	741 0 0
August	92 1 0	99 10 5	68 11 9	59 12 11	87	199	776 2 0
September	99 0 4	102 13 2	63 18 4	58 17 11	84	246	959 8 0
October	108 5 8	97 12 4	60 10 0	59 7 11	82	244	951 12 0
Dovember	95 14 0	71 3 3	63 5 11	58 17 11	78	233	908 14 0
Necember..	72 11 1	71 12 1	79 4 0	58 18 2	77	166	647 8 0
1892.							
January	50 19 4	84 14 7	78 8 0	59 0 5	75	171	666 18 0
February	89 19 5	83 14 5	56 6 7	58 15 5	74	207	807 6 0
March	118 13 3	118 13 3	68 8 4	57 6 8	73	265	1,033 7 0
Totals	1,121 16 2	1,124 9 1	784 13 10	..	76	2,590	10,100 17 0

It will be seen from the foregoing statement that the receipts from sales of water for last year was £1,121 16s. 2d., as against £1,388 17s. 5d. for the previous year, and the expenditure on maintenance £784 13s. 10d., as against £933 3s. 3d. for the former year. This shows that the sales of water diminished last year to the extent of £267 1s. 3d., and the expenditure decreased also to the extent of £148 9s. 5d., so that, although the sales do not come to as much as for the year 1890–91, still the decreased cost of maintenance makes the profits on the working only £118 11s. 10d. less than for the previous year. The actual profit on the working last year was £337 2s. 4d. The value of free water given to the miners as assistance last year in opening out ground was £96 19s.; the approximate quantity of gold obtained by those who used water from this supply last year (2,590) representing a value of £10,100 17s. Deducting the value of the sales of water from the value of gold obtained, it leaves £8,979 0s. 10d. as the earnings of seventy-six men for the year, which is equal to £118 3s. a man per annum, or about £2 5s. 5d. per week, being 6d. per week more than last year. Taking the profits last year they only returned about $\frac{3}{10}$ per cent. on the cost of construction, which amounts to £119,011 6s. 10d.

Kumara Water-race.

During last year considerable improvements have been made to the supply water-race, dam, and head-race tunnel, whereby more water can be supplied if required. The whole of the works in connection with this water-supply are in good order. The average quantity of water supplied from this water-race daily for the last year, exclusive of the quantity used for flushing the two tail-races—formerly known as No. 1 and 2 Sludge-channels—for 280 days in the year on which water is supplied (that is, deducting holidays, &c.), was 57·53 sluice-heads, while for the previous year it was 62·72 sluice-heads. A comparative result of the working of this race for the last nine years will be seen in the annexed tabulated statement, showing the transactions any month for the last nine years. The improvements made to the water-race last year may be classed under four heads—namely, Kawhaka Supply-race, Loop-line Dam, Head-race Tunnel, and Catch-water Races—on which there was an expenditure of £1,120 3s. 2d.

Kawhaka Supply-race.—The Kawhaka Supply-race, from its source in the Kawhaka Creek, at the concrete dam, to the point where it discharges into the Kapitea Creek, at the pipe-line of the Waimea Race, near the Loop-line Dam, is about five miles in length. This entire length has been cleared of all overhanging timber, scrub, and fern. Towards the lower end the race was completely blocked with timber and *débris*, the removal of which lowered the surface of the water about 3ft. This blockage during wet weather caused the race to overflow and flood the adjoining country, and only a small proportion of the water brought down by the supply-race ever reached the Loop-line Dam, as it went back again into the Kawhaka Creek, below Newton's.

Before the race was improved the sectional area of running water, when the race was full, was less than 9 square feet, and the velocity was 2¼ft. per second, giving about twenty sluice-heads. Now the sectional area of running water is 13 square feet, and the velocity 3½ft. per second, giving about forty-five sluice-heads, the whole of it being discharged into the Kapitea Creek, and thence into the Loop-line Dam. The dam now fills with about half the rainfall it formerly required to fill it.

From the lower end of the race to the tunnel at the head-works it has been thoroughly cleared of the accumulation of *débris* of many years, and in many places it has been made wider and deeper. The gradient of the race-bottom is now uniform, and to make it so it had to be made deeper in some places by 2ft.

Loop-line Dam.—The outlet-culvert from the Loop-line Dam has been strengthened and relined with substantial heart of red-pine, and, although its area has been diminished by 8in. in width and 9in. in depth, its capacity is still ample for all purposes. This was the weakest spot in the dam, but with the repairs now effected there is little danger of this portion of the work giving any trouble in future.

The screw for opening and shutting the outlet-gate is not in good condition, and may fail to do its work at any time; but there is on hand a new screw of larger dimensions and better construction, which was obtained from Dunedin, ready to replace the old one as soon as the dam is low enough to get it in position.

The by-wash has had nothing done to it during the year, and, as the scour is still going on, means will have to be taken to put a stop to it.

Head-race Tunnel.—During the year about one chain of the main race between the inlet end of the Head-race Tunnel and the little dam has been enlarged and timbered, and about two chains of the upper end of the tunnel has also been enlarged and substantially retimbered. New inlet-gates of much larger carrying capacity, with substantial screws for opening and closing, have been fixed at the tunnel mouth, and a length of 18 chains of tunnel has been lined top, bottom, and sides. These alterations and improvements have increased the carrying-capacity of the tunnel fully 25 per cent. Previously, the tunnel had a carrying-capacity of something less than 100 sluice-heads; its carrying-capacity now exceeds 125 sluice-heads. A new screw has been fixed on the outlet-gate of the little dam, as the old one was not in good condition; and new boxing and gates have been put in at the lower end of the Head-race Tunnel, for the better distribution of the race-water to the several branch races. In case of accident, a new by-wash has been put in between the upper end of the tunnel and the little dam, through which the whole of the race-water can be turned should necessity arise; by this means the race can be thoroughly emptied for the execution of repairs to either tunnel or race.

Catchwater Races, &c.—Catchwater races have been cut, by which a very considerable quantity of water, formerly running to waste, is now carried into the little dam, and full benefit is derived from any temporary heavy showers. The Kapitea Hill Race has been considerably enlarged, and is now capable of carrying seventy-five sluice-heads. Two new by-washes have been constructed, one at the lower end of the Kapitea Hill Race, and the other at Dillmanstown.

The foregoing improvements have rendered the race capable of supplying 25 per cent. more water than formerly; but the demand for water has recently been very small.

The following table will show the result of working the water-race last year, the number of men employed, and the approximate quantity and value of gold obtained by those using water from this supply:—

Month.	Sales of Water.	Cash received for Sales of Water.	Expenditure.	Outstanding Moneys at the end of each Month.	Number of Men employed.	Approximate Amount of Gold obtained.	Value of Gold.
1891.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		Oz.	£ s. d.
April	616 5 10	485 7 0	167 13 2	51 4 3	179	1,026	4,001 8 0
May	655 4 11	679 16 6	171 3 9	72 1 9	180	1,255	4,894 10 0
June	542 9 1	621 13 11	140 11 3	50 8 7	179	629	2,453 2 0
July	179 11 11	225 0 3	112 11 8	44 8 9	179	399	1,556 2 0
August	426 16 1	305 16 11	124 5 3	56 8 3	179	527	2,055 6 0
September	769 15 5	838 19 11	171 19 3	49 10 0	179	802	3,127 16 0
October	784 13 8	607 1 5	150 17 8	74 1 9	177	1,123	4,379 14 0
November	642 4 2	710 7 10	149 18 11	58 6 10	168	1,138	4,438 4 0
December	469 10 0	474 10 6	107 16 2	62 13 8	171	842	3,283 16 0
1892.							
January	291 3 9	310 13 7	95 4 10	66 5 6	166	767	2,991 6 0
February..	543 7 6	490 9 11	82 13 7	85 17 7	162	645	2,515 10 0
March	724 8 8	630 1 6	109 15 5	118 8 7	149	1,086	4,235 8 0
Total	6,645 11 0	6,379 19 3	1,584 10 11	..	172	10,239	39,932 2 0

It will be seen that the sales of water for last year amounted to £6,645 11s., to which must be added the value of water given towards the cost of deviations, £413 3s. 4d., making the total sales of water £7,058 14s. 4d., while the expenditure on maintenance for the same period was £1,584 10s. 11d. Comparing this year's returns with the previous one, in which the sales of water amounted to £6,665 12s. 8d., and adding the value of water given towards the construction of No. 3 Channel or tail-race—£913 18s. 4d.—the total sales amounted to £7,579 11s., the expenditure for the same period being £1,766 4s. 3d.; showing a decrease in the sales last year of £1,520 16s. 8d., and in cost of maintenance of £181 13s. 4d. The actual profit on the working last year was £5,474 3s. 5d. The value of free water given to parties to open out claims was £339 17s. 3d., and for assistance in working poor ground £656 7s. 2d., making a total of £996 4s. 5d. The average number of men employed in claims working with water from this supply last year was 172, while for the previous year the average number employed was 155. The approximate quantity of gold obtained by persons using water from this race last year was 10,239oz., representing a value of £39,932 2s. Deducting the value of the sales of water—namely, £7,058 14s. 4d.—from the value of the gold, it gives the average earnings of the miners as about £191 2s. 6d. per man per annum, or £3 13s. 6d. per week, being 1s. 4d. a man per week less than the earnings for the previous year. The profits on the working for the last year equalled 13·8 per cent. on the total expenditure on construction, which now amounts to £39,636 7s. 1d.

The following summary will show the result of working this water-race for the last nine years: During that period, £65,057 19s. 6d. was derived from sales of water. The value of water given for assistance was £6,575 17s. 1d.; for cost of deviations, £1,898 3s. 9d.; and towards the construction of the No. 3 Channel, or tail-race, £2,406 1s. 2d.; making the total value of water sold and given away amount to £75,939 1s. 6d., while the cost of maintenance for this same period was £13,445 5s. 11d.

SUMMARY showing the RESULT of WORKING the KUMARA WATER-RACE for Nine Years, from 1st April, 1883, to 31st March, 1892.

Water supplied.	Year.	Rate per Sluice-head per Week.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	Total Value of Water sold.	Total Value Free for Assistance.	Total Value Free for Deviations.	Total for Construction of No. 3 Channel.	Total Value Water supplied.	Average Number of Sluice-heads supplied Daily.	Expenditure.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		£ s. d.
Water sold ..	1883-84	3 0 0	371 16 5	465 2 1	700 2 6	583 9 7	702 7 6	626 16 3	808 10 5	777 3 9	774 17 11	698 2 6	1,064 0 0	774 6 0	8,346 14 11	..	..	..	..	..	..
Free	1883-84	..	46 2 6	44 5 0	183 11 8	108 19 2	108 0 0	85 7 6	244 7 6	172 18 9	63 12 6	103 9 2	86 5 0	139 3 4	..	1,386 2 1	..	..	..	..	..
			417 18 11	509 7 1	883 14 2	692 8 9	810 7 6	712 3 9	1,052 17 11	950 2 6	838 10 5	801 11 8	1,150 5 0	913 9 4	..	..	..	..	9,732 17 0	46·35	2,153 5 5
Water sold ..	1884-85	3 0 0	580 4 4	937 19 4	667 3 11	906 16 10	882 6 10	997 1 5	919 12 3	1,126 11 10	819 17 3	289 4 2	756 9 2	821 0 10	9,704 8 2	..	..	..	..	..	..
Free	1884-85	..	92 5 0	56 19 7	78 18 9	55 13 9	149 0 10	18 11 3	145 13 4	69 3 9	39 15 0	26 12 6	45 3 9	2 16 8	..	780 14 2	..	..	..	..	..
			672 9 4	994 18 11	746 2 8	962 10 7	1,031 7 8	1,015 12 8	1,065 5 7	1,195 15 7	859 12 3	315 16 8	801 12 11	823 17 6	..	..	..	..	10,485 2 4	49·92	1,656 0 1
Water sold ..	1885-86	2 10 0	665 16 0	796 6 9	893 5 3	745 19 7	773 19 10	943 13 5	953 15 6	997 7 8	697 13 5	686 4 0	708 15 8	935 19 7	9,786 16 8	..	..	..	..	..	..
Free	1885-86	..	24 13 9	9 2 0	..	..	23 15 0	31 3 4	22 1 3	18 11 10	18 7 2	49 1 4	1 5 0	13 2 6	..	221 3 2	..	..	..	..	..
			690 9 9	805 8 9	893 5 3	745 19 7	797 14 10	974 15 9	975 16 9	1,015 19 6	716 0 7	735 5 4	710 0 8	949 2 1	..	..	..	..	10,009 19 10	57·20	1,454 19 5
Water sold ..	1886-87	2 10 0	758 0 4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Water sold ..	1886-87	2 0 0	..	19 10 8	488 3 9	315 7 11	599 5 0	643 7 11	682 8 9	686 7 5	562 0 10	345 12 7	673 0 0	747 9 2	6,470 14 4	..	..	..	..	..	..
Free	1886-87	..	..	776 0 11	242 0 11	40 13 9	120 9 7	83 15 10	74 5 0	45 9 2	32 15 0	46 8 9	49 16 8	36 3 4	..	1,547 18 11	..	..	..	..	..
			758 0 4	795 11 7	730 4 8	356 1 8	719 14 7	727 3 9	706 13 9	731 16 7	594 15 10	392 1 4	722 16 8	783 12 6	..	..	..	..	8,018 13 3	56·19	1,398 18 10
Water sold ..	1887-88	2 0 0	535 5 10	679 7 8	167 10 10	656 4 7	684 16 1	694 5 0	591 12 1	710 0 0	535 10 10	519 15 5	670 17 6	734 4 5	7,169 10 3	..	..	..	..	..	..
Free	1887-88	..	26 11 8	40 19 2	15 13 9	23 10 0	47 7 11	4 11 8	34 16 8	42 10 0	27 10 0	28 6 8	19 11 8	15 17 3	..	347 6 5	..	..	..	..	..
			561 17 6	720 6 10	183 4 7	679 14 7	732 4 0	698 15 8	626 8 9	752 10 0	553 0 10	548 2 1	690 9 2	750 1 8	..	..	..	..	7,516 16 8	53·68	982 12 0
Water sold ..	1888-89	2 0 0	490 6 8	338 7 7	532 1 1	626 19 10	667 8 3	542 6 4	702 12 6	664 1 7	395 12 3	465 2 1	623 18 4	667 8 4	6,716 6 10	..	..	..	..	..	..
Free	1888-89	..	107 17 3	90 18 0	87 1 4	75 1 10	32 10 0	16 9 5	38 1 4	13 0 0	34 9 2	58 6 8	90 10 10	74 13 4	..	492 0 0	227 0 0	..	..	..	..
			598 3 11	429 5 7	619 2 5	702 1 8	699 18 3	558 17 9	740 13 10	667 1 7	430 1 5	523 9 7	714 9 2	742 1 8	..	..	..	..	7,435 6 10	53·10	1,024 1 9
Water sold ..	1889-90	2 0 0	401 13 4	495 16 4	256 16 8	377 16 3	353 4 2	237 7 11	318 10 10	293 8 4	159 18 9	219 15 10	248 19 7	186 16 8	3,550 4 8	..	..	..	..	..	..
Free	1889-90	..	45 15 0	55 3 4	43 0 0	92 15 0	105 15 0	93 1 8	41 10 0	103 18 4	105 13 4	48 17 6	54 8 4	71 5 0	..	396 2 6	465 0 0	..	..	..	..
Free, No. 3 Channel	1889-90	..	..	..	..	..	122 19 1	335 1 3	330 11 8	275 8 0	97 13 4	6 0 0	221 18 1	102 11 5	..	..	..	1,492 2 10	..	..	..
			447 8 4	550 19 8	299 16 8	470 11 3	581 18 3	665 10 10	690 12 6	672 14 8	363 5 5	274 13 4	525 6 0	360 13 1	..	..	..	..	5,903 10 0	42·16	1,424 13 3
Water sold ..	1890-91	2 0 0	300 12 6	355 11 11	368 3 2	423 9 0	622 17 11	666 7 1	720 16 1	701 5 10	578 1 8	546 17 11	691 17 11	689 11 8	6,665 12 8	..	..	..	..	..	..
Free	1890-91	..	113 5 0	119 14 2	70 7 11	71 17 6	82 9 7	110 15 8	93 13 9	106 0 10	57 5 5	113 6 8	133 2 6	130 5 10	..	409 5 5	793 0 5	..	..	..	..
Free, No. 3 Channel	1890-91	..	272 11 11	247 3 6	246 17 10	115 2 11	32 2 2	..	..	..	..	..	..	..	..	..	..	913 18 4	..	..	..
			686 9 5	722 9 7	685 8 11	610 9 5	737 9 8	777 3 9	814 9 10	807 6 8	635 7 1	660 4 7	825 0 5	819 17 6	..	..	..	..	8,781 16 10	62·72	1,766 4 3
Water sold ..	1891-92	2 0 0	616 5 10	655 4 11	542 9 1	179 11 11	426 16 1	769 15 5	784 13 8	642 4 2	469 10 0	291 3 9	543 7 6	724 8 8	6,645 11 0	..	..	..	..	..	..
Free	1891-92	..	143 11 5	191 16 8	44 3 6	..	82 16 11	151 14 7	118 10 1	233 1 8	213 11 3	137 0 10	64 11 8	28 9 2	..	996 4 5	413 3 4	..	..	..	..
			759 17 3	847 1 7	586 12 7	179 11 11	509 13 0	921 10 0	903 3 9	875 5 10	683 1 3	428 4 7	607 19 2	752 17 10	..	..	..	..	8,054 18 9	57·53	1,584 10 11
															65,057 19 6	6,576 17 1	1,898 3 9	2,406 1 2	75,939 1 6	..	13,445 5 11

NOTE.—The above does not include water for flushing purposes as follows: No. 2 Channel, 10 sluice-heads; No. 3 Channel, 23 sluice-heads. The average number of sluice-heads supplied daily is calculated each year on 280 working-days per annum.

Notwithstanding the different statements in my annual reports year after year, some person occasionally asks me to inform him as to the amount of loss each year in working the water-races on the West Coast; but if such person would examine my reports they would see that each year there has been a large surplus revenue arising from the races since their construction.

Taking the Kumara Water-race as an example, if the amount of money actually received from the sales of water—namely, £65,058, exclusive of the value of water given towards the cost of deviations and other works, and allowing £13,445 for maintenance, an actual profit is shown of £51,613 for a period of nine years, being £11,976 more than the cost of construction.

Waimea–Kumara Water-race.

The returns have been shown for each portion of this water-race separately; but it must be considered as one work, and, although the Kumara portion of the race pays extremely well taking it as a whole, the very large expenditure on construction of over two miles of heavy cast-iron pipes on the Waimea portion, the profits on the working would have paid good interest on the outlay. The total cost of this work, exclusive of the cost of the main tail-race, or what was formerly termed the sludge-channel at Kumara, is £158,647 14s. 9d.; but, as the main tail-race has been handed over to the miners, the cost of its construction has not now to be taken into account in calculating the rate of interest from profits.

The following statement gives the details of water supplied from the races, other than by sales:—

Free Water supplied from Waimea–Kumara Water-race from 1st April, 1891, to 31st March, 1892.

Name of Party.	Purpose granted.	Authority.	Amount of Authority.	Balance due 31st Mar., 1891.	Total for Deviations.	Total for Assistance.	Total for Opening up.	Total.	Balance due on Authorities, 31st Mar., 1892.
Kumara Water-race.			£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
J. Palmer and party	Deviation of water-race and substituting steel syphon	88/581	450 0 0	92 16 3	92 16 3	..	..	92 16 3	..
S. Pascoe and party	"	"	450 0 0	297 19 2	268 2 6	..	..	268 2 6	29 16 8
G. Watson and party	Poor ground ..	91/199; Telegram, 24/11/91	..	32 10 0	..	65 8 4	..	65 8 4	..
R. Ireland and party	" ..	91/199; 91/392	..	..	..	72 0 0	..	72 0 0	..
McIlveney and party	..	91/75; 91/91/950	..	..	..	40 10 0	44 2 11	84 12 11	..
J. Corrigan and party	Poor ground and opening out claim	M. 229	..	..	..	..	31 17 6	31 17 6	..
A. Trickey and party	" ..	91/950	..	..	..	..	129 0 7	129 0 7	..
N. Rothwell and party	" ..	M. 229	..	..	..	43 6 3	..	43 6 3	..
Williams and party	Poor ground ..	"	..	..	..	30 0 0	..	30 0 0	..
C. Hillier and party	" ..	91/309	..	..	..	41 7 1	..	41 7 1	..
E. Rochford and party	" ..	91/392	..	..	..	..	56 1 3	56 1 3	..
S. McNeil and party	Opening out claim ..	M. 229; 91/950	..	..	..	..	52 15 0	52 15 0	.. ..
W. Morris and party	" ..	91/308	..	..	..	35 15 0	..	35 15 0	
Thomas and party ..	Poor ground ..	91/391	..	..	..	32 10 0	..	32 10 0	..
Lee and party ..	Deviation of race, substituting steel pipes	251	150 0 0	..	49 4 7	..	..	49 4 7	100 15 5
Moore and party ..	Poor ground ..	91/463	..	..	..	32 10 0	..	32 10 0	..
Anderson and party	" ..	"	..	..	..	32 10 0	..	32 10 0	..
Harvey and party ..	" ..	91/392	..	..	..	37 10 0	..	37 10 0	..
D. Seater and party	" ..	"	..	..	..	32 10 0	..	32 10 0	..
Crump and party ..	" ..	"	..	..	..	27 0 11	..	27 0 11	..
J. Keller and party ..	" ..	"	..	..	..	37 10 0	..	37 10 0	..
T. Davidson and party	Deviation of race ..	"	..	..	3 0 0	..	..	3 0 0	..
T. Hughes and party	Poor ground ..	91/950	..	..	..	38 19 2	..	38 19 2	..
J. Light and party ..	" ..	"	..	..	..	32 10 0	..	32 10 0	..
Carew and party ..	" ..	"	..	..	..	24 10 5	..	24 10 5	..
Gibbons and party ..	" ..	"	..	..	..	..	26 0 0	26 0 0	..
					413 3 4	656 7 2	339 17 3	1,409 7 9	
Waimea Water-race.									
Martin Morris ..	Poor ground ..	91/308	..	..	..	14 19 0	..	..	..
J. Gargivitch ..	" ..	91/465	..	..	..	35 0 0	..	..	..
McKenna and party	" ..	91/738	..	..	..	26 0 0	..	..	..
A. Masiorini ..	" ..	Memo. 8/12/91	..	..	..	21 0 0	..	..	..
						96 19 0			

The profits on the working of this race last year give about 3·64 per cent. on the total cost of construction.

The following table will show the total returns and collateral advantages in the working of the water-race:—

Month.	Sales of Water.	Cash received for Sales of Water.	Expenditure.	Outstanding Moneys at the end of each Month	Number of Men employed.	Approximate Amount of Gold obtained.	Value of Gold.
1891.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		Oz.	£ s. d.
April	726 8 10	607 16 10	228 16 7	110 4 8	253	1,264	4,929 12 0
May	771 3 9	800 7 3	234 9 6	131 4 8	254	1,499	5,846 2 0
June	639 1 10	704 8 7	198 8 8	107 11 6	251	816	3,182 8 0
July	251 9 5	294 0 7	176 6 0	103 1 8	240	589	2,297 2 0
August	518 17 1	405 7 4	192 17 0	116 1 2	266	726	2,831 8 0
September	868 15 9	941 13 1	235 17 7	108 7 11	263	1,048	4,087 4 0
October	892 19 4	704 13 9	211 7 8	133 9 8	259	1,367	5,331 6 0
November	737 18 2	781 11 1	213 4 10	117 4 9	246	1,371	5,346 18 0
December	542 1 1	546 2 7	187 0 2	121 11 10	248	1,008	3,931 4 0
1892.							
January	342 3 1	395 8 2	173 12 10	125 5 11	241	938	3,658 4 0
February	633 6 11	574 4 4	139 0 2	144 13 0	236	852	3,322 16 0
March	843 1 11	748 14 9	178 3 9	175 15 3	222	1,351	5,268 15 0
Total ..	7,767 7 2	7,504 8 4	2,369 4 9	..	248	12,829	50,032 19 0

From this table it will be seen that the sales of water amounted to £7,767 7s. 2d., to which has to be added £413 3s. 4d., the value of free water given towards the cost of deviations at Kumara, making the total revenue £8,180 10s. 6d.; the expenditure being £2,369 4s. 9d., leaving a profit on the working of £5,811 5s. 9d. The total amount of free water given for other purposes last year was £1,093 3s. 5d. The average number of men employed in working claims with water from this supply was 248, and the quantity and value of gold obtained was 12,829oz., representing a value of £50,032 19s. Deducting the value of the sales of water, and the value of water given towards the cost of deviations, it leaves £41,852 8s. 6d. as the earnings of 248 miners for the year, which amounted to about £168 15s. 2d. per man, or £3 2s. 7d. a man per week, being about the same as for the previous year.

Nelson Creek Water-race.

This water-race is leased at a peppercorn rental for two years from the 1st August, 1891. The whole of the bridges and flumes, which have been erected for about seventeen years, are so decayed that the revenue the Government was getting from this race would not pay the cost of maintenance. The race was accordingly leased to John McNaughton, the former manager, to carry on for what he could make out of it. There is not a sufficient area of auriferous gravel-drifts commanded by this race to justify a large outlay in replacing the flumes and bridges. The sales of water for the year 1890–91 only amounted to £570, while the expenditure on maintenance for the same period was £940. The ground was also getting more worked out every year, so that the revenue would necessarily become less, and the average number of men that this supply was the means of keeping employed in the locality was only twenty-eight.

There is a splendid reservoir at the head of this water-race, which may be utilised some day as a storage-supply for a water-race to command the country between Nelson Creek and No Town Creek, where there are large areas of auriferous drifts which may some day be profitably worked by hydraulicing. There is also a considerable area of drift terraces between Nelson Creek and the Ahaura River that would pay for working with a good supply of water; this water-supply would also command that ground. The following table shows the receipts and expenditure for the four months previous to handing the race over to Mr. McNaughton:—

Month.	Sales of Water.	Expenditure.	Number of Men employed.	Approximate Amount of Gold obtained.	Value of Gold.
1892.	£ s. d.	£ s. d.		Oz.	£ s. d.
April	42 10 0	74 2 0	26	64	256 0 0
May	44 10 0	74 9 0	24	65	260 0 0
June	68 11 8	77 13 6	22	63	252 0 0
July	57 8 4	65 17 0	21	53	212 0 0
Total	213 0 0	292 6 6	23	245	980 0 0

This shows a loss on the working of £79 6s. 6d. for the four months; and the amount received for gold, after deducting the value of sales of water, was equal to about £1 18s. 6d. a man per week. The total cost of this work was £90,722 10s. 8d.

Mikonui Water-race.

This water-race has been handed over to the Ross Borough Council, who are intending to raise the necessary funds to complete it, at an estimated cost of over £60,000. The local body considers that if the water-race was completed they would derive a large revenue from it. At the present time it is only bringing in a revenue of £50 per annum, while the expenditure already made on the work by Government amounts to £25,927 4s. 6d. A large expenditure would also have to be made in completing the long tunnel between Donnelly's Creek and the Totara River side of the range before any supply of water can be obtained. The portion completed at the present time is used by a company to carry water from creeks for which they hold water-rights.

MOUNT IDA WATER-RACE.

Although this water-race has been in use for the last fifteen years, the revenue derived from the sales of water has never paid for the expense of maintenance, yet, notwithstanding this state of affairs, it is and will in the future be a valuable property. Even if there were no mining whatever, the elevation at which this race is constructed commands all the Maniototo Plains, and the water could be used for irrigation purposes. This water-race is managed by a local Trust, but certainly not with success. In January last Mr. R. Brown, County Engineer, and myself, at the request of the Hon. the Minister of Mines, inspected the race and the site of a proposed reservoir in the valley of the Eweburn.

The water-race is constructed from the middle branch of the Manuherikia River to Speck Gully, a distance of about seventy-seven miles, the water being conveyed in an open conduit for the whole distance, with the exception of about 7 chains of a tunnel, and four pieces of fluming, the largest of which is about 2 chains.

Shingle-creek Crossings.—There are a number of creeks between the head of the race and the place where it crosses the Marion Burn or left branch of the Manuherikia River; the ditch being constructed across the shingle-beds, every flood washes away the banks on the lower side, filling up the channel of the race. The following statement shows the nature of the creeks referred to:—

Name of Creek.	Width of creek-bed, all shingle.	State of Creek in Ordinary Weather.	Remarks.
	Chains.		
Manuka Creek	1	Water	Loose shingle-bed.
Little German Gully	0½	Dry	"
German Gully Creek	10	Water	"
Kirkwood Creek...	1	"	"
Little Bremner's Creek	0½	"	"
Big Bremner's "	1	"	Fair crossing.
Shepherd's Hut "	10	"	Loose shingle-bed.
Trinity "	0½	Dry	"
Old Shepherd's "	1	Water	Fair crossing.
Ten-chain "	10	"	Loose shingle-bed.
Hut "	1	"	Fair crossing.
Pierce's Gorge "	1¼	"	Bad crossing.

It will thus be seen that there are 37¾ chains of creek-beds composed of very loose shingle, across which the water-race channel is excavated. The result is that there is always a large amount of leakage, and, although some of these gullies and creeks are dry in fine weather, in wet weather they are mountain-torrents. The race is constructed alongside the foot of a high steep range, and the water is continually bringing down large quantities of shingle, which is deposited in the beds of the gullies and creeks. Therefore, after any heavy rain the ditches across these creeks are always either completely filled up to the surface of the bed, or else the water has scoured a deep channel in the shingle across the race-channel. These creeks and gullies being long distances apart, it takes a considerable time before the repairs are effected. In fact, at the very time when there is a good supply of water available, the race is invariably being repaired. This state of things should not exist; the race should be differently constructed across these streams, so that the water would be always available for mining.

Construction of Race.—The greater portion of the water-race is constructed on an easy sideling, and in many places over flat ground; but no attempt has been made to construct a foot- or horse-track alongside the race. This could have been easily done by the maintenance-men from time to time, by merely levelling down the top of the excavated material, so that a man could ride alongside the race for the whole of the distance, for purposes of inspection. Owing to the nature of the ground through which the race is constructed, constant attention, especially during wet weather, is necessary, and as each maintenance-man has from sixteen to twenty miles of race to look after it is absolutely necessary that he should ride in order to effect necessary repairs quickly.

Condition of Race.—The condition of the race itself is very unsatisfactory, the upper side in many places having partially slipped in, either during heavy rains, or probably after frost; and in some parts the material is still lying in the race. The vegetation on the lower side of the ditch in many places is very considerable, and hangs into the ditch amongst the water, which, of course, greatly reduces the carrying-capacity of the channel. Judging from the appearance of the top of the excavated material, and the complete rabbit-warren of the low side of the race, with holes burrowed in every direction, it leads one to suppose the race has not been thoroughly examined for several years, or, if it has, the motto has been to "Do nothing more than is actually necessary to make the water flow in the channel."

Capacity of Water-race.—There are several places where there are steep sidelings which could be done away with if the water were carried across the gorges in a siphon. This specially applies to Pierce's Gorge, and the Wedderburn. At the former place a siphon 30 chains in length would cut off nearly two miles of a very steep rocky sideling, which gives a great deal of trouble every spring: the frost loosening the high bank on the upper side, and filling up the race. The same thing occurs at the Wedderburn; and there a siphon from 40 to 50 chains in length would also cut off 4 miles 50 chains of very bad ground. According to the longitudinal sections of race-line, which we examined on our return to Naseby, there is about 36ft. fall between the

points where the siphon would join the ditching: with this fall a pipe 24in. in diameter would be sufficient to convey about twenty-five sluice-heads of water. The original dimensions of the open channel were 4ft. wide in the bottom, 7ft. wide on the top, and 3ft. deep, with a fall of 7ft. per mile. Assuming that the actual depth of water was 2ft. 6in., then the width on top of the water would be 6ft. 6in., or a sectional area of about 13 square feet. Taking the fall per mile and frictional surface into consideration, the carrying-capacity of the ditch ought to be about twenty-six sluice-heads, whereas it is reduced to a carrying-capacity of only from twelve to fifteen sluice-heads.

Constant Supply of Water.—There is frequently not sufficient water in the different streams to fill the ditch, and, unless a storage-reservoir is constructed to store the water in wet weather, a constant supply cannot be obtained. But if the water were conveyed across the shingle-beds of the different creeks in iron or steel piping, and the water of the creeks lifted into the race close to the foot of the range, where a rock bottom can be obtained, a far more regular supply would be insured. The ditch requires cleaning out from end to end, and the lower side closely examined to see that all the rabbit-burrows are stopped up. If this is not attended to a considerable leakage is bound to occur. At the place where the water is lifted out of the middle branch of the Manuherikia River there is, and always will be, a certain loss of water until better provision is made to turn it into the race. At present there are only a few stones laid across the bed of the stream, with shingle and sods laid against them. There should be a solid wall of concrete, if a foundation can be got, across the bed of the stream, with an intake-gate at the head of race, the wall to be so constructed as to act as a weir when there is more water in the river than the ditch can carry.

Eweburn Reservoir.—In regard to a storage-reservoir, there is a very good site at the Eweburn, with solid-rock abutment on one side, and, apparently, rock on the other; but this is not certain, as there is a low saddle projecting behind the block of rock, which has the appearance of being the former bed of this creek. According to a survey made by Mr. R. Brown, a reservoir could be constructed for £10,000, which would have a storage-capacity of 57,000,000 cubic feet of water, and would give a supply of fifteen sluice-heads of water for eight hours a day for a period of seventy-eight days, after allowing 40 per cent. for absorption and evaporation. There is, however, a doubt in my mind as to whether a good foundation for the embankment of the reservoir on the Naseby side of the Eweburn can easily be got. A few shafts would require to be sunk to test this before a reliable estimate could be given of the cost of construction; and, as these shafts could be put down for very little expense, the work should be undertaken: this could be done during the winter months, when mining cannot be carried on for the frost.

Surprise Water-race.—Ever since the construction of the Mount Ida Water-race, the Trust has always complained about the agreement made with the proprietors of the Surprise Water-race to carry a certain quantity of water from the Eweburn free of charge. This was owing to the Mount Ida Race being only at about from 6ft. to 8ft. on a higher level, and in following round the contour of steep sidelings the excavated material filled up the Surprise Race. Consequently, an arrangement was made with the proprietors of this race to abandon it, and the Government agreed to convey two sluice-heads from the Eweburn, when there was water in this creek, and deliver it to the proprietors of the Surprise Water-race, free of charge, at their dam near Naseby. This water has been supplied for the last fifteen years; but in February last the Government purchased the rights of this water-race for £590. At that time there was an arrangement to lease the right of water coming to the proprietors of the Surprise Race to Jacob Lory, for twelve months. The Government has carried out that arrangement, and leased the right to the water that the late proprietors were entitled to for £55 per annum. The lease expires on the 27th January, 1893.

R. Johnstone's Water-rights.—As stated elsewhere, R. Johnstone holds two water-rights, and has two water-races constructed, one from Marion Burn, or eastern branch of the Manuherikia River, and another from the Ida Burn. At the time of my visit to the district there were about five sluice-heads of water in each of those water-races; but this quantity only holds good for a short time after rains. The Miners' Association advocate the purchase of Mr. Johnstone's water-rights from the Marion Burn, for which he requires about £2,000. In regard to the extra supply of water that can be got out of the Marion Burn, it would make very little difference to the extra quantity of water in the Mount Ida Water-race, inasmuch as in ordinary weather, when there is a supply in the Marion Burn, there is a good supply of water in the Mount Ida Race, and when the water becomes short in the race there is very little to be got from the Marion Burn. As a constant supply is desired, the reservoir at the Eweburn is by far the best way of obtaining it. On examining the stream flowing down the valley of the Eweburn, it struck me that it was questionable whether a supply of water could be got from it to fill this reservoir; but the present Manager of the race, as well as the County Engineer and the Chairman of the Trust, assured me that a large body of water comes down this stream in time of floods and wet weather, and that there will be no difficulty in getting the reservoir filled at least once a year; which would mean about three months' supply of water for the field.

Estimated Revenue.—From what could be gathered from the manager of the water-race, if there were a constant supply of fifteen sluice-heads of water for ten months in the year, I understood that the revenue from sales of water would amount to £1,700 per annum, while the expenditure would be about £1,100. Judging from the appearance of the ground, and considering that larger quantities of water would be used if available, the race should be cleaned out to its original dimensions, which would give it a carrying-capacity of about twenty-six sluice-heads when water was available. Indeed, it would be good policy to distribute extra water amongst the miners at first free of charge when the same was available, as this would demonstrate the extra quantity of ground that could be operated on with a larger supply of water, and eventually lead to more water being used, thereby ultimately increasing the revenue. If this race were maintained and managed

in the same manner as the Government water-races on the West Coast, it ought to pay its way, and not be a continual drag on the consolidated revenue.

The following statement will show the receipts and expenditure on the water-race for the year ending the 31st December, 1891 :—

Months.	Sales of Water.	Cash received for Sales of Water.	Expenditure.	Amount of Outstanding Moneys at End of each Month.	Number of Men employed.	Approximate Amount of Gold obtained.	Value of Gold.
1891.	£ s. d.	£ s. d.	£ s. d.			Oz.	£ s. d.
January	115 10 0	142 2 1	73 18 4	No monthly record kept. The outstanding accounts on the 31st December, 1891, amounted to £1,548 10s. 10d. About £1,050 of this amount is reckoned bad, having accumulated during the last fifteen years, and should have been written off.	A full supply of water gives employment to about 130 men. The number of men employed is regulated by the quantity of water supplied. When water is scarce they are engaged in "falling" and other day-work.	300	1,155 0 0
February	66 7 3	114 19 8	96 14 2			200	770 0 0
March	70 8 4	79 13 4	117 14 0			250	962 10 0
April	59 16 8	128 16 0	72 4 9			150	577 10 0
May	76 3 4	31 0 0	58 8 0			250	962 10 0
June	35 6 8	62 11 6	79 11 9			100	385 0 0
July	..	84 10 8	35 14 0			..	..
August	43 0 0		98 14 0			50	192 10 0
September	125 3 4		154 2 0			300	1,155 0 0
October	150 0 0		124 16 8			300	1,155 0 0
November	140 0 0	100 4 1	78 7 4			300	1,155 0 0
December	140 0 0	178 10 4	120 8 8			450	1,732 10 0
Totals ..	1,023 15 7	922 7 8	1,110 13 8			2,650	10,202 10 0

This statement shows that the sales of water for the year amounted to £1,023 15s. 7d., as against £1,027 17s. 8d. for the previous year; and the expenditure on maintenance, £1,110 13s. 8d., while for the former year it was £1,061 9s. 5d. Taking the cost of maintenance and sales of water for the last year, they show a loss on the working of £86 17s. 1d. The average number of miners employed working claims with water from this supply last year was about 130, and the approximate quantity of gold obtained was about 2,650oz., representing a value of £10,202 10s. Deducting the value of the sales of water from the value of the gold it leaves the average earnings of the miners at £70 12s. per annum, or £1 7s. 2d. a man per week.

Summary of Water-races.

The following statement shows the collateral advantages of the working of the water-races—that is, the number of men that have been profitably employed on the goldfields, and the approximate quantity of gold obtained by means of these water-races. Previous to the last year there was a direct revenue of 2s. per ounce of gold obtained. This duty being now abolished, it will not in future enter into the question of collateral advantages. It can, however, be asserted that owing to the construction of some of the large water-races a large number of men have been profitably employed during the past fourteen years on the goldfields who otherwise would not have been. Up to the time when the duty on gold was abolished, the revenue on the gold obtained by miners using water from these races amounted to £27,977 18s.

Statement showing the Profits and Losses on the Working of the Water-races for Fourteen Years.

Name of Water-race.	Value of Sale of Water, including Value of any Gold obtained in Sludge-channel.	Expenditure.	Profit or Loss on Working.	Average Number employed.	Approximate Amount of Gold.	Value of Gold obtained.	Duty received on Gold obtained.	Total Profit or Loss, with Value of Gold Duty added.	Total Cost of Construction.
Waimea-Kumara Water-race and Sludge-channel.	£ s. d.	£ s. d.	£ s. d.		Oz.	£ s. d.	£ s.	£ s. d.	£ s. d.
Thirteen years ending the 31st March, 1891	111,837 5 8	72,698 15 6	39,138 10 2	381	207,280	773,756 7 3	20,728 0	59,866 10 2	..
Year ending 31st March, 1892	7,767 7 2	2,773 17 9	4,993 9 5	248	12,829	50,032 19 0	..	4,993 9 5	..
Totals	119,604 12 10	75,472 13 3	44,131 19 7	371	220,109	823,789 6 3	20,728 0	64,859 19 7	180,612 12 11
Nelson Creek.									
Thirteen years ending the 31st March, 1891	17,364 0 7	15,123 0 7	2,241 0 0	53	32,698	125,069 17 0	3,269 16	5,510 16 0	..
Four months ending 31st July, 1892	213 0 0	292 6 6	*79 6 6	23	245	980 0 0	..	79 6 6	..
Totals	17,577 0 7	15,415 7 1	2,162 13 6	52	32,943	126,049 17 0	3,269 16	5,431 9 6	90,722 10 8
Argyle.									
Thirteen years ending the 31st March, 1891	5,530 16 10	5,455 7 7	75 9 3	17	8,040	30,738 12 0	804 0	933 2 11	14,701 15 3
Mount Ida.									
Thirteen years ending the 31st March, 1891	17,744 5 10	21,263 1 1	*3,518 15 3	106	31,761	120,180 10 0	3,176 2	342 12 10	..
Year ending 31st March, 1892	1,023 15 7	1,110 13 8	*86 17 1	130	2,650	10,202 10 0	..	86 17 1	..
Totals	18,768 1 5	22,373 14 9	*3,605 12 4	107	34,411	130,383 0 0	3,176 2	245 15 9	66,356 3 8
Grand Totals ..	161,480 11 8	118,717 2 8	42,764 10 0	547	295,503	1,110,960 15 3	27,977 16	71,470 8 9	352,393 2 6

* Shows a loss on the working.

GOLD- AND SILVER-MINING.

The returns of the results of gold-mining operations for the last year show a considerable increase in the yield of gold over that produced for the previous year. This increased yield has taken place on every goldfield in the colony. It may be, in some measure, due to two causes in the Middle Island—first, the wet season last year which gave a plentiful supply of water, and, secondly, owing to the anticipation of the abolition of the duty, a good deal of gold was held by the banks during the quarter ending the 31st of March, 1891, instead of being entered for duty for exportation. This second reason is very patent in the case of the quantity entered for duty in Otago for that quarter. According to the Customs returns there were only 64oz. gold of a value of £250 exported; while for the quarter ending the 30th June there were 47,302oz., valued at £189,207, entered for export. The average quantity entered for duty from Otago for four quarters previous to the March one referred to was 15,852oz. per quarter. In regard to the yield from the West Coast, the average quantity entered for duty for export for four quarters prior to the 1st of January, 1891, was 22,574oz. per quarter. Taking, therefore, the average returns for the four quarters referred to from all the districts in the Middle Island, where the duty was abolished after the 1st April, 1891—namely, 15,852oz. from Otago, deducting 64oz. entered for exportation, it leaves 15,788oz. held by the banks for this quarter; and in the case of the West Coast, the average being 22,574oz. per quarter, there was 20,092oz. entered for exportation, leaving 2,482oz. kept back, which would show that about 18,270oz. of gold had been held by the banks that should not be fairly credited to last year's produce. If this quantity be added to the yield for 1890–91 it would make the produce for that year 189,350oz. instead of 171,080oz., the total quantity entered for export last year being 276,535oz. The 18,270oz. would have to be deducted from this, which would leave the actual yield last year to be 258,265oz. This shows that the yield from the mines last year was 68,915oz., representing a value of £275,660 more than for the year previous.

The following is a comparative statement of the quantity and value of gold entered for export for the last two years ending the 31st March last :—

Name of District.	Year ending 31st March, 1892.		Year ending 31st March, 1891.		Increase for 1892.
	Quantity.	Value.	Quantity.	Value.	
	Oz.	£	Oz.	£	Oz.
Auckland	40,525	162,760	38,630	153,678	1,894
Marlborough	7,020	28,026	2,333	9,332	4,687
Nelson	5,301	20,192	1,610	6,406	3,691
West Coast	118,158	472,672	86,792	347,161	31,366
Otago	105,531	423,527	41,715	168,744	63,816
Totals	276,535	1,107,177	171,080	685,321	105,454

The Otago District shows the greatest increase last year, but this district for the previous year showed a falling-off in the yield of gold to the extent of 30,680oz. from the return for 1889–90. It is extremely gratifying to find that the produce of gold from the mines of the colony last year is more than it has been since the year 1886–87, and, notwithstanding the depression in mining properties in the Thames District, the returns last year show an increased yield, taking the County and Borough of Thames conjointly, of 781oz.

The returns of silver are not clearly shown, as a large portion is exported in bullion. The actual returns of silver exported only include what the banks forwarded from the silver alloy in the gold purchased in the colony. There is, however, a considerable quantity of silver exported by the Waihi Company, from Auckland. Their returns for the month of May last showed that bullion to the value of £5,000 was exported, of which more than one half in weight was silver. This was ascertained from the bank, where one of the directors of this company showed the month's bullion to the Hon. the Minister of Mines and myself, when we were officially informed as to its value.

QUARTZ WORKINGS.

NORTH ISLAND.

Auckland District.

Puhipuhi.

The result of mining operations on this field last year has been very disappointing. Great expectations were formed as to the richness of the field, but, as these expectations were not realised when the ore came to be tested in bulk, those in charge of the crushing-plant had to bear the blame. It seems that the outcrops of the lodes were richer in silver than they proved to be at lower depths; some of the assays of the ore from the prospectors' claim, and also from tests of parcels varying from 3,700lb. downwards, made at the Thames School of Mines, showed the ore to be payable for working. Notwithstanding the disappointments met with, Puhipuhi is a field deserving of being better prospected. There are a number of large lodes traversing the country where rich deposits of argentiferous ore are likely to be met with. In some of the mines there is a little gold in the lodes; but, as far as prospecting operations have been carried on, it has been found that silver is the predominant metal. The time at my disposal would not admit of my visiting this field last year; but from the report of Mr. Wilson it will be seen that Mr. Hartmann is still engaged in carrying on experiments in the extraction of the silver from the ore by the

cyanogen process. It is, however, very questionable whether he will be successful with this process in extracting a fair percentage of the silver; it is better adapted for treating gold ores, at least this has proved to be the case by all the experiments yet made with this process, both by Mr. McConnell, the manager of the Crown Company at Karangahake, who was specially sent out by the Cassell's Company from Glasgow to introduce the cyanogen process in this colony, and also by Dr. Scheidel, the managing director of the Sylvia Company at Tararu, who is treating the concentrates from that company's ore by the same process.

The prospectors' claim seems to be the only one where a large amount of work has been done, the total quantity of ore crushed from this claim with their own plant being about 100 tons, which yielded 1,220oz. of silver worth about 3s. per ounce, which would represent a value of £183. During the last year a ton of ore was sent to the School of Mines from the Waipu Claim for treatment, which yielded about 46oz. bullion, worth about 3s. 9d. per ounce, representing a value of £8 12s. 6d. per ton. It is said that the lode from which this ore was taken is from 3ft. to 5ft. in thickness, having the appearance of a lode which would pay for working. Mr. Alexander McKay, F.G.S., Assistant Geologist, has recently examined this filed, and his valuable report entirely coincides with my opinion respecting the future pospecting of this district. The following is Mr. McKay's report:—

"Between the 16th and 23rd of February I made an examination of the Puhipuhi Silverfield, and have the honour to submit the following report thereon:—

"On the occasion of my first visit to this field, in 1890, the weather was so bad that little or no work could be done. At that time comparatively little work had been done, and that chiefly on the claim known as Prospectors' No. 1. Several short drives had been put into the hill at or near the creek-level. These, though generally driven on quartz lodes, showed but feeble traces of silver-ore. These works lay higher up the creek than the camp-site at that time. The direction of the lodes was ascertained to be in the above instances nearly north and south. One reef, however, which crosses the creek two or three chains above the camp, trended more in a north-west and south-east direction, and had the peculiarity of being highly charged with pyrites. The other reefs abounded in iron-oxides, but were generally free from pyrites. At that time a prospecting-shaft was being sunk on the lode where it cropped up on the side of the hill, at a height of about 120ft. above the level of the creek. This had been sunk to a depth of 60ft.; and the reef, 2ft. to 4ft. in thickness, was fairly rich in silver-ore. Ore was being brought to grass at the time of my visit, and from the heap in the paddock I selected four samples, one of which was the best I could find, another the worst, and the two others I judged of as being of intermediate grade. These samples were afterwards analysed in the Colonial Laboratory, at Wellington, and yielded silver at the following rates per ton: the first sample gave 352oz., the second 236oz., the third 64oz., and the fourth 13oz. The average of the four samples is thus 69oz.; but, as the last sample was manifestly of very inferior quality as compared with the bulk of the stone then being brought to grass, it is clear that the average yield should be considered as somewhat more than as above stated.

"I noted the character of the quartz and that of the rocks carrying the reefs, and in both cases the peculiarities of these have been described in the Geological Reports for the year 1890–91. But the work done in the field at that time was not sufficient towards the formation of an authoritative opinion as to the value of the observations that had been made.

"Opportunity offering, I paid a visit to the district in February last, and examined most of the more important mines and claim-holdings. I also made a more careful examination of the country rocks of the district, and examined the district for silver and gold and other minerals.

"Since my first visit a good deal of work has been done on the Prospectors' Claim No. 1. Two levels have been driven in the lode, and a good deal of quartz has been stoped out, principally from the rich shot on which the shaft was being sunk when I first visited the field The reef at both levels was explored to a considerable distance north and south of this, but without coming across stone of equal value. All, or most, of the richer stone has been taken to the mill for treatment, and that now stacked at or near the mine-mouth does not appear to be of any very rich description. The stone from the lower levels gives distinct indications that below the water-line the reef will assume the character of a pyritous lode which will, probably, not favourably affect the readiness of the extraction of the silver. The quartz also continues to be of the same refractory character, a good deal of it being of a very dense and tough description. As regards the permanence of the lode, it has been proved along the lower level for about 100ft., and there can be no doubt that it will live underfoot below the water-level as far as it is likely to be followed by the application of ordinary means. As regards the amount, distribution, and occurrence at low levels of the silver-ore in the lodes, it seems that the prospecting-shaft chanced to be placed on the richest shot of the ore yet met with; but silver is not absent from the other parts of the lode, and it cannot be but there is a probability of equally rich shots of argentiferous stone being found at greater depths than any that has yet been reached in this mine. There can be no doubt that silver-ore is distributed throughout most parts of the reef, and the whole question of its paying-quality will hinge upon the payability of the amount per ton that constitutes the average yield. This is clearly dependent on the cost of treatment.

"*Prospectors' No. 2.*—Three tunnels have been driven for short distances on at least two reefs. One or other of these is evidently a continuation of the main lode in Prospectors' No. 1. Work at the time of my visit was being carried on in the lower level, and stone was being stacked at the mouth of the tunnel. A good deal of this showed silver-ore, but I could not say that it appeared to be very rich. Such stone as I saw would have paid very well had the ore been gold instead of silver, but I fear richer stone must be discovered before the prospects can be characterised as being payable. The stone is of the same character as the lode-stone in Prospectors' No. 1.

"*Young Colonial Mine.*—I was distinctly disappointed with what I saw in this mine. A sample of quartz was received at the Colonial Laboratory last winter from this mine. It gave a high return

of silver, amounting to about 1,100oz. per ton, and I naturally anticipated seeing something of more than ordinary interest in the mine. Two tunnels have been driven; the upper one on the lode inside the eastern drive had fallen in. The reef showed in the roof and walls at the junction of this with the southern drive. It did not seem of a very definite character; yet it was from this part that the very rich specimen or specimens were obtained. There was but a small paddock of stone at the mine mouth, and this appeared to be of no very high quality. It is, however, only fair to state that I was informed that this had been picked over and over again by specimen-hunters, and what remained could not be expected to represent fairly the quality of that part of the lode from which it was taken. The quartz here is of the ordinary type of Puhipuhi reef stone. The containing-rocks are somewhat different from what appear in Prospectors' No. 1 and Prospectors' No. 2 Claims. Here the rocks are a dark slate, or a grey quartz rock, having a slate or flaggy structure.

"*Caledonian Mine.*—This is in the continuous reef, which has been prospected by a drive along the lode for about 100ft. The stone, which is of a light-grey colour, and of the ordinary character of Puhipuhi stone, is stacked at the mouth of the mine, and, although very rich samples are not obtainable from the heaps, nor in the mine, silver may be detected in most of the stacked stone. The lode is held within rocks of the same character as those which contain the Young Colonial reef. This mine seems the most promising of those situate on the western slope of the Puhipuhi table-land.

"*Waimarie Claim.*—The Maori or Waimarie Claim is situate a little more to the north-east than the two last described. The quartz is of a dark colour at the mine face, but weathers white at the outcrop. This is due to the presence in the joints of the stone of powdery manganese oxide. I was told that good samples had been obtained from the reef driven on in this claim, but there was no one on the ground to verify this statement, and the samples taken have not as yet been analysed. The containing-rock is a black contorted concretionary slate, which to the eastward adjoins and underlies the chert or quartz rock described as occurring in the Young Colonial and Caledonian Claims.

"*Matilda Claim, and Claims on the Waikari side of the Table-land.*—Other claims were examined on the side of the field, which, as the character of the reef stone and country rock are essentially the same as in those already described, I need not lengthen out this report by specially describing. But further to the east, on the brow of the Puhipuhi table-land, near Comstock Hotel, is the Matilda Claim, which deserves a passing notice on account of its having been asserted that the stone in it contains bromide of silver. I brought samples of the stone, but it contained no bromide of silver, nor trace of any ore of silver whatever. The so-called reef is nothing more than the grey chert or quartz rock already described, which on exposure has weathered to a milky-white colour. Of the claims on the Waikari side of the table-land, only the Luminary and Santa Claus Claims were visited by me.

"*Luminary Claim.*—The Luminary Claim is at the level of the stream on the east side of the table-land. There is a good body of stone, but I saw no indication of the presence of silver. The containing-rock is of a clay character, the chert or quartz rock having been passed over in the descent from the table-land. Three tunnels have been driven on this holding, that at the creek-level being the largest, not exceeding 100ft. in length.

"*Santa Claus Claim.*—The Santa Claus Claim lies on the eastern border of the table-land, a little to the south of the trig. station, and nearly opposite to the surveyed site of the township. This has been taken up as a gold- and silver-mining lease, but so far as I know neither of these metals, nor even a quartz-reef, have yet been found. The ground was first applied for by Mr. O'Brien as a lease for the purpose of mining or collecting cinnabar, this ore of mercury having been discovered in small quantities in the small creeks descending from the table-land to the Waikari on this side. Subsequently, part of the ground applied for was pegged out as a gold- and silver-mining lease, and this double holding was in existence at the time of my visit.

"*Cinnabar.*—Of gold or silver I saw none, nor evidence of any, but of cinnabar there exists very definite indications—sufficient for the vigorous prosecution of search for the lode were the obstacles surrounding the search less difficult than I found them to be. The prospects of cinnabar have hitherto been obtained in three small creeks following east across the Santa Claus Claim. In the middle of one of these a fair prospect can be obtained—say, one ounce to the dish of stuff taken from the creek-bed. These indications were naturally followed up towards the table-land from whence the creek took its rise, but it was disappointing to find that the prospect of ore did not beyond a certain point improve in this direction, and that the slope was so thickly covered by large volcanic boulders, broken away from the edge of the table-land, that along the run or wash of ore it was almost impossible by ordinary means to reach the bed-rock.

"On the ridges between these different small streams the bed-rock could be reached, and at two places short tunnels had been made, the lower, that most to the north-east, being started under the impression that the old rock formed a bar beyond which lay, in deeper ground, an alluvial wash containing the cinnabar main deposit. The pug wall of a fault or slide, cutting across a soft cherty grey slate, had led to this misconception of the real state of things, and when I arrived on the ground the prospectors were in great doubt as to the source of the ore, and the proper method of prospecting this piece of ground. I had samples of the ore washed from the bed of the creek, hoping that adhering fragments of rock might give a clue to the rocks in which the lodes should be sought for, because the amount actually to be obtained from the alluvial deposits of the creek would hardly be worth the cost of the preparatory works required to collect it. But the ore was pure and showed no trace of adhering rock. Most of it was well water-worn, or appeared to be so, and this not because it travelled far, but owing to the soft nature of the mineral itself. Still, a closer examination showed that much of it had travelled no great distance, nor so far as to abrade the original surfaces the ore possessed when it was set free from its rock matrix. These unabraded surfaces were of that character which would be natural to it, and which it might be expected the ore would possess, had it been formed in the cavities which abound in the volcanic rocks of the

table-land, and I was forced to refer the prospectors to these as the probable source from which the ore was set free. However, on more carefully examining the larger samples which I brought to Wellington I find one sample veined with cherty quartz, clearly indicating that the source of the ore is not the volcanic rocks, but the chert or quartz rock which has been already described as present in the Young Colonial, Caledonia, and Matilda Claims, on the east side of the table-land. These same rocks appear under the volcanic sheet at the steep pinch in the road by which the upper table-land is reached from the south, and these rocks strike along the east side of the upper table-land, and are present on the very ground over which the cinnabar has been obtained. I have now no doubt that it is from these rocks that the ore has been liberated.

"This is a much more hopeful and satisfactory conclusion than referring the source of the cinnabar to the volcanic rocks, since in the latter case there was but little chance of a connected body of ore of any bulk, while it is in every way probable that a lode exists somewhere in the quartz rock to which it is now referred.

"*Conclusion.*—The examination made and above described leads unavoidably to the conclusion that the Puhipuhi Silverfield forms part of a mineralised region stretching along the east coast of the Auckland peninsula, both to the north and south of the limits of this field. The quartz reefs are well defined, and prove themselves that they live through a vertical depth of 500ft. to 700ft., or from the level of the Puhipuhi table-land to the valley of the Waikari at the Luminary Claim, and the lowest levels at which reefs have been found on the opposite west side of the table-land; and there can be no doubt that they continue to a great depth below the drainage-levels of the country. Almost all the reefs contain silver-ore, more or less, and this also is a hopeful sign for the field and its future prospects. Unfortunately, the average percentage of ore is perhaps too little to enable it to be treated profitably, with the appliances at present on the field. In this latter respect, however, there is room for improvement; and in respect of a richer stone being present at deeper levels than yet attained to there is also hope. But, unfortunately, many disappointments have damped the ardour of those engaged in developing the resources of the field—nor would I wish it understood that there are not good reasons for the present depressed state of mining at Puhipuhi; still less would I be warranted in saying anything that might lead to further hope and further disappointment—but, for all that, there is the possibility of a great future for the Puhipuhi and adjoining district as a field for mining enterprise."

Coromandel District.

Mining in the immediate vicinity of Coromandel has not been carried on so successfully as in the previous year; but, taking the returns from the whole of the district, including Kuaotunu, there has been more gold obtained than for many years previous. The returns show that the mining claims comprise an area of 569 acres, on which an average of 240 men were employed on wages, or working their own claims, and 36 men were working on tribute, making a total of 276 men on the field; and that during the year 12,595 tons of quartz were crushed, which yielded 12,047oz. gold; also, 435 tons of tailings were treated, with a result of about 145oz. gold. This makes the total yield of gold for the past year 12,192oz., being an average of about 44oz. 3dwt. of gold for every man employed on the field.

Tokatea Range.—There have been fewer men employed on this range than in former years; and the reason given for this is that the principal ground, comprising 90 acres, was held, until recently, by three companies—namely, the Harbour View, Royal Oak, and Tokatea. None of these companies employed any men on wages during last year, and only eighteen men were employed on tribute. Recently, the licensed holdings of the Royal Oak and Harbour View have been forfeited. The former was at once taken up by Mr. Joseph Witheford, of Auckland, and he has let portion of the ground on tribute, at 5 per cent. of the gross yield of gold, for a period of three years, and another portion, at 10 per cent., for a considerable period. The former tributers crushed about 2cwt. of stone a few days prior to my visit, which yielded 188oz. melted gold. Mr. Witheford deserves credit for throwing the ground open on a low tribute for a lengthened period, as the miners state it gives them a chance of doing dead-work and to properly open up the mine, instead of having to pay from 20 to 25 per cent. of the gross yield of gold, they will now have an opportunity of earning fair wages. When a company's tribute was exacted, nothing but extremely rich stone was crushed: auriferous quartz, giving 2oz. of gold per ton, was not considered sufficiently rich to send it to the crushing-battery. During the last year there were six men and twenty-two tributers employed in all the claims on this range, the six men getting about 23 tons of quartz, which yielded about 611oz. of gold, being an average of 26oz. 11dwt. per ton; and twenty-two tributers got 13 tons of quartz, which yielded 394oz. of gold, being an average of about 30oz. 2dwt. per ton. Taking the total number of men employed on the range—namely, twenty-eight—and the total quantity of gold produced for last year—namely, 1,005oz.—it gives an average of about 35oz. 18dwt. of gold for every man employed, or a value of about £99 per man, which is a considerably less average than for the previous year. The richest find last year was obtained from the Try Again Claim, when two men got 1 ton 14cwt. 20lb. of stone, which yielded 463oz. of gold.

There is a very large lode passing through this range, termed by the miners a "buck" reef; portions of this lode have been crushed from time to time by different parties, which yielded from 3dwt. to 15dwt. per ton. A very rich shot of gold was found in this lode in the Tokatea Company's ground, on the side of the range facing Kennedy Bay; but very little prospecting has been done on it on the Coromandel side of the range. There is no place in the Coromandel district where prospecting could be carried on with a better chance of success than on this lode. No doubt the lode contains very low-grade ore, but there is every prospect of rich shots of gold being found in some portions of it. The whole of the Tokatea Range is full of small stringers of quartz interlaced amongst the tufaceous sandstone, and almost every small vein branching off this large lode carries

gold. It is on these small veins where most of the gold from this range has been obtained for many years past. If a low-level adit were constructed along the course of this lode, with uprises at certain distances apart, there is every probability of a considerable area of payable ground being opened up; and, if such proved to be the case, it would require a large crushing-battery erected on the flat to treat the ore. In addition to this main lode, there are many parts of this range that would pay by quarrying out and putting the whole of the material through a crushing-battery, on the same principle as that adopted by Messrs. Hansen and Comer at the Thames in working the material from the Kuranui Hill. Several hundred tons of headings and quartz from the old mullock tips on this range would pay handsomely to send to a crushing-plant of this description, by a cheap means of transit to the battery.

Scotty's Company.—This company took up the ground which was worked successfully by the Corby Company for several years. It adjoins the northern boundary of the Kapanga Company, and has three lodes running through it—namely, Scotty's, Kapanga, and the Corby. The company is formed almost entirely with capital from Sydney. The ground has been prospected for the last three years, from an adit constructed at as low a level as can be got, but nothing payable has been found above the level of the adit, although small patches of specimen-stone have been obtained at different times. Since this company commenced operations they have constructed over 2,000ft. of drives, besides stopes and uprises, and have spent a considerable amount of money. The best stone found by them is in the floor of their adit on Scotty's Lode; and they now contemplate either sinking a shaft, or making arrangements with the Kapanga Company to work the ground at a deeper level from the old Coromandel shaft. A statement was shown me by Mr. Witheford, which set forth that between the years 1864 and 1868, 41,518oz. of gold was taken out of the Kapanga and Scotty's Lode, above the 300ft. level, the richest portion of these lodes being found some distance below the surface; and, as all the ground in the licensed holding held by Scotty's Company is intact under 100ft. below the surface, there appears to be a fair probability of rich shots of gold being found in the lodes at a greater depth than they hitherto have worked. During last year they had an average of eleven men at work prospecting the unworked portions of the upper levels, and they crushed 40 tons of stone, which yielded 84oz. of gold.

Kapanga Company.—This company and the Coromandel Company have now amalgamated their properties with Blagrove's Freehold; but they have not been so successful as in former years in carrying on mining operations. During last year forty-eight men were employed in and about the Kapanga Mine. They crushed 792 tons of quartz, which yielded about 1,638oz. of gold; and five tributers were employed in the Coromandel Mine, who got 10½ tons of quartz, yielding about 62oz. of gold. Previous to the amalgamation of these companies, the Coromandel Company expended £22,951, and all the gold they obtained was 248½oz., representing a value of £740 11s. This expenditure was exclusive of any moneys in connection with the London office.

The workings in the Kapanga Mine have been carried on from the 300ft. level, and between this and 400ft., principally on the Kapanga Lode. The 300ft. level has been driven on for a considerable distance to the southward, and stoping operations have been carried on above and below this level, but with the exception of a small patch of gold-ore encountered in sinking a winze nothing of importance has been struck.

The reef in the 300ft. drive has been disturbed and heaved by a slide trending about east and west and dipping to the north. After driving about 50ft. in an easterly direction four small veins of quartz were intersected, all of them bearing north-east and south-west and underlying to the west. The country at this point is terribly broken, containing a large quantity of water. The branches cut may belong to the main portion of the reef, but split up owing to the influence of the slide, or very probably they may simply be hanging wall-stringers; if this is so the main part may yet be ahead of the present workings.

To give better ventilation to this section of the mine, a cross-cut from Scotty's Reef at the intermediate level (between the 300ft. and 420ft. level) was constructed, giving backs about 70ft. vertical, and an uprise was constructed to make the connection with the winze alluded to above. Some driving and rising was also done on Scotty's Reef at the 300ft. and intermediate levels, but no payable quartz was struck.

The two reefs (Kapanga and Scotty's) have a general bearing of north and south, underlying to the west at various angles. Generally speaking, when the angle is about 6in. from the horizontal, with a good hard hanging wall, gold is most likely to be met with. The manager states that the precious metal is mostly found on the footwall of Scotty's Reef, and on the hanging wall of the Kapanga Reef. Scotty's Reef is composed of pug or clay, quartz, calcite, and iron and arsenical pyrites. The composition of the Kapanga Reef consists of pug or clay, quartz, calcite, iron and arsenical pyrites, antimony at times, occasionally stains of green carbonate of copper.

The sinking of the engine-shaft was suspended some time since owing to insufficient engine-power, but a 40in. cylinder direct-acting Cornish beam pumping-engine with 9ft. stroke, formerly erected at the Coromandel Mine, is in course of erection at the Kapanga Mine, which will be capable of contending with the water to a depth of 2,000ft. if necessary. The present depth of shaft is 572ft. Sinking will be resumed as soon as the erection of the engine is finished and the pitwork completed.

Blagrove's Freehold.—In this property there are a number of quartz reefs and leaders generally running about north and south, underlying to the west. The engine-shaft which has just been commenced is sunk 50ft., and will intersect at first a cross lode bearing east and west, and dipping to the north. The other reefs will be cut in the shaft at various depths. Where seen on the surface the reefs will average in width from 2in. to 2ft. The company have a spare steam-engine with a cylinder 18in. in diameter, and 3ft. 10in. stroke, which they intend to erect on this portion

of their property for pumping. At the time of my recent visit to this district the work in the Coromandel portion was carried on by a few tributers.

Kauri Syndicate's Property.—A few claims are being worked on the syndicate's property; but it does not appear that much prospecting has been done. Mr. Lanigan is still carrying on mining operations at Opitonui, but the return last year does not show satisfactory results. There was an average of six men employed in connection with the mine and crushing battery. Four hundred tons of quartz were crushed, which yielded 80oz. gold; there were also 200 tons of tailings treated, which gave 55oz. gold. This shows that the average yield of gold from the quartz was 4dwt. per ton, and from the tailings 5½dwt. per ton.

At Otonguru, Murphy and party opened out a large lode somewhat similar in character to the Try Fluke lode, being full of oxides of magnesia and iron. They have done a considerable amount of prospecting, but at the time of my visit they had suspended operations. During last year they crushed 3 tons of quartz, which yielded about 14oz. gold, and had two men employed. There is a large lode going through their claim, but unless the stone were rich it would not pay to convey it to a crushing-battery, it has to be packed on horses for a distance of about seven miles to Kuaotunu to be crushed.

Owera Company.—This company has been working and prospecting the ground for about three years, and has opened out a large lode on several levels, which has so far proved payable for working. Only the richest portion of the lode could be sent away, as it had to be taken to the Thames for treatment. During last year 30 tons of quartz was crushed, which yielded 80oz. gold, being an average of 2oz. 13dwts. per ton. The mine being on the Kauri Syndicate's property, the syndicate have in all their conditions of lease a right to have an interest in any mine after it has been prospected and proved payable, up to the extent of one-half; provided they pay the prospectors the proportionate share of the cost of carrying on prospecting operations and opening up the mine. The Kauri Syndicate, in this case, hold half the shares in the Owera Company, and have recently been the means of getting a crushing-battery of ten heads of stamps, a stone-breaker, and two berdans erected for the company, so that the lode already proved can be worked with success. A tramway connects the mine with the battery, and when the plant is complete they will be able to keep it constantly at work for a long time, provided the water holds out for supplying the motive-power. A water-race has been taken for some distance from both branches of the Owera Creek, and a reservoir constructed with a capacity of 5,500,000 gallons of water. The water is led from the reservoir in a pipe 20in. in diameter to a Pelton water-wheel, which is placed under a head of 37ft. at the battery. This plant was purchased from Mr. Adams, of Waiorongomai, being portion of the large crushing-battery formerly belonging to the Te Aroha Gold- and Silver-mining Company. Crushing was only commenced two days prior to my visit. The company now intend to take the whole of the lode out, and put it through the battery if after a sufficient trial it proves to be payable.

Mahakirau.

There are several people prospecting in this locality, and the original prospectors are still working their claim; but the returns last year show that they are only carrying on prospecting operations with two men, as only four tons of quartz was crushed, yielding about 12oz. gold.

Kuaotunu.

The mines in this locality are looking very well, and the field presents a more permanent appearance than it did on my last visit. There are numerous lodes on the field which are now being worked with payable results; and, judging from the appearance of these lodes at the different depths, and the yield of gold obtained from them, this is a goldfield capable of affording profitable employment to a large population for many years. The lodes are not rich, but they contain large quantities of ore, which, if treated by economical appliances, cannot fail to prove payable for working. There are now four crushing-batteries, of ten heads of stamps each, at work on the field—namely, the Try Fluke, Great Mercury, Red Mercury, and Mr. Curtis's battery; and there is another in course of erection by the Mariposa Company, which will also consist of ten heads of stamps. All these batteries are worked by steam power, and are within a radius of forty chains. Four of them are erected alongside the dray-road leading from the Try Fluke Mine to the ocean-beach. This road is used to cart all the quartz to the batteries, and also to bring up fuel for the engines from the ocean beach, where it is landed from vessels.

State of Road.—The road leading from the ocean-beach to the mines is at the present time in a very bad state, and portions of it in the winter months, if not repaired, will become quite impassable. A portion of it has been metalled, but there are still about one and a half miles which has not been metalled. The road being formed in a clay cutting, in wet weather it becomes a complete bog, and not fit for traffic. The number of small crushing-plants all erected, it may be said, alongside each other, requiring a staff of hands at each plant, increases the cost of crushing and extracting the gold considerably from what it would be if the whole of the plants were combined into one, and all the quartz treated at one plant. Great complaints are made about the present cost of crushing with steam power, and there are no creeks near this locality where water can be procured for motive-power.

Estimate of Electrical Plant.—The mine-owners are taking steps to ascertain if water can be got from any of the creeks or rivers as a motive-power to generate electricity to drive a crushing-battery. A deputation of the miners waited on me while at Kuaotunu, and showed me a communication they had had with Mr. Fletcher, electrical engineer, Dunedin, in reference to a plant and its cost. Two of the mine-managers on the field examined the Mahakirau Creek, and also the Waiwawa River, which empties itself into the head of Mercury Bay, at Gumtown. They state

there is an unfailing supply of water in the latter river, and that 100 sluice-heads of water can be obtained from this source in dry weather. They also state there is 70ft. of fall in one mile of this river, and that in measuring the quantity of water they found the average depth of a cross-section of the stream to be 40ft. wide by 10in. in depth, these measurements being taken during the dry season. Taking these measurements and fall as correct, the quantity of water in the stream would be equal to about 137 sluice-heads; but if an allowance be made of 1in. in depth of the water for inequalities in the bottom of the bed of the river, and taking the cross-section of the water as 40ft. wide and 9in. in depth, with a fall of 70ft. per mile there would be about 117 sluice-heads. The data supplied to Mr. Fletcher was that 100 sluice-heads of water could be obtained with a fall of 30ft., and the distance that the electricity would have to be transmitted would be fourteen miles. He was also asked to give an estimate of the cost of an electric plant, as well as his opinion as to whether such a plant could be utilised economically for supplying motive-power for the crushing-batteries. The following is an extract from the reply sent by Mr. Fletcher:—

"One hundred sluice-heads of water with fall of 30ft.—reckoning a sluice-head 60 cubic feet per minute—this would give 340 theoretical horse-power. A water-motor using this quantity of water and giving out 150-horse power would have an efficiency of only 46 per cent.—a very poor result. With a properly-constructed turbine you might assume an efficiency of 70 per cent., which would give about 238 effective horse-power. However, I will take your assumption of 150-horse power as the amount of power available to drive the electric generators.

"The losses in transmission are as follows: (1) Electric generators; (2) line, or conductors; (3) motors. The electric generators will give out 85 per cent. of the power required to drive them, so that we have 85 per cent. of 150, or 127·5-horse power, given out to the electric-generators for transmission to the motors. The loss in the line or conductors depends on three things—(*a*) their length, (*b*) their diameter, (*c*) the quantity of electricity sent through them.

"With high-pressure water a small quantity will do a certain amount of work, so that the higher the pressure we use the smaller the quantity of water required for a given amount of work; and, consequently, by working at a high pressure, pipes of smaller diameter can be used.

"I have allowed 10 per cent. loss on the line, so that the power the motors will receive would be 127·5-horse power, less 10 per cent., or 114·75-horse power. The motors will give out mechanical power of 85 per cent. of the electric energy put into them, so that the power available for driving the stampers would be 85 per cent. of 114·75; or 97·5-horse power. The total efficiency of the plant would be $\frac{97·5}{150}$ = 65 per cent.

"As to the cost of an electric plant, the following approximate figures are sufficiently accurate for the present. Material for power and telephone line, including copper conductors, telephone-line insulators, wooden arms for poles, bolts and nuts, for fourteen miles of line, say, £1,500. This sum does not include poles, or erection of same.

"The cost of electric generators and one motor of 100-horse power would be, say, £1,600. If four small motors are required, the cost would be £2,000. Unless there is any costly work necessary to obtain water-power, the whole scheme could be carried out at a cost of £3,500 or £4,000. The cost of maintenance is not a heavy item."

The electric plant would only be one item in the total cost of the scheme. If a hundred sluice-heads of water had to be taken out of a river, and conveyed in either an open conduit or flume until 30ft. of fall was acquired, and pipes from this point to a turbine, the cost would be considerable. Indeed, it would be better to have twenty sluice-heads of water with 150ft. of fall, which would give an equal horse-power to a hundred sluice-heads with a fall of 30ft. However, the scheme is only in embryo, and more information will be required to ascertain the actual amount of fall that can be obtained, and the cost of constructing the water-race and headworks to lift the water with tank and pipes. If twenty sluice-heads of water can be obtained at an elevation of 150ft., according to Mr. Fletcher's own showing it would give 65 per cent. of 238-horse power, or about in round numbers 150-horse power, which would be capable of driving a crushing-battery of forty heads of stamps, having a stone-breaker, with the requisite number of pans and settlers. The cost of crushing with such a plant would be minimised to such an extent that the low-grade ore that is now left intact in the lode, or used for filling the stopes, would be made to pay.

Try Fluke Company.—This company has been continually engaged in opening-out and working their mine since the field was first opened. They got a block of very rich stone near the surface, when the yield from several crushings went about 10oz. gold per ton. They erected the first crushing-battery on the field, and have been able to keep it fully employed on quartz from their mine since its erection. They have thoroughly tested their mine down to a depth of 300ft., and the lode continues to go down, carrying gold uniformly for about the last 250ft., averaging from 10dwt. to 15dwt. per ton; this yield is obtained from their crushing-plant, and it can be safely asserted that there is at least as much gold being washed into the creek. The only difference in their plant since my last visit is that they allow the tailings and water to go into a box about 20ft. long, 2ft. wide, and about 2ft. deep, having a number of bars to slip in on the outlet end of the box, as the tailings rise up, the slimes and muddy water being run into the creek. The actual tailings are stored, and are being treated in one of Fraser's pans in charges. The Watson-Denny, Price's, and Fraser pans, having continuous discharges, were all failures; they then tried these pans by working the ore in charges, and found that they got much better returns. There was only one of Fraser's pans being used at the time of my visit, and that was employed both for grinding and amalgamating, no settler being used. The loss of gold from this company's plant is perfectly appalling; what ought to be going into the pockets of the shareholders is being daily carried away by the water in the creek towards the ocean. On my representing to the manager of this company the great loss of gold in the muddy water, he had 20 gallons of the water boiled down to dryness, and sent me the residue, which was treated by a thorough amalgamation at the Colonial Laboratory, and gave gold at the rate of 9dwt. 16gr. per ton. Considering that the tailings are all being stacked for further treat-

ment, it can safely be asserted that not more than about 36 per cent. of the gold is extracted by the ordinary battery process.

In regard to their mining operations, they have driven along the lode on the No. 2 level for a distance of 420ft., and stoped about 130ft. in length to a height of 60ft. on north end, and for a length of 90ft. and a height of 70ft. on the south end, leaving a block of 200ft. in length between, with about 150ft. of backs. The No. 3 level is 130ft. below No. 2, and the lode has been driven on here for a distance of about 420ft., and stoped out to an average height of 30ft. The lode varies in thickness from 2ft. to 12ft., but where the lode is wide there is only from 3ft. to 4ft. of it sent to the crushing-battery, the rest being considered too low-grade to pay with their present appliances. The above remarks refer to the Try Fluke Lode, which is easily distinguished from all the other lodes on the field, the quartz being very soft and friable, mixed with the oxides of iron and manganese. In the north end of the Try Fluke Mine another lode branches off, and is termed the Kuaotunu. It varies from 6in. to 9ft. wide, and the whole of the ore is payable for working. During the year ending the 31st March last 5,032 tons of quartz were crushed, which yielded 3,172oz. 10dwt. of gold, and 120 tons of tailings, which yielded 42oz. of gold; making a total of 5,152 tons treated for 3,214oz. of gold, being an average of over 12¾dwt. of gold per ton. The average number of men employed by the company last year was thirty-one.

Red Mercury Company.—This company's mine is situated to the north of the Try Fluke, on the same line or belt of country; but the two mines are a considerable distance apart, there being three claims between them—namely, the Carbine, Mariposa, and John Bull. The manager of the Red Mercury Company states that the lode he is working on is the same that branches from the main lode in the Try Fluke Mine; but this is very questionable, as the character of the stone appears to be different, and the lode is more compact and much harder than the lode known as the Kuaotunu in the Try Fluke ground. The lode varies from 4in. to 3ft. in width, and has been driven on for a distance of 440ft., carrying good ore. Recently they have purchased a crushing-battery of ten heads of stamps, also some of Price's pans and settlers that formerly belonged to the Public Crushing Company. During the last year they crushed 1,249 tons of quartz, which yielded 1,826oz. 10dwt. of gold, being an average of over 1oz. 9dwt. gold per ton. The returns given the department are, however, slightly different from those in their balance-sheet, as published in the *Mining Journal* of the 1st June for year ending 31st March last, which shows 1,267 tons of quartz crushed, yielding 1,730oz. 18dwt. gold, and that the cost of getting this quantity of ore at the mine was £2,700 16s. 9d., which is returned as wages and mine requisites. This shows that it cost £1 11s. 2d. per ton to get the stone out of the mine, and that crushing alone cost £948 19s., which is equal to about 11s. per ton; and cartage cost £226 5s., another 2s. 4d. per ton; so that the total cost of getting and crushing their quartz last year was £2 4s. 6d. per ton.

Great Mercury Company.—This company's claim adjoins the northern boundary of the Red Mercury, having the same lodes passing through it. They have been working the same lode that is worked in the Red Mercury Mine, but the ore appears to be of less value. However, this is not certain, as the present manager, who has only recently taken charge, states that he is now getting very good returns from the same ore which the two former managers could not make pay. This company have erected a crushing-battery of ten heads of stamps, with two of Fraser's and two of Price's pans, and two settlers. They have also recently erected a set of settling-boxes for tailings and slimes, and are lifting the water with an elevator-belt and using it again in the battery. The latter appliance was not being used on the day of my visit, the water from the settling-pits flowing into the creek. The tailings are fed into the pans in charges of 1,500lb.; this is ground for three hours and then the muller is lifted, and the pulp amalgamated for two hours with 115lb. of mercury in each pan, the pulp being kept at a temperature of 110°. The manager, Mr. Pettigrew, states that by this process of treatment he gets about 87 per cent. of the gold, which is an exceedingly high percentage, if the assay-value be correctly ascertained. The system of treatment is similar to that adopted by the Waihi Company; but the plant is greatly inferior to that of the latter company, which does not get above 70 per cent. of the assay-value by the wet-crushing process. Any one inspecting the plant used by the Great Mercury Company would hardly think that more than 65 per cent. of the assay-value of the ore was saved. During the last year 2,693 tons of ore was crushed, which yielded 1,469oz. gold, being an average of 10·9dwts. per ton.

Other Companies and Claims.—There are thirteen mining companies on this field, which have been getting less or more gold last year, with numerous lodes of an auriferous character passing through their ground. No doubt some of them may not prove payable, but the majority of the present claims will be found to give fair returns for working, and new claims will from time to time be taken up as the country gets better prospected. There are at the present time 276 acres held in mining claims, on which 135 men are employed, and during the past year 11,228 tons of quartz was crushed, which yielded 8,792oz. of gold, being an average yield of 15⅝dwt. of gold per ton. There was also 235 tons of tailings treated, which yielded 90oz. of gold per ton.

Gold-saving Appliances.—The claimholders on this field are becoming more alive to the necessity of adopting different appliances for saving gold, but each is waiting on the other to see who will try the first experiment. They all agree that the loss of gold is considerable, and some of them fortify themselves with the belief that they cannot be losing more than 50 per cent. of the gold, while some of the managers state they are saving 87 per cent. of the assay-value; but if the ore were carefully sampled for assay purposes it would very probably be found that nothing like this high percentage of gold was obtained from the ore. The appliances at the Great Mercury Company's crushing-plant for the extraction of gold is the best at present on the field; but even this is greatly behind the appliances adopted by the Waihi Company, who have by far the best amalgamating plant in the colony, and, taking into consideration that this company only gets about 70 per cent. of

the gold by the wet-crushing process, it cannot be expected that an inferior appliance can obtain a higher percentage; but, until someone by actual demonstration shows the claimholders that a large percentage of gold can be extracted from the ore, they will go on in the old way, crushing the quartz and extracting the gold in the ordinary manner. If one of their neighbours erected machinery capable of extracting a few pennyweights more per ton than by the method now in use others will imitate the example, with the belief that they are using the most perfect appliances that can be obtained. This has recently been fully demonstrated on this field by the use of the different pans for treating the tailings. One of the patentees of these pans assured me that he was extracting 96 per cent. of the gold with his pan-amalgamation process. Such statements fill people with false hopes that they have arrived at the consummation of their efforts to extract the highest percentage of the gold from their ore; but by carefully sampling the ore and making regular assays they will soon find out that they have been deceiving themselves.

By any system of wet-crushing, in the Kuaotunu field, where the gold is disseminated through the quartz in particles much finer than the finest silk-dressed flour, a large portion must be carried away as float-gold in the water. Indeed, this can easily be ascertained by pounding a small piece of stone in a mortar, washing the pulverised ore in a tin dish, and panning it off into another vessel filled with water; it will be found that there is as much gold held in suspension in the water as was amongst the ore, and, after repeating the operation in clean water for two or three times, gold will still be found in a state of suspension. This experiment was made by myself on some of the Try Fluke ore, by panning it off into a second tin dish filled with clean water, then pouring off the water into another tin dish, and repeating the operation several times, when a fine rim of gold was always found after any panning-off. Mr. Richards, on my recent visit to this field, stated that he had made experiments with tailings, and also with slimes, by treating them in a berdan, and while the tailings gave a value of about £2 5s. a ton, the slimes gave a value of £3 2s. 6d. per ton. The loss of gold on this field can easily be conceived, when the gold is in many instances so fine that it cannot be distinguished without the aid of a powerful microscope, and on its immersion in water it will not precipitate for a great length of time; the muddy water flowing over the tables, and running into the creeks, must carry off a very large percentage of gold with it. The question for consideration is how is this to be prevented, and what other appliances can be used to prevent this loss.

The question of the best method for the extraction of gold entirely depends on the character of the ore. Some classes of ore may be successfully treated by amalgamation, while other classes are better suited for chlorination, leaching, or smelting. A person having charge of a crushing-battery requires to have a knowledge of the chemical properties of the ore that he has to deal with, and to adopt the most effective and economical system of extracting the metals. The Kuaotunu ore seems to be particularly adapted to chlorination, or to be treated by either the Cassell or Bohm cyanogen process, the gold being in a tolerably free state, and in such fine particles, that it should be easily extracted by either process. The question to consider is, Whether the extra expense of treatment would be justified by the larger percentage of gold obtained? In order to show this: The average yield of the ore treated last year was 15⅔dwt. per ton, or an average value of about £2 4s. per ton; and, admitting that 50 per cent. of the gold at the present time is saved, this would make the ore have an assay-value of £4 8s. per ton. The Cassell process is said to extract from 85 per cent. to 98 per cent. of the gold; but allowing it to save 85 per cent., then the value per ton saved would be about £3 14s. 9d., as against £2 4s. by the present method. The cost of actually pulverising the ore will be the same in both cases. Therefore it is only the extra cost of leaching with the cyanogen solution and precipitation, together with the royalty charged for the use of Cassell's process, that have to be taken into consideration, this would be about 12s. 6d. per ton for treatment, and 6s. per ton royalty, making a total of 18s. 6d. per ton, which would still leave the value of gold extracted to be £2 16s. 3d., as against £2 4s. by the present method; or, taking the number of tons crushed last year, namely, 11,228, the extra value of the gold obtained would amount to £6,877 6s., which would have gone into the pockets of the shareholders, instead of being wasted. Bohm's process is likely to be less costly than Cassell's, and, although it has never yet been actually in operation in the colony, it is likely to save as high a percentage of gold as the other, the principal re-agent being the same in both processes, only in Bohm's plant the filtration of the solution is more perfect. Mr. Bohm is now engaged in erecting a plant at Waihi, and the actual results of working the ore on a large scale will soon be known. He has also designs of a chlorinating plant, which would be applicable to the Kuaotunu ore; but it is questionable whether the expense of chlorination can be kept within either of the other processes; but, if so, a good chlorination plant would be certain of extracting about 90 per cent. of the gold.

Permenancy of the Field.—On this field, the gold seems to follow down the lodes as far as they have been tested, and the character of the country rock would lead to the inference that the lodes will prove payable for working at a much greater depth; but until further prospecting has been carried on, and the lodes properly tested, no one can rely on how far they may carry gold down, *i.e.*, the soft tufaceous sandstone may be replaced at the deeper levels with a hard blue rock, which may cause the lodes to pinch out. However, there is a large amount of ore in sight which will pay for working, and the field presents a more permanent appearance than it did on my previous visit.

The following detailed statement of returns from the mines in the Coromandel District for the year ending the 31st March, 1892, shows that the total quantity of quartz crushed last year in the Coromandel County was 12,559 tons, which yielded, exclusive of gold produced from tailings, 11,557oz., giving about 18dwt. 11gr. of gold per ton, or an average of 41oz. 17dwt. of gold for every man employed in connection with mining claims. Comparing the return of the last year with the previous one, it shows that last year there was an increase of 5,944 tons of stone crushed, and 1,754oz. of gold, while the number of men employed was 63 less last year than in the previous one: —

Locality and Name of Mine or Company.	Area of Land held.	Average No. of Men Employed.		For Owners.		For Tributers.		Tailings treated.	Gold obtained.
		Wages.	Tributers.	Quartz crushed.	Gold obtained	Quartz crushed.	Gold obtained.		
	A. R. P.			Tons cwt. lb.	Oz. dwt.	Tons cwt.	Oz. dwt.	Tons	Oz. dwt.
Tokatea Range—									
Tokatea..	30 0 0	..	13	..	..	8 0	114 10	..	..
Queen of the North ..	3 0 0	1	..	1 0 0	18 10	..	..	..	..
Royal Oak	30 0 0	..	3	..	..	1 0	126 0	..	..
Bismarck	12 0 0	..	4	..	..	2 0	134 0	..	..
Harbour View	30 0 0	..	2	..	..	2 0	19 8	..	..
Rob Roy	3 0 0	3	..	20 0 0	129 3	..	..	..	..
Try Again	6 0 0	2	..	1 14 20	463 0	..	..	..	..
	114 0 0	6	22	22 14 20	610 13	13 0	393 18	..	..
Kapanga—									
Kapanga	68 2 23	48	..	792 7 0	1,634 8	..	..	..	..
Scotty's..	30 0 0	11	..	40 0 0	84 0	..	..	..	..
Coromandel	39 2 10	..	5	..	..	10 10	61 18	..	..
Mint	6 0 0	6		..	..	..	..	..	..
Premier..	5 0 0	..	2	..	..	12 0	31 18	..	..
	149 0 33	65	7	832 7 0	1,718 8	22 10	93 16	..	..
Cabbage Bay—Vizard's ..	10 0 0	2	..	4 10 0	49 10	..	..	..	..
Kopukaitahi—Prospectors' ..	6 0 0	2	..	0 0 20	4 5	..	..	..	..
Opitonui—Lanigan's ..	20 0 0	6	..	400 0 0	80 0	..	..	200	55 0
Owera—Owera	10 0 0	8	..	30 0 0	80 0	..	..	..	..
Otonguru—Murphy's ..	10 0 0	2	..	3 0 0	13 18	..	..	..	..
Waikoromiko—Lille's ..	10 0 0	3	..	3 0 0	250 2	..	..	..	..
Manaia—Maori	10 0 0	2	..	2 0 0	3 0	..	..	..	..
Mahakirau—Mahakirau ..	6 0 0	2	..	4 0 0	11 16	..	..	..	..
Puia—Prospectors'.. ..	10 0 0	2	..	14 0 0	8 14	..	..	..	..
	92 0 0	29	..	460 10 20	501 5	..	..	..	..
Kuaotunu—									
Try Fluke	18 1 0	31	..	5,032 0 0	3,172 10	..	..	120	42
Carbine	5 0 20	9	..	387 0 0	620 10	..	..	..	..
Kuaotunu	15 0 0	2	..	100 0 0	45 5	..	..	..	..
Red Mercury	14 0 0	23	..	1,249 0 0	1,826 10	..	..	..	..
Great Mercury	28 0 12	34	..	2,693 0 0	1,469 3	..	..	3	2 9
Just-in-Time	8 3 24	3	6	128 0 0	103 4	344 0	373 0	..	..
Kapai	11 0 0	4	..	120 0 0	103 0	..	..	..	..
Mariposa	4 2 6	4	..	380 0 0	239 0	..	..	7	6 4
John Bull	5 0 28	2	..	105 0 0	20 2	..	..	..	..
Irene	7 2 0	5	1	389 10 0	234 0	12 0	14 5	..	..
Otama	20 1 20	2	..	22 0 0	214 16	..	..	..	..
Black Jack	30 0 0	2	..	76 0 0	60 16	..	..	..	..
Waitaia..	30 0 0	4	..	158 0 0	199 16	..	..	..	..
Sundry claims	77 0 0	10	..	32 0 0	22 0	..	..	70	26 0
	274 3 30	135	7	10,871 10 0	8,330 12	356 0	387 5	200	76 13
Sundry claims in other portions of Coromandel District	38 0 0	5	..	16 0 0	10 10	..	..	35	13 0
Totals	668 0 23	240	36	12,203 1 40	11,170 16	391 10	873 19	435	144 13

Thames District.

Mining operations during the past year have not been conducted so successfully as formerly, especially in the vicinity of Grahamstown and Waiotahi Creeks. The principal main lodes at the present time payable for working are pretty well taken out to water-level, and although there is still a good deal of auriferous quartz left on the upper levels, the companies prefer letting sections of their mines on tribute to employing labour to work the blocks. The general character of the country in the vicinity of the Moanataiari and Waiotahi Creeks is a tufaceous sandstone, having large numbers of thread-like veins of quartz running through the country rock in every direction, but generally branching away from one of the main lodes. Some of these thread-like veins contain a deal of gold, and, although they may appear like the thickness of a thread in places, by driving on them they sometimes widen out to 2in. and more in thickness, and are often full of very rich specimen-stone. This is found to be the case in the Waiotahi and Cambria Mines, where a large portion of the gold is obtained from these veins. There are still considerable blocks of stone left which are not considered payable at present for working; but when once a more effective and economical method of reducing and treating the ore comes into operation many of these blocks will yet pay to take out. Lodes which a few years ago were looked on as valueless are now being worked with success, and improvements are continually being made in appliances for extracting the bullion, which all tends to point out that the day is not far distant when both the mining and metallurgical operations in connection with gold and silver will be conducted on more effective and economical lines.

Testing the Deep Levels.—As far as mining operations on the Thames proper are concerned, the time is fast approaching when combined action will have to be taken by the companies holding ground affected by the present drainage appliances to test the ground at a deeper level and to find

a more economical pumping-plant. Some of these companies at the present time are trying to combine to effect this object, asking the Government for a subsidy towards testing the deep ground. In the present state of depression in monetary affairs at the Thames, there is no single company, nor combination of the present companies, that could find the means of procuring a large pumping-plant and sink a shaft to a depth of 2,000ft., as mentioned by some of the leading mining men as a scheme to be set on foot. Outside capital will have to be procured, and to obtain this sufficient inducement will have to be held out to get people to invest their money in the venture. The ground at the deep levels is practically of no value to the present companies, as they can never work it unless on some large combination scheme, where everyone on the field affected by drainage is interested.

The deepest shaft at present on the field where pumping machinery is erected is 640ft., and at this level, which is about 625ft. below sea-level, a considerable amount of prospecting has been done, and numerous lodes and leaders cut containing gold. A company was formed in 1884, called the Caledonian Deep-level Prospecting Company, who constructed a drive from the main 640ft. level, at 275ft. from the shaft, for a distance of 825ft., when the drive cut the Moanataiari slide; but the quantity of mullock and water met with at this slide filled the drive for some distance back from the face, where a strong barricade of timber was placed to prevent the mullock from travelling further. In driving this distance seven different lodes and leaders were cut through, varying from 18in. to 4ft. in thickness, all of which were auriferous but not considered rich enough to open out on. At 125ft. back from the slide a cross-cut was driven in a north-west direction for 500ft., and in a south-east direction for 800ft. In the south-east cross-cut a lode 9ft. 6in. in width was cut at 100ft., another lode 11ft. thick was cut at 150ft. The large lodes averaged from 4dwt. to 5dwt. of gold per ton. The company afterwards cut another lode and drove on it for 600ft., which averaged from 12dwt. to 15dwt. of gold per ton. In the north-west cross-cut there were four different lodes cut through which contained gold, antimony, and copper-pyrites. These only went from 2dwt. to 3dwt. of gold per ton. A good deal of prospecting was done by the Deep-level Cross Company, and by the County Council, in a northerly direction from the bottom of the pump-shaft, and several lodes containing refractory ore were cut through; but at that time this class of ore was looked on as valueless, and consequently was never tested to ascertain its value. The Caledonian Deep-level Prospecting Company arranged to pay the proprietors of the ground 10 per cent. of the gross yield of gold below a certain level. On account of the heavy rate they had to pay for drainage, and not finding any very rich ore, they gave the tribute up, and the water was then allowed to rise in the pump-shaft to the 400ft. level.

Some two years ago the Saxon company, in order to work below this level, agreed to pay an extra drainage-rate if the water was kept down to the 500ft. level. This rate, £97 10s. per month, was paid by this company for two years and four months, until recently, when they abandoned the lower levels, and the water is now allowed to rise to the 400ft. level again in the pump-shaft. Very rich stone was got in the New Prince Imperial and Deep-level Cross Companies' Mines, from the 300ft. level downwards, but it cut out as the lode went down. The same thing takes place in every lode. The gold in the lodes, especially in New Zealand, is always found in shots and ledges with the lodes cutting entirely out and making again. There is ample proof that large lodes exist at the 640ft. level, and that all those cut through carry less or more gold. No doubt, if these lodes were driven on for some distance, rich deposits of gold would be found in some of them.

Although the Big Pump shaft is the deepest where pumping machinery is erected, there is a shaft on the Queen of Beauty Mine which is about 730ft. in depth; but no work has been done in this mine for about five years. A bottom level was constructed which cut the lode, where some rich specimen-stone is said to have been obtained; but the influx of water on cutting the lode was such that the pumps, which had a 6ft. stroke, making eleven and twelve strokes per minute, could not contend with it. This strain broke the engine-shaft, and work was suspended, the company going into liquidation. They had two sets of 12in. pumps, but this was not sufficient to contend with the water at this depth. The shaft is still intact, and may be useful in the future when the deep levels come to be tested—as all those engaged in mining at the Thames point out this ground as the best site for sinking a shaft to test the deep levels, the strike of the lodes all tending in this direction.

The greatest difficulty in sinking a shaft on this field is the large volume of water to be contended with. The present drainage-pump is 24in. in diameter, worked by a direct-acting Bull engine, having an 8ft. stroke. The manager, who is also the engineer, of this plant informed me that it requires five and a half strokes per minute to keep down the water at the 500ft. level; and he is under the impression that it would take six and a half strokes per minute to keep down the water at the 640ft. level, while it only takes about three strokes to keep the water down at the 400ft. level. At the time the Queen of Beauty pump was at work a large portion of the field was drained by the Big Pump, and consequently there would not be so much water in the ground for the Queen of Beauty pump to lift as there would be if the Big Pump was stopped entirely. Any new pumping-plant would have to be of such dimensions and power as to be able to cope with the whole of the water. In making a comparative analysis of the quantity of water lifted by the Big Pump, working six and a half strokes per minute, and the Queen of Beauty pump, working twelve strokes per minute, the water lifted by the Big Pump, allowing a loss of 3in. in depth of column at each stroke, would be 948 gallons of water per minute; while the Queen of Beauty pumps—namely, two 12in. in diameter, with a 6ft. stroke, and working twelve strokes per minute—taking the loss on the same basis as the other, would only lift 646 gallons of water per minute. The travel of the plungers in both the Big Pump, working six and a half strokes per minute, and the Queen of Beauty pump, working twelve strokes, are both in excess of the economical travel of the plunger of a pump, which should not exceed 90ft. per minute—the travel in case of the Big Pump being 104ft., and in the Queen of Beauty 144ft., per minute. Seeing, therefore, the speed the latter pump was worked at, the sudden breakage is easily accounted for. It may be safely assumed that, if a new shaft, or the present Queen of Beauty shaft, be sunk to test the deep levels, it will require a pump capable of lifting more water than the Big Pump did

at the 640ft. level. Nothing less than two 20in. pumps would be of any service, and it is questionable whether these would be sufficient when the ground came to be opened up, as their lifting capacity, with 90ft. travel per minute, is only equal to 1,141 gallons of water per minute.

If 1,141 gallons of water had to be lifted from a depth of 2,000ft. it would require a steam-engine capable of being worked up to 864-horse power. The consumption of fuel to generate steam for any type of engines to be capable of pumping this quantity of water to a depth of 2,000ft. would be considerable; and if such a project is ever put in operation those connected with it should be equally as careful in getting the most economical engines as the proprietors of an ocean-going steamer would be, as the price of coal supplied at the Thames will always form a great element in the cost of working. The present pumping plant costs about £323 per month to work from the 500ft. level. Last year the wages amounted to about £1,265, and fuel and other expenses to £2,609. It will be seen by this that cost of fuel alone must be about £50 per week.

Another scheme is spoken of as likely to be successful in causing fresh developments to be made, and that is by extending the Moanataiari tunnel, and, instead of continuing it on a straight course, to carry it further to the northward, cutting through the different lodes which are known to exist on the upper levels. This tunnel is now constructed for a distance of 3,077ft. in the Moanataiari Company's ground, and would still have to be constructed for a considerable distance before it would be within any other company's boundary. If the tunnel were carried on a straight course, it would go through the Fame and Fortune ground, and head towards Karaka Creek. By extending it in a more northerly direction the Miners' Union state that it would cut the Golden Age, Reuben Parr, 23rd of June, Orlando, Watchman, Star of the South, Success, Sons of Freedom, Dixon's, and other reefs. It is estimated that the cost of extending this tunnel 2,000ft. would be £4,000, and to connect it with the surface by two uprises would cost an additional £3,000. The tunnel would go through ground held by different companies, who would be the parties benefited by such a scheme. The President of the Miners' Union submitted to me a plan showing the direction in which it was proposed to extend the tunnel; but he had no definite scheme, beyond the fact that the construction of such a work would be likely to lead to new discoveries, and revive the mining industry on this field.

To take the several localities in the Thames County where mining operations are carried on, there has been an increased yield of gold over last year in every locality with the exception of Grahamstown, Waiotahi Creek, Una Hill, and Te Tapa; but as most of the principal mines are in the two former localities, a falling-off in the returns from these mines causes a great depression in mining generally throughout the whole of the district.

Tapu.—There have been two claims in this district where gold has been obtained, namely, Sheridan's and Bell's. These comprise an area of about 25 acres. The average number of men employed during last year was seven, who obtained 73 tons of quartz, which yielded 219oz. 12dwt. of gold. The yield of gold for the previous year from this district was 164oz. 15dwt., which is 44oz. 17dwt. less than last year.

Waiomo.—There is a considerable area of ground held in many claims in this district, but very little work has been done during last year. Some very refractory ore was shown me from the Monowai Mine, which contained a good deal of sulphide of zinc, and said to be rich in silver and gold. However, this can only be proved by assay, as no fine gold was seen in any of the ore shown me. The lode is said to be from 6ft. to 18ft. in thickness, and has been tested on three levels. The proprietors of this mine have erected a stone-breaker, four McKay pans, a settler, and a berdan to treat the ore. This mode of treatment is not likely to save a high percentage of the bullion. There is also a large lode passing through the Mount Zeehan Mine, from which ore containing rich assay-value has been taken. The proprietors of this mine intend to pulverise the ore with stamps, and treat the dust in a cyanogen solution. No gold was obtained from this district last year, but high expectations are formed of it being a gold-producing locality for several years to come.

Tararu.—There are several parties prospecting in this locality, and great hopes are formed by those residing in the district of rich lodes being discovered further back. This is also borne out by the formation of the country, and the lodes running back into the range. The Sylvia Mine is the farthest up the creek, and similar ore can be found still farther back; but, as there is no road at present over which the quartz could be conveyed to be tested in bulk at the crushing batteries, except some rich ore is found on or near the outcrops, these lodes will never be properly tested. During last year there was 3,500 tons of quartz crushed from this locality, which yielded gold and bullion equivalent in value to about 3,866oz. gold, while for the former year the yield of gold from this locality was only 515oz. 16dwt.

Shellback.—There are several mining-claims in this locality, but very little work has been done during last year. Three mining companies hold about 44 acres of ground, on which five men have been employed; these have obtained 71 tons of quartz, yielding 104oz. 16dwt. of gold, while for the previous year only 35oz. 11dwt. of gold was obtained.

Kuranui.—The yield of gold from this locality has been considerably more than it was for the previous year. There were three gold-producing claims in this locality last year, comprising an area of about 36 acres, on which fifty-one wages-men and eighteen tributers were employed. The gold obtained by these last year amounted to 3,765oz., while for the former year the yield was only 2,301oz., and forty-five men were then employed.

Moanataiari.—The yield of gold from this locality last year is a little more than for the previous year; but, taking the number of men employed in the respective years, the yield of gold per man is the same—nearly 44oz. During last year there were ten gold-producing mines in this locality, comprising an area of 169 acres, on which 188 men were employed. These obtained 16,808 tons of stone, which yielded 8,209oz. 16dwt. of gold, while for the previous year there were 177 men employed in connection with the mines, the yield of gold amounting to 755oz. 10dwt.

Grahamstown.—There was a considerable falling-off in the yield of gold from this locality last year, both in quantity and the yield per man employed. During last year there were only three gold-producing claims, comprising an area of about 61 acres, on which 115 men were employed. There were 11,891 tons of quartz crushed, which yielded 5,150oz. 16dwt. of gold, being equal to

44¾oz. of gold per man; while for the previous year there were 117 men employed, 16,514 tons of quartz crushed, yielding 7,550oz. 10dwt. of gold, being equal to about 64½oz. of gold per man. One of these claims has since suspended operations on the low levels, from which most of the gold last year was produced.

Waiotahi.—There has also been a large falling-off in the yield of gold from this locality. During last year there were eight claims producing gold, comprising an area of about 120 acres, on which 128 men were employed. There were 6,365 tons of quartz crushed, which yielded 5,848oz. 8dwt. of gold, being equal to nearly 46oz. of gold per man. For the previous year there were 155 men employed, and 8,170 tons of quartz crushed, which yielded 9,398oz. 9dwt., being equal to about 60½oz. of gold per man.

Waiokaraka.—There was only one gold-producing claim in this locality last year, comprising an area of nearly 30 acres, on which there have been twenty-five men employed, and 2,482 tons of stone crushed, which yielded 2,068 oz. 9dwt. of gold., being equal to over 82½oz. of gold per man employed; while for the former year there were thirty-one men employed and 1,583oz. 17dwt. of gold produced, being equal to about 51oz. of gold per man.

Karaka.—There were six gold-producing claims in this locality last year, comprising an area of 55 acres, on which twenty-five men have been employed and 723 tons of quartz crushed, which yielded 1,183oz. 2dwt. gold; while for the former year twenty-four men were employed and 1,017oz. 19dwt. of gold produced, showing an increased yield last year of 165oz. 3dwt.

Una Hill and Te Papa.—There has been a falling-off in the yield of gold from this locality last year; nevertheless the prospects of the place are equally as good as in former years, and it is expected that next year's gold returns will bear this out. There were eight gold-producing claims in this locality last year, comprising an area of about 114 acres, in which fifty men were employed. There was 1,639 tons of quartz crushed, which yielded 2,189oz. 14dwt. of gold, being equal to 43¾oz. of gold per man employed, while for the former year there were forty-two men employed and 3,331oz. 18dwt. of gold produced, being equal to about 79⅓oz. gold per man.

Hape Creek.—There were more men employed in this locality last year than for the previous year, and, although there was an increased yield of gold, the quantity produced per man was nearly the same in both years. During last year there were two gold-producing claims, comprising an area of about 45 acres, on which twenty-nine men were employed and 372 tons of stone crushed, which yielded 333oz. 2dwt. of gold, being about 11½oz. gold per man; while for the former year fourteen men were employed and 171oz. 5dwt. gold produced, being equal to about 12oz. of gold per man. This is by far the lowest average of gold produced for the number of men employed in any locality in the Thames District. The inference is that there was a large amount of dead-work done last year.

Puriri.—Gold was discovered in this district many years ago, but it is only within the last three years that the mining operations have been continuously carried on. There are now two small crushing-batteries on the field, which afford ample facilities for prospecting operations to be carried on in this district, as prospectors can get their quartz tested on the field, instead of having to send it to the Thames as in former years. Taking the quantity of gold obtained last year—220oz. 16dwt.—for the result of six men's labour, being 36¾oz. per man, while for the former year three men only got 51½oz., or 17oz. per man, the yield of gold last year may be said to have given the men employed small wages.

Tairua.—There has been a small quantity of gold obtained from this district for many years past, but the difficulty of access, there being no passable roads, especially during the winter months, prevents people coming to this locality to prospect. Some very rich stone was obtained here several years ago, when a crushing-battery was erected, and which is still being used. Were it not that there is a crushing-machine on this field there would be no mining carried on, for the roads are in such a state that the expense of getting trial crushings sent away to either Thames or Kuaotunu would be so great that it would require very rich stone to pay for working. During last year 124 tons of stone was crushed, which yielded 91oz. 19dwt. gold, only three men being employed.

The following statement will show the comparative results of mining operations in different localities in the Thames District for the last two years, ending the 31st March in each year:—

Name of Locality.	1890-91.						1891-92.						Gold Increase.	
	Number of Wages-men and Tributers employed.	Tons of Quartz crushed.	Yield of Gold.	Tons of Mullock crushed.	Yield of Gold.	Bullion or Gold from Tailings.	Number of Wages-men and Tributers employed.	Tons of Quartz crushed.	Yield of Gold.	Tons of Mullock crushed.	Yield of Gold.	Bullion or Gold from Tailings.	1891-92.	1890-91.
			oz. dwt.		oz. dwt.	oz. dwt.			oz. dwt.		oz. dwt.	oz. dwt.	oz. dwt.	oz. dwt.
Tapu ..	9	179	164 15	..	..	..	7	73	219 12	..	..	..	54 17	..
Tararu ..	25	1,167	515 16	..	..	..	56	3,500	1,160 12	..	..	*9,864 0 / 2,705 0	2,705 0	..
Shellback ..	2	26	35 11	..	..	..	5	71	104 16	..	..	..	69 5	..
Kuranui ..	45	1,062	711 10	19,228	1,389 2	..	69	2,835	2,594 12	21,953	1,170 5	..	1,664 5	..
Moanataiari	177	8,570	7,767 12	1,401	86 0	..	188	16,858	8,209 16	..	..	..	356 4	..
Grahamstown	117	16,514	7,550 10	..	..	..	115	11,891	5,150 16	..	..	..	..	2,399 14
Waiotahi ..	155	8,170	9,398 9	..	..	..	128	6,365	5,848 8	..	..	..	..	3,550 1
Waiokaraka	31	1,093	1,583 17	..	..	..	25	2,482	2,068 9	..	..	..	484 12	..
Karaka ..	24	868	1,017 19	..	..	..	25	723	1,183 2	..	..	..	165 3	..
Una Hill and Te Papa	42	1,428	3,331 18	..	..	..	50	1,639	2,189 14	..	..	..	..	1,142 4
Hape Creek..	14	158	171 5	..	..	..	29	372	333 2	..	..	..	161 17	..
Puriri ..	3	108	51 10	..	..	..	6	263	220 16	..	..	..	169 6	..
Tairua ..	2	114	24 0	..	..	..	3	124	91 19	..	..	..	67 19	..
Sundries ..	65	1,037	699 3	632	..	3,613 13	18	..	1,343 12	..	..	3,981 15	1,012 11	..
Total ..	711	40,494	33,023 15	21,261	1,475 2	3,613 13	724	47,196	30,719 6	21,953	1,170 5	6,686 15	7,555 15	7,091 19

* The 9,864oz. of bullion represents a value of £7,674 5s., which would be equivalent to 2,705oz. of gold.

This shows a falling-off in the yield of gold in three localities of about 7,092oz.; but in the other localities the yield has increased, and even in the localities where the largest falling-off has occurred—namely, Grahamstown and Waiotahi—the average yield per man last year was 44¾oz. and 46oz. respectively, which cannot be considered a low average. It certainly shows that the ground is still capable of producing sufficient gold to give those employed fair wages. The fact of the Saxon Company suspending their operations at the low levels, where an average of ninety-two men found constant employment, the company also being a large contributor towards the payment of drainage-expenses, has cast for a time a gloom over the place. But, to take the district as a whole, mining cannot be said to be in a bad state. The principal gold-producing companies last year were as follow:—

Sylvia Company.—This company has gone to a large expenditure in the erection of concentrating machinery and appliances for extracting the gold and silver from the ore. They have one of the most complete plants in the colony for the class of ore there is to deal with in the Upper Tararu district. The ore contains galena, copper-pyrites, blende, gold, and silver, and is therefore of a refractory character, requiring a different process of treatment from the general bulk of the ore in the Thames District. During last year 3,480 tons of ore was crushed, which yielded 1,153oz. gold, and about 335 tons of concentrates, which yielded 9,864oz. of bullion, representing a value of £7,874, the value of the gold being about £4,202, making the total receipts for the year £12,076. The workings in the mine have been confined to stoping from the No. 2 and No. 3 levels, and a commencement has been made to construct another level from the side of the terrace adjoining Tararu Creek, which, when completed, will give 200ft. of backs to the No. 3 level. The character of the ore and size of the lodes continue about the same as for the previous year. The managing director, Dr. Scheidel, speaks very hopefully of the lode continuing to a great depth. Taking the quantity of ore treated last year—namely, 3,480 tons—and the value of the gold and bullion obtained—£12,076—gives an average value of about £3 9s. 5d. per ton.

The following description of the mode of treating the ore at the Sylvia Company's works where the Cassell process is used, was handed to me by Dr. Scheidel, Ph.D., Assoc. University of Freiberg, Germany, who is managing director for the company:—

"*Treatment of Sylvia Ores.*

"I have the honour, at your request, to place at your disposal a brief account of the results obtained during the first year of operations in the concentrating works of the Sylvia Company, Tararu, Thames, and on the cyanide extraction plant, lately added to the company's gold-saving appliances.

"I gave you last year a description of the company's ore-dressing plant, constructed and erected by Mr. H. W. F. Kayser and myself, and I am now able to report that the first year's operations realised fully the expectations as to the efficiency of the plant.

"The total quantity of quartz put through the mill of ten heads on 332 days amounted to 5,300 tons, or about 16 tons every twenty-four hours. The battery is quite capable of putting through 25 tons per day, but the scarcity of water during a lengthened period reduced the motive-power, and thereby the capacity of the crushing plant, to such an extent as to lower the day's average to above figure. The total amount of concentrates obtained from the crushing-dirt amounted to 440 tons, of £12,033 value. The value of the crushing-dirt varied considerably—the great bulk of the quartz assayed before treatment between £3 and £4, a considerable tonnage reached as high as £10 per ton, and at other times very low-grade stuff had to be dealt with. The value of the tailings going to waste varied between 9s. and 15s. per ton: occasionally higher figures were obtained, the consequence of a failing water-supply: the concentrating machinery requires a certain speed, corresponding with eighty-five strokes of the stamps per minute, and gives at such pace better results in dressing than at a reduced rate of motion. The amount of free gold saved on the plates amounted to 1,278oz., value £4,629, or £3 12s. per ounce. The quantity of free gold saved per ton of ore amounted to 4dwt. 19gr., value 17s. 5d. The amount of concentrates saved averaged 8·3 per cent., one ton of quartz yielding 1cwt. 1qr. 17lb., of the value of £2 5s. 5d. The total value saved per ton of crushing-dirt amounted, between concentrates and free gold, to £2 9s. 8d., the average value saved of the assay-value per ton of ore being estimated at 80 per cent. The concentrates obtained were classed as follows: Jigger concentrates, first-class slime concentrates, second-class slime concentrates, and buddle concentrates. The average amount of jigger concentrates amounted to 4oz. 5dwt. of gold and 20oz. of silver—value £20—per ton. Such concentrates contain a small percentage of galena; they consist chiefly of iron- and copper-pyrites and zinc-blende; they further contain a small percentage of quartz, which it has not been found advantageous to separate completely. The first-class slime concentrates represent only 32·5 per cent. of the total production of concentrates, but their value is equal to 52 per cent. of total value. They contain a high percentage of sulphide of lead—in some instances as high as 20 per cent.; they are almost absolutely clean, containing only a fraction of 1 per cent. of quartz. Although solid veins of rich galena are only seldom met with, sulphide of lead is pretty equally distributed all over the mine in small quantities. It slimes considerably in the crushing process, and carries a higher percentage of gold and silver than any of the other minerals composing the concentrates. Its presence is always conspicuous, and quite a feature on the slime-concentrating tables. From clean galena on the tables as high assays as 48oz. of gold and 98oz. of silver, value £206 per ton, have been occasionally obtained. The average assay-value of first-class slimes amounted to 10oz. 6dwt. of gold, and 44oz. of silver per ton, value £47 16s. The single assays varied considerably: values as high as £95 per ton have been obtained.

"Differing from methods applied to other ores, I finish the first-class slimes in one sole operation, which way of proceeding I found most expedient and economical. The middle products from the slime-tables go to a triple table, where they are finished. In the finished state they are called second-class slime concentrates. Their total production amounted to 93 tons, their value to £1,730. They contained in average—gold, 4oz. 5dwt.; silver, 20oz. They contain a very small percentage of

lead, as is easily understood from the way by which they are obtained, and are free, or very nearly so, from quartz. The middle products of the triple table go over the same table again, till they are clean. Their quantity is included in the total figure of second-class slimes. The tailings from the single tailings go through a buddle, and the headings from the buddle over the triple table. The tailings from all the jiggers go through another buddle; the headings are twice re-treated in a dressing-buddle. The clean concentrates thus obtained are termed buddle concentrates; their quantity amounted to 26 tons, their value to £795. One ton buddle concentrates contained in average 7oz. 15dwt. of gold, and 29oz. 5dwt. of silver; value £35 7s. The total weight of buddle concentrates amounted to only 5·6 per cent. of the total of concentrates produced. As the materials from which the buddle concentrates are obtained are the tailings from the other concentrating-machines, their small percentage speaks for the efficient working of the whole plant. The tailings leaving the works pass through a large ripple-box, from which the headings are again brought into the works and passed through the dressing-buddle. They give an insignificant quantity of concentrates, which is included in the above-stated buddle concentrates. The working of the concentrating plant, and the system on which the operations are carried out, will be easily understood from the attached table. As results from the table, all by-products or middle products (products not finished in one—the first —operation) undergo a repeated treatment, and all tailings are worked over and over again before they are finally discarded. It is due to this system that the concentration of the Sylvia ore is brought to its present perfection. The whole of the crushing and dressing plant worked constantly with the greatest precision, and no money had to be spent on alterations or repairs.

"It is only natural that the working of machinery never seen before on this field, and hardly ever used for concentration of gold-ores anywhere, required a time of apprenticeship for the men employed in the sheds. The employés, however, soon got used to the work, which is by no means arduous. The whole of the machinery, crushing, and concentrating, is attended to per shift by one amalgamator, doing duty as well of shift-boss; one feeding-boy; one lad attending to jiggers and sundry work; and one man at the slime-tables. The working-expenses amount to £4 7s. per twenty-four hours, or to 3s. 6d. per ton of ore when 25 tons of quartz are put through. Such expenses include cost of crushing, amalgamating, and concentrating. The cost of crushing and amalgamating amounts to 1s. 8d.; so that the cost of concentration is covered by 1s. 8d. per ton. The above figures include wages only. The present Sylvia concentrating plant has been erected as an experimental one, with the view of increasing its size in accordance with results and circumstances. The same number of men now employed could almost superintend a plant of double the extent, when the costs of crushing, amalgamating, and concentrating would be still further and considerably reduced.

"The question as to whether loss is occurring by the washing-away of extremely fine gold and very finely-divided but valuable galena, has occupied my attention to a degree. It has been found that the loss thus occurring is of such trifling nature as to be of no account. The experiments have finally established the claim of the Sylvia plant to be one thoroughly adapted to its purposes; and, on the other hand, the results shown by the above figures prove that an ore, refractory and low-grade, which yields 80 per cent. of its assay-value in 8 per cent. of its weight after concentration, must necessarily be a concentrating-ore. The results of experiments on chemical treatment of such low-grade ore as represents the average of last year's crushing-dirt do not warrant any alteration in the general treatment as carried on by the present system. Extremely rich ore, as is occasionally found in pockets or bunches in the mine, does not require any concentration, but is extracted after previous reduction to a fine state of division. The whole proceedings in the dressing-sheds are regularly and scientifically controlled. The value of crushing-dirt and tailings is regularly ascertained by assay, a system which would be valuable for many establishments to adopt where attempts at gold-saving are carried on with indifferent appliances, when defective machinery and methods would be soon superseded by better ones. The attached plates will further illustrate the Sylvia Company's concentrating plant and its working. My full description of the machinery itself may be found in the New Zealand Government Mining Report, 1891. (See C.–4, 1891.)

"It was originally intended to dispose of the concentrates by sale in the highest market; but the low prices offered for the low-grade jigger and second-class slime concentrates made an extractive treatment on the spot not only desirable and preferable, but an imperative necessity. The expenses for bagging, carting, shipping, insurance, and treatment abroad are so great that they will seriously interfere with the exportation of all complex ore excepting such as are of high value.

"I investigated, in my position as managing director and metallurgist to the Sylvia Company, the question of local treatment of the concentrates, and decided on the adoption of the cyanide-of-potassium extraction process. Considering the most complex character of the concentrates—a mixture of galena, zinc-blende, iron-, and copper-pyrites—it was *a priori* not certain that, without previous roasting, a solution of cyanide of potassium would effect anything like a satisfactory extraction of gold and silver; but not only experiments on a small scale, but the eminently successful treatment of about 350 tons of such material, have proved the efficiency of such treatment, of which I am pleased to record here the results. After previous trials made with the process on an experimental scale, I was intrusted by the board of directors with the construction and erection of a plant for cyanide treatment of concentrates, which has since proved a success both chemically and mechanically. I attach two plans, with the following description of the plant, which consists of three large agitators, three vacuum filters, a grinding-pan, cyanide-solution tank, tanks for gold-solution, vacuum and other pumps, and other minor appliances. It is capable to put through, according to the quality of the material, up to 20 tons per twenty-four hours. The whole plant is of local manufacture. The filtration of the concentrates, after terminated agitation, and their complete liberation from gold-cyanide solution, has been a difficult problem to solve in those few places where the agitation process has been extensively carried out. The construction of my vacuum filter, of which I also enclose plans, has easily overcome all difficulties. Its application has vastly contributed to make the cyanide process a success with the Sylvia Company.

"I forward a table showing the efficiency of the apparatus by comparing assays of material filtered and washed by its means with assays of the same material washed with a very much greater quantity of water in the laboratory. Up to date 341 tons of concentrates have been passed through the cyanide-extraction plant, to which the various qualities contributed as follows: Jigger concentrates, 138 tons, value £2,688; first-class slime concentrates, 111 tons, value £5,326; second-class slime concentrates, 71 tons, value £1,427; buddle concentrates, 19 tons, value £637; lead-ore, 18cwt., value £84. The results of extraction have varied in accordance with the quality of the material, the slimes generally giving better results than the other products, and the (richer) first-class slimes returned a higher percentage of gold and silver than the lower-grade materials. Eminently satisfactory results have been obtained from the first-class slimes, from which as high as 96·45 per cent. of the assay gold, and 94·59 per cent. of the assay silver value were extracted. The average of extraction from 110 tons of first-class slime concentrates amounted to 86·11 per cent. of the gold value, and 67 per cent. of the silver, or 85·22 per cent. of the assay-value. The average extraction from 71 tons of second-class slimes returned 85·34 per cent. of the gold, 68·7 per cent. of the silver, or 82·62 per cent. of the total value. The average extraction of 64 tons jigger concentrates amounted to 80·32 per cent. of the gold, 50 per cent. of the silver, and 75·37 per cent. of the total value. The average extraction from 19 tons of buddle concentrates amounted to 77·9 per cent. of the gold, 54·45 per cent. of the silver, and 74 per cent. of the total value. The average extraction from 341 tons of concentrates amounted to 82·67 per cent. of assay-value. The total value of bullion extracted amounted to £7,916. There is still a large stock of concentrates on hand, which is at present undergoing treatment. The tailings are stacked for a possible future re-treatment, as it may be possible in future to turn the lead and copper contained in the concentrate tailings to account.

"I attach further tables showing the results of extraction of a large tonnage of each class of concentrates. The time of agitation and the strength of solution applied varied in accordance with the quality of the material. The quantity of cyanide used for the highest grade of ore amounted to less than 1 per cent., and for low-grade material considerably under 0·5 per cent. The time of agitation varied between five and twenty-four hours. The use of cyanide solution, so eminently successful with our concentrates, will very likely be successful with other classes of ores as a re-agent for extraction of gold and silver. The process is patented in New Zealand by the Cassell Company, and in Glasgow, under the name of the McArthur-Forrest process. The Sylvia Company acquired the right of using the re-agent on payment of a royalty of 7½ per cent. on the bullion extracted. The patentees did not interfere with the construction of the plant, which was left in my hands.

"The company's mine has supplied the works during the year with the required amount of crushing-dirt without difficulty. A low level is now being put in, which will give between 240ft. and 680ft. of backs.

"Last summer's exceptionally dry weather interfered to some extent with the working of the concentrating plant. Although droughts of a similar character are fortunately extremely rare in the Thames District, interruptions of operations may in future be prevented by constructing a second water-race about 150ft. above the present one, which will vastly increase the motive-power from about the same quantity of water.

"The results of the Sylvia works, both concentrating and extracting, have been, as detailed above, successful. The plant for crushing, concentrating, and extracting is one of the most complete and effective for gold-saving, and it is to be hoped that the pioneer work thus done by the Sylvia Company may prove beneficial to New Zealand's mining industry."

TABLE showing efficiency of Dr. A. Scheidel's Patent Vacuum Filter for separating Gold and Silver Solutions from Ore, Tailings, and other materials.

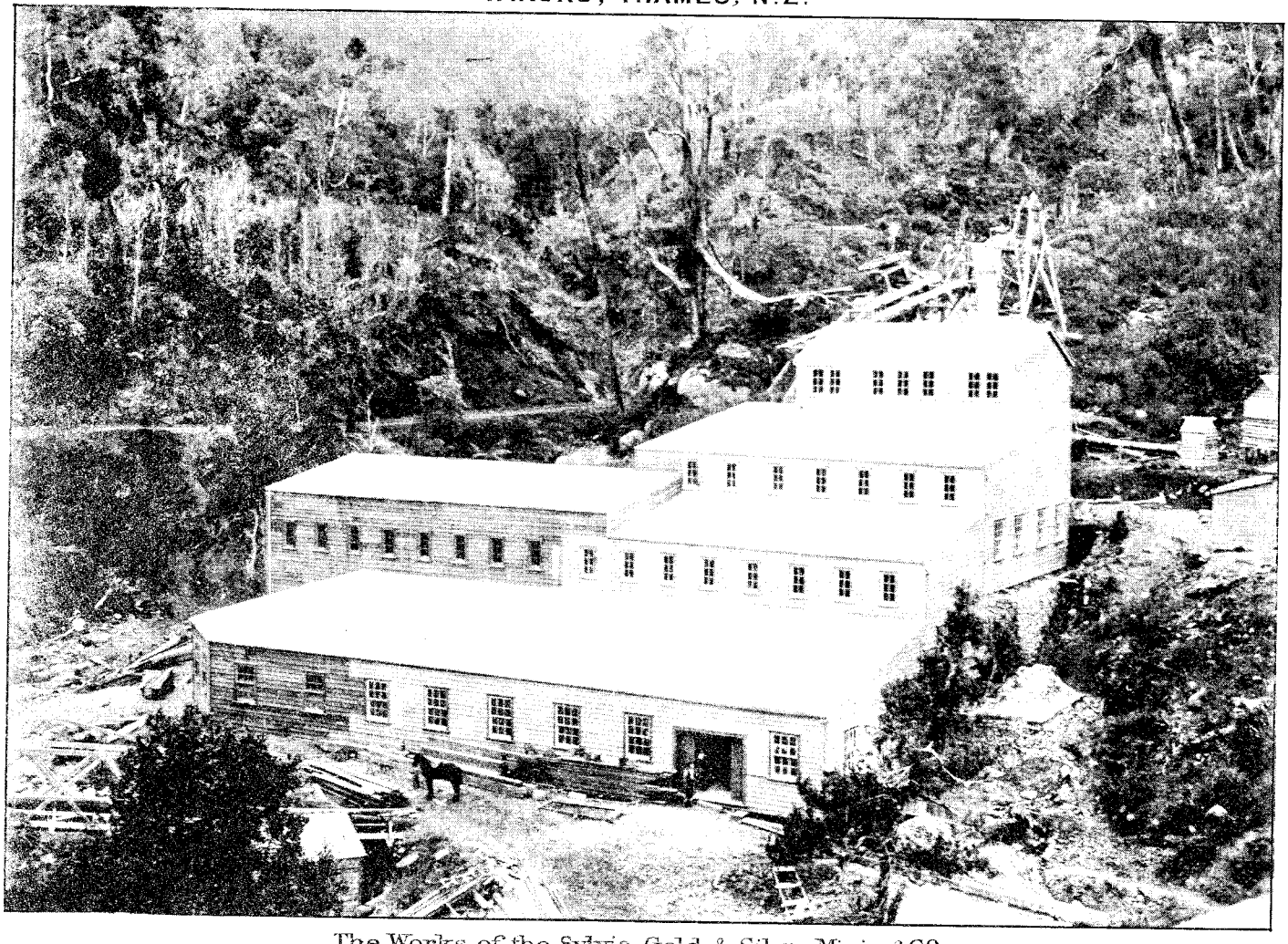
Assays of Discharge-Samples washed in Laboratory with Water (100 times weight of sample).									Assays of Filter-Residue after washing Tailings with two-thirds of their weight in Water, on Dr. A. Scheidel's Patent Vacuum Filter.								
Gold.			Silver.			Value.			Gold.			Silver.			Value.		
Oz.	dwt.	gr.	Oz.	dwt.	gr.	£	s.	d.	Oz.	dwt.	gr.	Oz.	dwt.	gr.	£	s.	d.
0	6	13	14	14	0	3	10	3	0	6	13	14	0	22	3	9	3
0	16	8	21	4	16	6	9	1	0	16	8	20	14	21	6	7	5
0	9	19	8	0	2	3	3	2	0	9	19	7	13	13	3	2	0
0	6	13	13	1	8	3	5	2	0	6	13	12	8	6	3	3	3
0	9	19	15	7	2	4	5	3	0	9	19	15	0	13	4	4	2
0	9	19	10	2	13	3	9	6	0	9	19	10	2	13	3	9	6
0	9	19	11	11	22	3	14	0	0	9	19	8	9	21	3	4	8
0	9	19	9	16	0	3	8	3	0	9	19	9	16	0	3	8	3
0	9	19	6	0	21	2	17	2	0	9	19	5	11	2	2	15	8
0	6	13	6	4	3	2	4	11	0	6	13	4	18	0	2	0	7
0	6	13	3	11	21	1	17	0	0	6	13	3	11	21	1	17	0
0	6	13	4	11	11	1	19	8	0	6	13	3	18	10	1	17	7
0	9	19	5	14	8	2	16	3	0	8	4	4	9	20	2	6	2
0	9	19	4	18	0	2	13	7	0	9	19	3	15	3	2	10	3
0	13	2	7	3	18	3	13	8	0	13	2	8	3	8	3	16	8
0	13	2	8	0	2	3	16	4	0	13	2	8	0	2	3	16	4
0	16	8	11	8	16	4	19	5	0	16	8	11	5	10	4	19	1
0	13	10	5	19	5	3	3	8	0	13	10	5	19	5	3	3	8
0	9	19	7	7	0	3	1	3	0	9	19	6	13	22	2	19	1
0	3	6	3	8	14	1	3	1	0	3	6	3	15	3	1	4	1
0	8	4	8	18	0	2	19	1	0	8	4	8	11	12	2	18	6
0	8	4	11	0	12	3	5	8	0	8	4	10	0	12	3	2	8
0	5	12	10	10	0	1	4	6	0	5	12	10	0	0	1	3	0

TABLE showing Results of Cyanide Treatment of Concentrates.

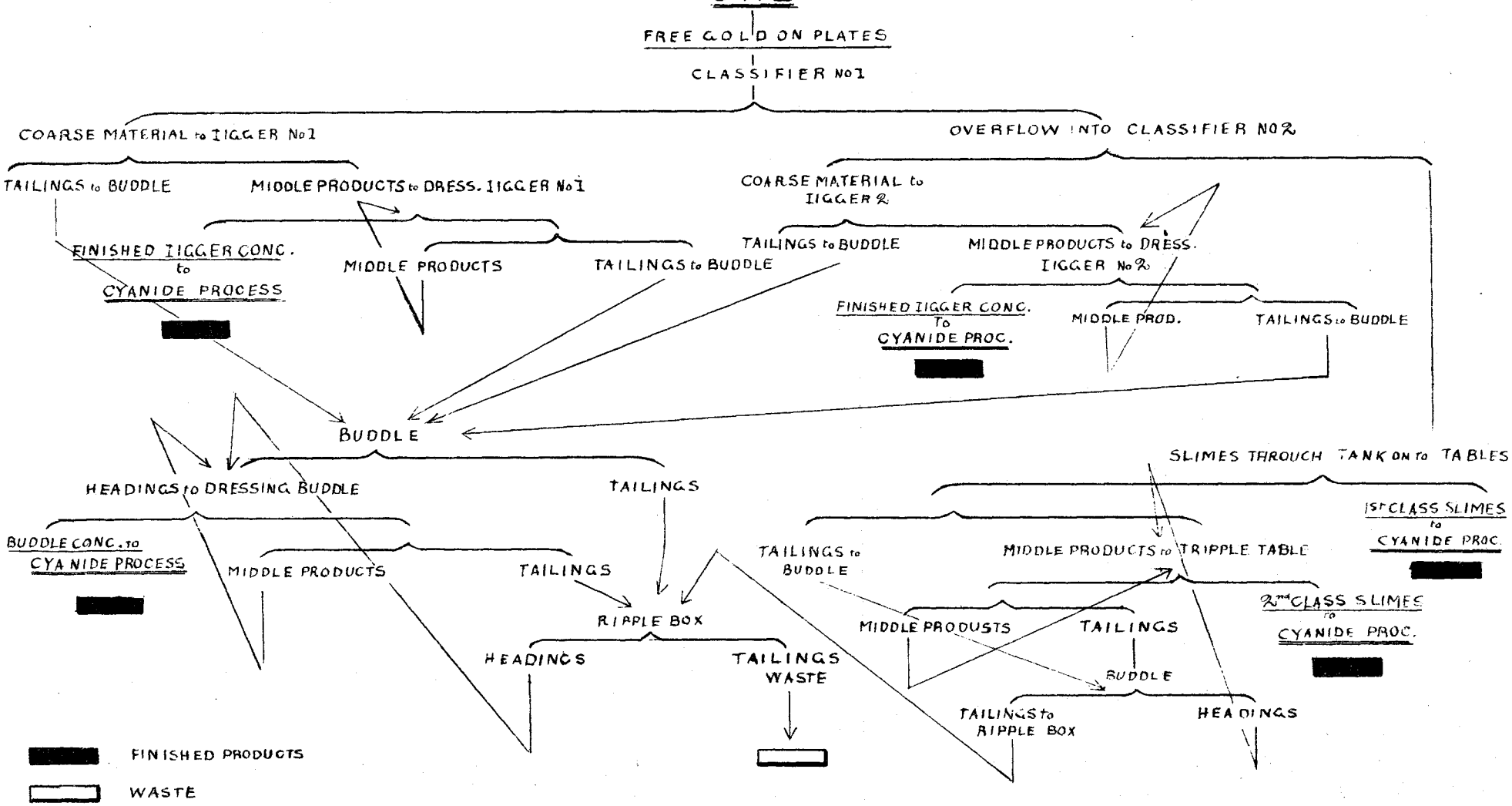
Assay per Ton before Treatment.			Assay per Ton after Treatment.			Extracted per Cent.		
Gold.	Silver.	Value.	Gold.	Silver.	Value.	Gold.	Silver.	Value.
			FIRST-CLASS SLIME CONCENTRATES.					
Oz. dwt. gr.	Oz. dwt. gr.	£ s. d.	Oz. dwt. gr.	Oz. dwt. gr.	£ s. d.			
8 13 3	32 6 19	39 9 3	0 9 19	5 11 1	2 15 8	94·35	70·35	93·04
9 2 22	38 7 16	42 6 9	0 6 12	14 0 22	3 9 3	96·45	82·12	91·85
10 2 12	54 11 20	48 14 0	0 16 8	20 14 20	6 7 5	91·92	86·34	86·96
7 13 12	41 19 12	37 0 2	0 9 19	7 13 12	3 2 0	93·70	86·69	91·35
7 3 17	37 1 12	34 6 0	0 6 12	12 8 6	3 3 3	95·81	65·19	90·82
7 13 12	50 6 3	50 6 3	0 9 19	15 0 12	4 4 2	94·12	70·00	89·36
7 0 6	42 19 8	34 10 0	0 9 19	10 2 12	3 9 6	93·58	76·50	90·00
8 6 14	40 6 20	39 7 5	0 9 19	8 9 20	3 4 8	94·58	75·00	91·76
9 6 4	41 3 4	43 8 2	0 9 12	8 19 16	3 6 2	95·17	76·19	92·40
12 11 12	55 13 22	58 13 0	1 6 3	15 7 1	7 10 7	89·65	72·42	87·30
11 11 22	48 3 16	53 12 0	0 13 1	12 1 17	4 8 4	95·20	80·92	91·78
14 4 4	44 2 0	63 9 2	0 13 1	14 14 0	4 16 5	95·43	63·17	91·35
12 1 17	51 18 19	56 2 5	0 19 14	16 6 16	6 7 1	92·10	68·59	90·25
12 1 17	52 5 3	56 3 9	0 13 1	14 17 6	4 16 9	94·61	70·00	91·46
10 12 8	29 11 6	46 17 10	1 6 3	6 17 4	6 4 11	87·74	76·83	86·77
11 5 9	46 16 6	52 1 9	1 2 20	16 9 22	7 1 0	90·23	64·76	86·46
11 11 22	40 16 16	52 9 9	0 13 1	12 8 6	4 10 5	94·38	69·61	91·43
10 2 15	34 2 17	45 14 6	1 9 9	6 4 3	6 16 5	85·65	81·12	85·13
10 12 8	30 7 14	47 0 5	2 9 0	4 8 4	10 9 1	76·89	85·51	77·77
10 12 8	34 2 17	47 11 8	2 2 11	5 4 12	9 5 7	79·25	84·25	80·55
17 12 19	76 8 19	81 16 3	2 2 11	16 0 3	10 17 10	88·07	78·95	86·74
12 8 6	36 1 6	55 3 5	2 5 17	7 10 6	10 5 6	85·89	79·46	79·68
9 6 4	45 11 9	44 1 4	0 13 1	11 8 16	4 6 5	93·00	75·00	90·39
9 12 17	42 12 14	44 18 10	0 13 1	12 5 0	4 9 1	93·23	71·25	90·09
10 2 12	45 17 22	47 7 7	0 13 1	16 9 22	5 1 1	93·57	62·2	89·34
8 19 16	38 17 11	41 15 1	0 13 1	6 13 22	3 12 2	92·74	82·89	91·38
11 5 9	45 17 22	51 19 1	0 16 8	16 0 3	5 13 4	92·89	65·11	89·13
12 1 17	47 13 3	55 10 5	0 16 8	21 7 22	6 9 5	93·37	55·40	89·28
11 15 4	40 19 23	53 3 10	0 13 1	15 0 12	4 17 4	94·47	63·38	90·89
8 6 14	37 8 1	38 18 5	0 16 8	13 11 3	5 10 5	90·00	62·41	86·59
10 2 12	45 16 10	47 7 3	0 16 8	19 2 4	6 2 8	92·00	58·21	87·12
8 9 20	38 1 3	39 13 6	1 2 20	14 14 0	6 15 7	86·99	61·37	82·98
10 9 1	53 8 4	49 16 5	0 16 8	24 0 4	6 17 4	92·35	55·16	86·25
8 19 16	46 17 12	42 19 1	0 17 23	18 14 1	6 17 11	90·40	61·05	91·50
			SECOND-CLASS SLIME CONCENTRATES.					
4 8 4	24 0 4	21 4 10	0 9 19	6 0 20	2 17 2	88·90	73·36	86·56
5 1 6	26 9 4	24 4 6	0 6 12	3 18 9	1 17 7	93·58	86·43	92·36
6 7 9	27 15 8	29 12 9	0 16 8	8 0 1	4 9 4	87·40	71·36	84·97
5 4 12	25 3 1	24 13 6	0 13 1	10 2 12	14 2 8	87·47	59·85	83·37
5 4 12	25 9 14	25 7 2	0 13 1	10 15 14	4 4 8	87·50	57·80	83·44
4 18 0	22 10 19	18 19 6	0 3 19	8 0 20	3 4 8	90·92	62·45	83·12
4 11 11	21 17 17	21 11 3	0 11 10	7 15 4	3 8 9	89·92	64·54	84·23
3 11 20	16 13 4	16 17 4	0 9 19	5 11 1	2 15 8	87·33	66·67	83·68
4 8 4	18 9 3	20 8 4	0 13 1	5 4 12	3 8 1	85·23	71·82	83·34
5 1 6	19 15 6	23 4 11	0 6 12	4 18 0	2 0 7	94·06	75·16	91·38
3 18 9	16 19 17	18 4 8	0 9 19	4 1 16	2 11 2	88·47	75·82	85·99
4 1 16	17 9 12	18 19 2	0 6 12	3 11 20	1 17 0	92·50	79·60	90·50
5 7 19	24 0 4	25 3 2	0 6 12	1 6 3	1 11 10	94·40	94·59	93·84
3 15 3	18 12 9	17 16 4	0 6 12	3 18 9	1 17 7	92·11	79·04	89·61
2 15 12	13 4 14	13 1 11	0 8 3	4 9 20	2 6 2	85·40	66·29	80·14
4 1 16	20 8 4	15 7 9	0 16 8	6 7 9	4 4 5	80·25	68·88	72·64
3 11 20	18 2 14	17 11 10	0 16 8	4 1 16	3 17 4	77·47	77·64	78·07
3 18 9	18 5 20	18 8 5	0 14 16	7 11 21	4 1 8	82·06	58·64	88·86
3 18 9	17 12 19	18 6 6	0 9 19	3 15 3	2 10 3	89·74	78·69	86·33
2 12 6	18 5 20	13 3 9	0 3 6	3 15 3	1 4 1	93·78	79·46	90·87
			JIGGER CONCENTRATES.					
3 18 9	16 6 16	18 2 5	0 13 1	6 4 3	3 11 1	83·33	61·96	80·38
3 18 14	13 11 3	15 14 10	0 13 1	4 14 17	3 6 5	81·01	63·53	78·90
4 8 4	21 7 22	20 16 11	0 14 16	7 18 10	4 2 3	83·36	63·11	75·47
4 18 0	20 5 1	22 12 9	0 13 1	8 3 8	3 16 8	86·74	59·76	81·73
3 11 18	18 2 16	17 1 6	0 13 1	8 0 1	3 16 4	81·82	55·59	77·64
4 4 22	22 17 8	20 8 1	0 16 8	11 5 9	4 19 1	81·08	51·65	75·73
5 1 6	24 13 6	23 18 10	0 13 1	10 9 1	4 3 10	87·11	57·67	82·81
5 4 12	27 8 19	25 0 3	0 19 14	15 16 20	6 5 9	81·26	42·15	75·00
7 0 11	30 4 8	32 12 7	0 19 14	14 0 22	6 0 4	86·05	53·47	81·59
3 15 3	17 3 0	17 11 10	0 16 8	8 0 1	4 9 4	78·26	46·64	74·60
3 18 9	19 12 0	18 12 6	0 13 1	6 17 4	3 12 7	83·29	64·79	80·37
4 4 22	15 0 12	19 4 8	0 16 8	8 13 3	4 11 2	80·91	42·33	76·30
4 11 11	15 13 14	20 12 8	0 19 14	10 5 19	5 9 1	78·57	34·18	73·54
4 8 4	15 13 14	19 19 8	0 16 8	7 16 19	4 8 9	81·40	50·03	77·69
4 18 0	15 16 20	21 19 5	1 2 20	8 13 3	5 17 4	76·53	45·25	73·34
3 15 3	21 7 22	18 4 7	0 13 1	8 9 20	3 17 10	82·66	60·42	78·59
4 4 22	18 2 14	19 14 0	0 13 1	7 16 19	3 15 9	84·52	53·66	80·71
2 5 17	15 7 1	11 9 1	0 8 4	9 4 13	3 0 5	82·22	40·00	73·36
3 15 23	14 3 8	17 6 2	0 13 1	9 12 17	4 1 2	82·66	31·88	76·58
6 7 9	32 18 20	30 8 1	0 19 14	18 5 20	6 13 1	84·25	44·52	78·15
5 1 6	27 18 14	24 8 5	0 19 14	15 13 14	6 5 2	80·19	43·90	74·38
4 4 22	17 9 12	19 12 2	0 16 8	8 0 1	4 9 4	80·95	54·15	77·04
3 15 3	16 16 11	17 10 7	0 19 23	8 11 12	4 17 8	73·33	48·80	72·00
4 8 4	17 2 4	20 10 2	0 19 14	8 8 3	5 4 2	77·27	54·71	74·63
1 15 22	22 5 6	10 10 5	0 8 4	4 16 8	2 6 9	77·27	78·20	77·61
2 9 0	23 13 16	13 6 10	0 11 10	5 19 5	3 3 8	76·71	74·85	76·13
1 12 16	17 19 8	9 4 8	0 4 21	5 12 17	1 16 4	85·08	68·56	80·32
2 9 0	23 13 16	13 6 10	0 9 19	7 7 0	3 1 3	80·01	68·96	77·04
2 2 11	24 16 13	12 3 11	0 8 4	8 18 1	2 19 1	80·76	70·02	75·77

NOTE.—It is but fair to add that the Company's books were examined by me, and that the results here shown are taken from them. The ore is carefully assayed every day, and the result entered in a book kept for the purpose in above form, which shows that a fair percentage of the precious metals are obtained. It will be seen that the richer the concentrates the higher percentage of gold and silver are saved.

TARURU, THAMES, N.Z.

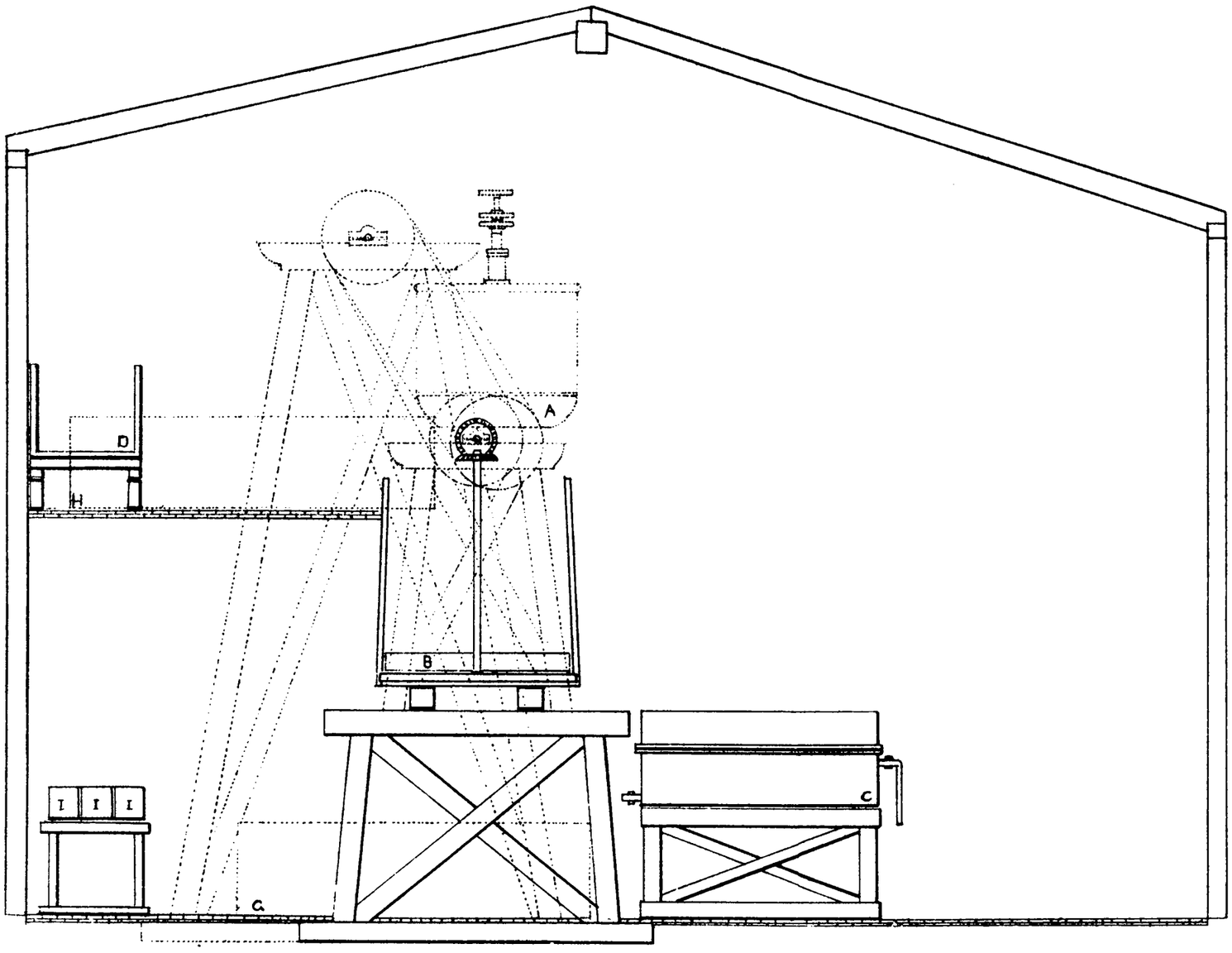


The Works of the Sylvia Gold & Silver Mining Co
Erected by Dr A. Scheidel.



THE CONCENTRATION PROCESS IN THE WORKS OF THE SYLVIA GOLD AND SILVER MINING COMPANY NO LIABILITY TARARU THAMES N.Z.

W. A. Ickeiod
Hawera, June 1st 1892



Scale
4 3 2 1 0 4 8 12

LONGITUDINAL SECTION

Dr A. SCHEIDEL'S

PLANT FOR THE EXTRACTION OF

GOLD AND SILVER FROM ORES

BY

CYANIDE OF POTASSIUM

(Mc ARTHUR-FORREST PROCESS)

IN THE WORKS OF

THE SYLVIA GOLD AND SILVER MINING COMPANY

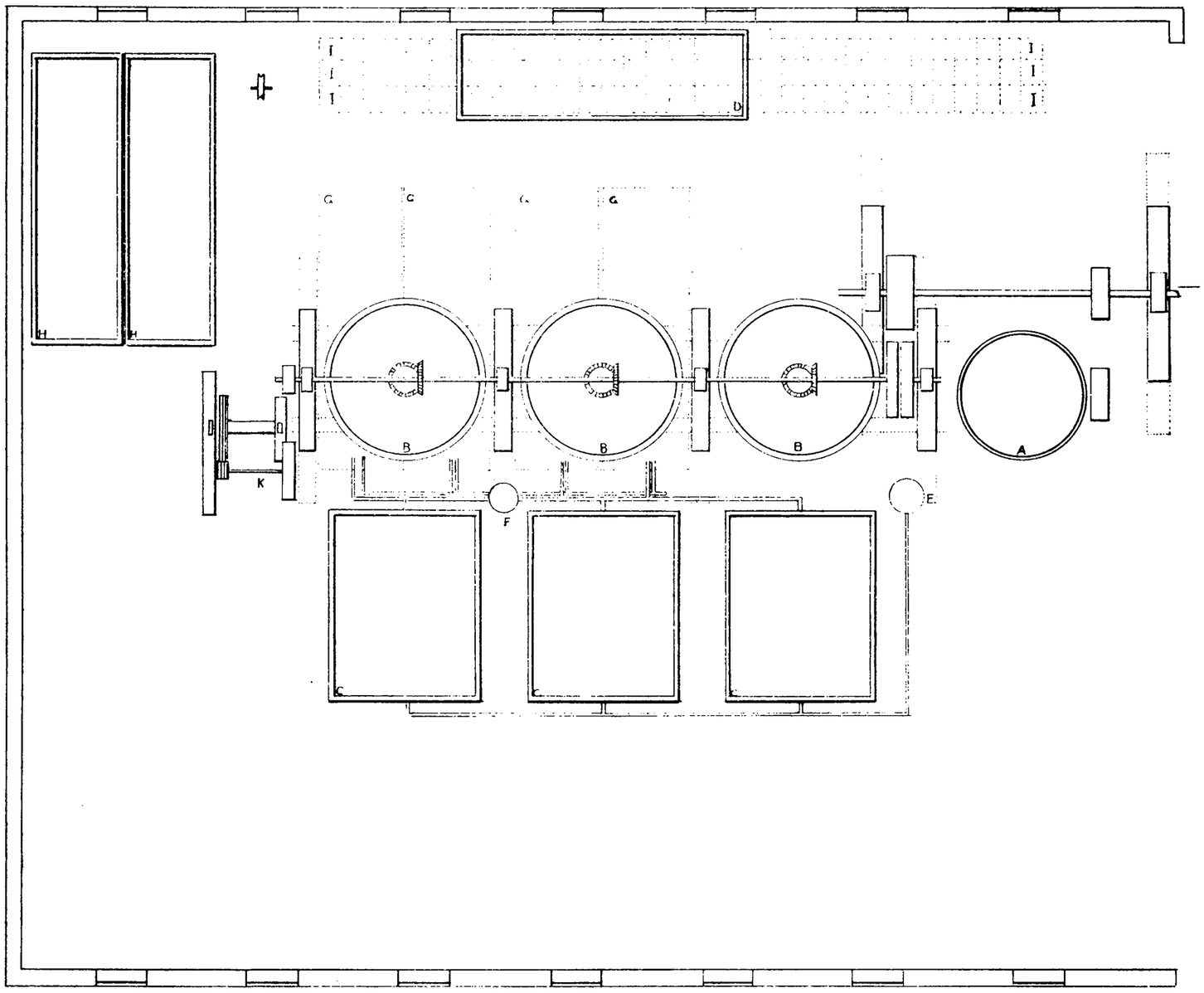
NO LIABILITY

TARARU THAMES N.Z.

A McKAY PAN
B AGITATOR
C Dr SCHEIDEL'S PATENT VAC. FILTER
D STORE SOLUTION TANK
G GOLD SOLUTION TANK
I ZINC FILTERS FOR GOLD PRECIPITATION
H GOLD SOLUTION TANK

Hamner N.Z.
Nov 1891

Dr A Scheidel



Scale
4 3 2 1 0 4 8 12

PLAN

— Dr A. SCHEIDEL'S —

— PLANT FOR THE EXTRACTION OF —

— GOLD AND SILVER FROM ORES —

BY

— CYANIDE OF POTASSIUM —

(MACARTHUR-FORREST PROCESS)

IN THE WORKS OF

— THE SYLVIA GOLD AND SILVER MINING COMPANY —

— NO LIABILITY —

TARARU THAMES N.Z.

A McKAY PAN
B AGITATORS
C Dr SCHEIDEL'S PATENT VAC. FILTER
D STORE SOLUTION TANK UPPER FLOOR
E VACUUM PUMP
F GOLD SOLUTION PUMP
G GOLD SOLUTION TANKS GROUND FLOOR
H GOLD SOLUTION TANKS UPPER FLOOR
I ZINC FILTERS FOR GOLD PRECIPITATION
K FRICTION GEAR OF LIFT

Thames N.Z.
Jan. 1894.

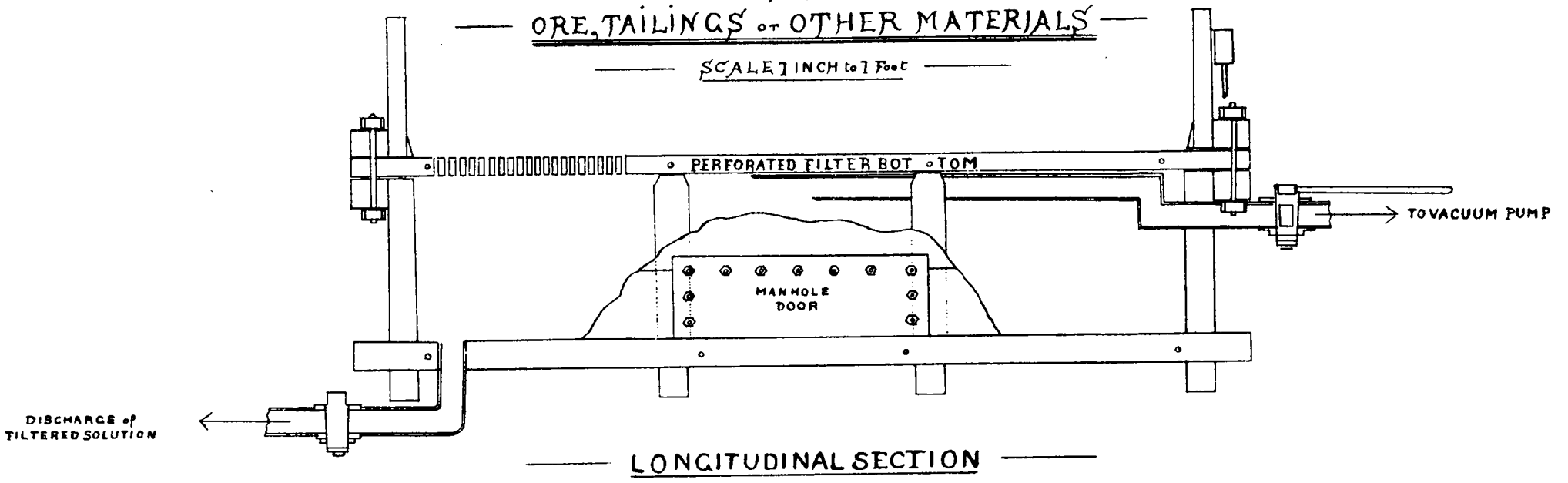
F. A. Scheidel

Dr A. SCHEIDEL's

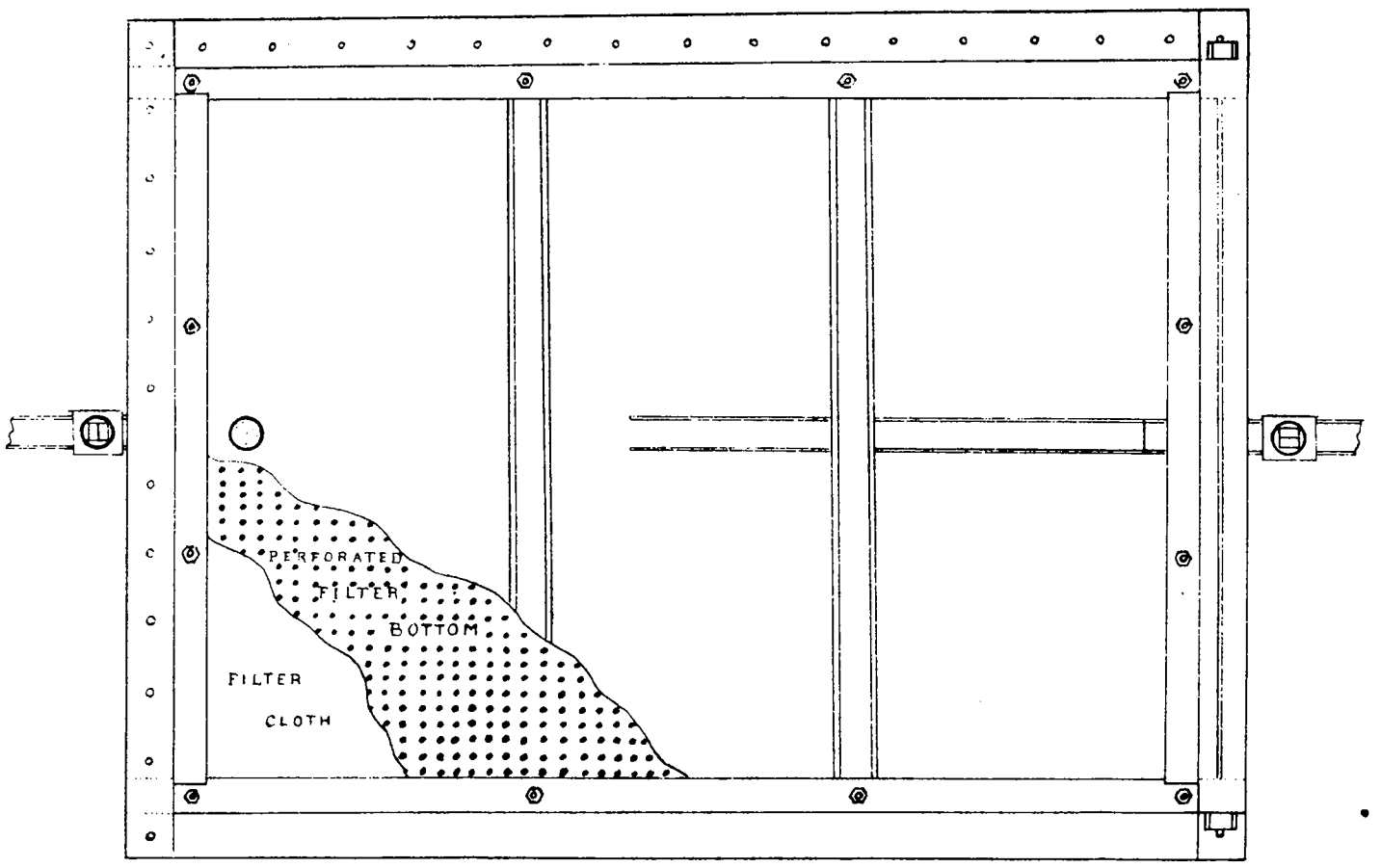
PATENT VACUUM FILTER

FOR SEPARATING GOLD AND SILVER SOLUTIONS FROM ORE, TAILINGS or OTHER MATERIALS

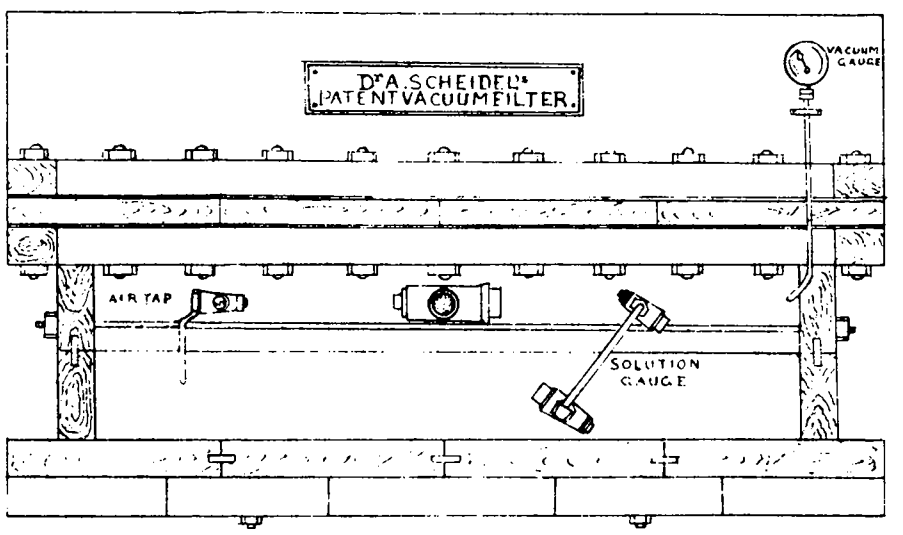
SCALE 1 INCH to 1 Foot



LONGITUDINAL SECTION



HORIZONTAL SECTION



FRONT VIEW

Dr A. Scheidel
Kansas, U.S. 1891.

Kuranui Nos. 2 and 3.—These mines are held by Mr. Comer and Mr. Hansen respectively, they each have crushing-batteries, and are crushing the material as it is quarried from the hill in a face. The whole of the Kuranui Hill is composed of tufaceous sandstone, with lodes, leaders, and veins of auriferous quartz running through it, and some very rich stone was obtained from this ground in the early days of the field. During last year Mr. Comer crushed 13,091 tons of mullock as it was quarried from the hill, which yielded 753½oz. gold, being an average of 1dwt. 3·6gr. of gold per ton; this Mr. Comer says pays him for working. He employed sixteen men on wages in obtaining the mullock and crushing it, and ten men have been employed on tribute. The tributers obtained last year 228 tons of stone, which yielded 319oz. gold.

Mr. Hansen crushed 8,862 tons of mullock, which yielded 416¾oz. gold, being an average of 22·47gr. of gold per ton. He had thirteen men employed on wages, and four men as tributers. The latter got 35 tons of stone, which yielded 62oz. gold. When it is taken into consideration that the gold is only worth about £2 15s. per oz., the value of the material treated would, in the case of Mr. Comer, represent 3s. 2d. per ton, and that of Mr. Hansen 2s. 7d. per ton. Both amounts seem very little in comparison with the expenses and labour in getting and crushing the mullock. It shows, however, that by careful management very low-grade material can be made to pay for working.

Hazelbank Company.—This company was formed in September, 1890, with a nominal capital of £10,500, of which scrip to the value of £2,100 was given to the shareholders, and about £1,824 has been actually paid in calls. The mine is situate in the Kuranui block, and their workings last year were carried on No. 1 level, which is about 203ft. below the surface, and No. 3 level, 347ft. below the surface. There are several lodes and auriferous veins of quartz running through the ground, but none of them are of a great width. Last year they had an average of twenty-two men employed on wages, and four men as tributers. The company crushed 2,197 tons of stone, which yielded 2,050oz. gold. They also crushed 375 tons of stone for the tributers, which yielded about 164oz. of gold.

Moanataiari Company.—This company was formed in November, 1888, taking over the property belonging to the old company of the same name. They have a subscribed capital of £24,955, of which scrip to the value of £2,670 has been given to the shareholders, and £9,905 has been paid up in calls, without having as yet received any return for the money invested. They have, however, a mining property that is yet likely to become a valuable one, and they have an adit-level from the sea-beach into Kuranui Hill for a distance of 3,077ft., which will be of great service in testing the deep levels in the back country; indeed, this adit-level may be said to be the key to a large area of auriferous ground; and it is large enough for a horse to be used for haulage, with a double line of rails for the whole of the distance. Their principal workings last year were confined to the Golden Age and Reuben Parr Lodes. The Golden Age Lode was cut at the level of the low adit, but so far as has been tested it did not prove payable for working; but on rising 200ft. above this payable stone was obtained. In some places this lode is over 20ft. in width, all stoped out and sent to the battery. The Reuben Parr Lode has been found payable to within 140ft. of the adit-level, the shot of gold extending for 230ft. along the lode. This lode and that of the Golden Age joins at about 108ft. above the adit-level, where one would naturally expect to find good stone. But it is not so in this case. A good deal of the gold is obtained from small veins of quartz branching off the main lodes, and interlacing the sandstone formation. During the last year sixty wages-men and fifty-five tributers were employed by this company, and 9,988 tons of quartz crushed on behalf of the company, which yielded 4,493oz. of gold; and for the tributers, 1,252 tons of quartz, which yielded about 639oz. of gold. At the time of my recent visit they were keeping thirty heads of stamps going night and day. Taking the returns from this company's balance-sheet for the year ending the 31st October last, there were about 9,027 loads of quartz crushed for the company, yielding 6,099oz. gold; and 1,318 loads crushed for tributers, which yielded about 1,136oz. gold. Taking the total number of loads crushed at the battery—namely, 10,345, and the wages and expenses in connection with the crushing-battery, which were £2,798 14s. 7d., it shows the actual cost of crushing as 5s. 4¾d. per load; but as each load averages fully 1½ tons, the cost of crushing would be about 3s. 7½d. per ton: the cost of mining, taking mine-wages and mine-expenses, which amounted to £10,108 6s. 3d., being the cost of getting 9,027 tons of quartz, equal to about £1 2s. 4¾d. per load.

Saxon Company.—This company's mine has been the largest gold-producing mine on the Thames field for the last three years, more men haveing been employed on wages during that period than in any other mine on the field. Recently the company have abandoned the lower workings where they were getting the gold. It is said that they have gutted out the best of the lode from No. 6 level, and that they propose to work the blocks of stone in the top levels on tribute. They were working at a deeper level than any company on the field, and had to pay a heavy contribution towards drainage—£97 10s. per month. Now that they have come up to the upper levels the drainage contribution is reduced to £43 per month. The suspension of this company's mining operations at the deep levels will be felt by many business people on the Thames, as it has been the means of throwing about ninety-two wages-men out of employment. According to statistics supplied me by the manager, the results of the company's mining operations for three years and two months prior to stoppage were 30,585 loads of quartz and 3,330lb. of picked stone crushed—equal to 45,800 tons—which yielded 24,345oz. gold, representing a value of £66,346 10s., showing an average yield of 10dwt. 16gr. of gold per ton. During the above period, £2,500 was paid in calls and £12,500 in dividends. Deducting the dividends from the value of the gold produced it shows that £53,846 was the actual expenditure in connection with mining and crushing operations. This is equal to an expenditure of about £1,417 10s. per month, which may be said to have been expended principally in the Thames Borough. The results of working the mine last year were not so encouraging as in former years, as, according to the directors' report at their

last annual meeting, there was a loss of £1,111 on the year's operations. The balance-sheet for the year ending the 28th January last shows that 7,385 loads of quartz and 1,143lb. of picked stone —equal to about 11,000 tons—were crushed, which yielded 4,672½oz. gold, representing a value of £12,895 8s.; cash from sundry crushings £65 18s.; making the total receipts £12,961 6s.: while the expenditure on mining operations amounted to £11,556 19s. 3d.; in connection with crushing-plant, £2,090 8s. 9d.; and in connection with office-expenses, £355 9s. 9d.; making a total expenditure of £14,006 7s. 9d. This shows a loss on the workings during the above-mentioned period of £1,111. Taking the expenditure on mining operations, and the number of tons of quartz sent to the crushing-battery, the cost of raising every ton of quartz was £1 1s., and the actual cost of crushing 3s. 9½d., making the total cost of mining and crushing £1 4s. 9½d. per ton, or £1 16s. 11½d. per load.

In regard to the future prospects of the mine, Mr. T. A. Dunlop, the mine-manager, in his annual report of the 28th January last, states that "the prospect all along the floor of the No. 6 level is very encouraging—indeed, more so than at any of the upper levels, especially east of the No. 2 break, on all three reefs. Some splendid specimens came from the drives on both No. 1 and new reef, and these two reefs should junction about 75ft. under No. 6 level. Both being strong lodes, and running in a splendid channel of country, there is every reason to believe that the future prospects on the lower level will be even better than from the upper levels." This, coming from the mine-manager, who has been over three years in charge of the mine, and well acquainted with all the workings, is very encouraging to the shareholders, and shows that they have a property likely to continue to be a payable investment, if drainage at a moderate cost can be effected. In order to get drainage, the main level at 640ft. in the Big Pump shaft would have to be extended, or, at least, a drainage-tunnel constructed from this level to the Saxon shaft; and, as the length of this drive would be considerable, and the cost of drainage at 640ft. would be greatly increased, the company consider it more judicious, at the present time, to carry on operations on the upper levels, and to wait for some combined action being taken to test the deep levels on the field. This company was formed in December, 1884. The paid-up capital is £7,083, and the dividends paid amount to £15,417.

May Queen Company.—This company have lately increased their capital from £25,000, in 50,000 shares of 10s. each, to £29,500, in 59,000 shares of 10s. each, and have purchased the whole of the Trenton Company's mining property. The latter company was formed towards the end of 1885, and have been working the ground without meeting with much success. They have, however, proved that by sinking their shaft to a deeper level they will get the same lodes which run through the Saxon ground; but they cannot sink and open out at a deeper level until some combined action is taken for drainage to a greater depth, either by the Big Pump, or other pumping machinery placed on the Queen of Beauty shaft. The Trenton Company have paid up £8,987 in calls, and have liabilities to the extent of £1,212. The May Queen have agreed to given them one share for every four shares held in the Trenton, on condition that the calls owing were paid up. These amount to about £950, and the balance of liabilities due will be paid by the present company. The additional capital is to enable the company to allot the required number of shares to the Trenton Company.

During last year the Trenton Company had an average of ten men employed. They crushed 127 tons of quartz, which yielded 194oz. of gold. The May Queen Company crushed 2,482 tons of quartz, which yielded 2,068oz. of gold, an average of twenty-five men being employed. According to the last year's balance-sheet the value of the gold from the quartz crushed was £5,799, and from tailings £94, making the total receipts in connection with the mine £5,893; while the expenditure amounted to £5,619, leaving a balance to the good of £274. The paid-up capital of this company amounts to £1,667.

Cambria Company.—This company are carrying on operations in their mine on Nos. 2, 3, and 4 levels; the No. 3 level being about 170ft. below the level of the top of the Big Pump shaft. The principal portion of the gold is obtained from small leaders and veins of quartz, similar to those found in the Waiotahi Company's Mine. Their balance-sheet for the year ending December last shows that about 1,272 tons of quartz was crushed, which yielded 1,356oz. of gold, representing a value of £3,734, and that £1,839 was received for crushing quartz for other parties; making the receipts for the year £5,573: while the expenditure in connection with the mine was £4,149; on the crushing-plant, £2,082; and for new machinery, £130; making the total expenditure £6,361. This shows a loss on the year's transactions of £788; but having a cash balance at the commencement of the year of £796, it enabled operations to be carried on without making calls. During the year ending the 31st March last the company had an average number of thirty-three men employed; and 1,900 tons of quartz was crushed, which yielded 1,565oz. of gold, representing a value of about £4,304. The actual amount of capital paid up in calls in this company is £1,181 5s., while the total dividends amounted to £79,357 10s.

Waiotahi Company.—This is one of the most prosperous mining companies on the Thames Goldfield. It has been dividend-paying for the last twelve years, and although the dividends each year do not amount to a large sum, the steady returns make the mining property a valuable one. This is one of the mining companies where it is always a pleasure to inspect the mine, everything being done in a thoroughly workmanlike manner. Most of the gold is obtained from small veins of quartz, branching off from the main lodes, and running through the tufaceous sandstone in all directions. The great aim of the manager of this mine is to mix the quartz from every portion of the mine, and when a rich patch of stone is discovered it is held over as a stand-by to always regulate the monthly yields of gold; by this means the manager is always able to carry on prospecting operations, and open out fresh deposits. This company has been in existence for the last twenty-one years. Its subscribed capital is £18,000, of which £15,000 has been paid up in calls, while £26,250 has been paid in dividends. During last year 2,262 tons of quartz were crushed, yielding 2,859oz. gold; and £2,250 was paid in dividends, being 15 per cent. on the capital invested.

Fame and Fortune Syndicate.—This syndicate is represented by Mr. Kersey Cooper, who has afforded profitable employment to a large number of men for several years past, working ground that formerly was abandoned as valueless. The returns for the last year are not nearly so good as for the year previous. There is still a large quantity of gold in the ground, and richer stone may be again cut at any time. There are several lodes passing through the claim, with auriferous veins of quartz traversing the country rock, branching off from the main lodes. The principal portion of the gold was obtained last year from the upper levels. The low adit level, which was constructed at great expense, did not open out payable ground at the deep levels. During last year thirty men were employed on wages, and ten men as tributers. The wages-men got 1,928 tons of quartz, which yielded 982oz. gold; and the tributers 43 tons of stone, which yielded about 55oz. gold.

The following statement will show all the gold-producing mining companies in the Thames County, with the area of ground held by each, the number of wages-men and tributers employed, and the quantity of quartz and mullock treated during the year ended the 31st March last, with the yield of gold therefrom :—

Locality and Name of Mine.	Area.	Average Number of Men employed.		For Owners.			For Tributers.		Tailings.	
		Wages-men.	Tributers.	Quartz crushed.	Mullock crushed.	Retorted Gold.	Quartz crushed.	Retorted Gold.	Quantity treated.	Gold obtained.
South Hauraki.	A. R. P.			Tons cwt. lb.	Tons.	Oz. dwt.	Tons cwt. lb.	Oz. dwt. gr.	Tons cwt. lb.	Oz. dwt. gr.
Tapu—										
Sheridan's ..	20 3 4	5	..	23 0 0	..	185 0	..	..	..	..
Ball's	4 0 0	2	..	50 0 0	..	34 12	..	..	..	..
	24 3 4	7	..	73 0 0	..	219 12	..	..	..	..
Tararu—										
Norfolk	30 0 0	6	..	20 0 0	..	8 0	..	..	..	..
Sylvia*	179 3 6	50	..	3,480 9 94	..	1,152 12	..	..	..	..
	209 3 6	56	..	3,500 9 94	..	1,160 12	..	..	..	..
Shellback—										
Nordenfeldt ..	15 3 31	1	..	15 0 0	..	9 10	..	..	..	..
Waitemata ..	15 0 0	2	..	25 0 0	..	26 0	..	..	..	..
Mountain Flower ..	13 1 26	2	..	31 0 0	..	69 6	..	..	..	..
	44 1 17	5	..	71 0 0	..	104 16	..	..	..	..
Kuranui—										
Hansen's	14 3 10	13	4	..	8,862	416 15	35 0 40	62 1 0	..	..
Comer's	13 1 37	16	10	..	13,091	753 10	228 0 0	319 5 0	..	..
Hazelbank ..	7 2 11	22	4	2,197 0 0	..	2,049 15	375 0 0	163 11 0	..	..
	35 3 18	51	18	2,197 0 0	..	3,220 0	638 0 40	544 17 0	..	..
Moanataiari—					..					
Moanataiari ..	94 3 26	60	55	9,985 0 0	..	4,493 5	1,252 0 0	638 12 0	..	..
Alfred	10 1 5	4	2	121 0 0	..	92 0	41 0 0	100 12 0	..	..
Freedom	6 1 10	..	3	..	..	..	97 0 0	48 17 0	..	..
Orlando	15 0 0	6	..	350 0 0	..	471 0	..	..	..	..
Calliope	8 0 0	6	..	127 0 0	..	168 19	..	..	..	..
Flying Cloud ..	10 2 30	3	..	82 0 0	..	39 10	..	..	..	..
New Whau ..	..	4	6	40 0 0	..	16 0	109 0 0	656 0 0	..	..
New Alburnia ..	15 1 0	12	10	300 0 0	..	270 0	212 0 0	132 0 0	..	..
Dixon's Extended ..	3 2 18	3	12	..	..	..	4,142 0 0	999 11 0	..	..
New Chum ..	5 0 0	2	..	..	..	83 10	..	..	..	..
	169 0 9	100	88	11,005 1 22	..	5,634 4	5,853 0 0	2,575 12 0	..	..
Grahamstown—										
Saxon	17 1 21	92	..	11,078 0 0	..	4,764 17	..	..	..	..
Victoria	34 1 30	6	6	..	..	..	570 0 0	228 0 0	..	..
Caledonian ..	8 3 12	11	..	243 0 0	..	157 19	..	..	..	..
	60 2 23	109	6	11,321 0 0	..	4,922 16	570 0 0	228 0 0	..	..
Waiotahi—										
Waiotahi	19 3 15	36	..	2,262 0 0	..	2,859 5	..	..	..	..
New Manukau ..	3 0 15	6	..	55 0 0	..	39 18	..	..	..	..
Cambria	15 2 17	33	..	1,900 0 0	..	1,564 19	..	..	..	..
Trenton	22 1 16	10	..	127 0 0	..	197 13	..	..	..	..
Fame and Fortune..	55 0 11	30	10	1,928 0 0	..	981 12	43 0 0	54 14 0	..	..
McCurdy's ..	3 0 0	2	..	18 0 0	..	77 0	..	..	..	..
Berry's	1 0 0	1	..	9 0 0	..	57 9	..	..	..	..
Monarch	..	..	..	23 0 0	..	15 18	..	..	..	..
	119 3 34	118	10	6,322 0 0	..	5,793 14	43 0 0	54 14 0	..	..

*Also bullion, 9,864oz. 7 dwt., value £7,874 5s.

Locality and Name of Mine.	Area.	Average Number of Men employed.		For Owners.			For Tributers.		Tailings.	
		Wages-men.	Tributers.	Quartz crushed.	Mullock crushed.	Retorted Gold.	Quartz crushed.	Retorted Gold.	Quantity treated.	Gold obtained.
South Hauraki—con.	A. R. P.			Tons cwt. lb.	Tons.	Oz. dwt.	Tons cwt. gr.	Oz. dwt. gr.	Tons cwt. lb.	Oz. dwt. gr.
Waiokaraka—										
May Queen ..	29 2 27	25	..	2,482 0 0	..	2,068 9	..	..	..	..
Karaka—										..
Adelaide	12 0 30	..	7	..	..	..	157 0 0	131 0 0	..	..
Lone Hand ..	27 3 35	4	8	..	..	..	283 0 0	467 19 0	..	..
Claremont ..	1 0 0	1	..	3 0 0	..	154 13	..		..	..
E. and M... ..	1 3 10	2	..	0 1 6	..	131 3	..	..	..	..
Hokianga	2 0 36	3	..	65 0 0	..	175 7	..	..	..	..
Karaka	10 0 0	..	..	215 0 0	..	123 0	..	..	..	..
	55 0 31	10	15	283 1 6	..	584 3	440 0 0	598 19 0	..	..
Una Hill and Te Papa—										
Dives	21 3 15	6	..	480 0 0	..	720 0	..	..	..	..
Occidental ..	21 0 9	12	..	439 0 0	..	662 7	..	..	..	..
Pride of Karaka ..	14 3 24	8	..	160 0 0	..	267 10	..	..	..	..
Magnolia	17 2 30	8	..	240 0 0	..	199 14	..	..	..	..
Boyle's (Rox) ..	3 0 22	1	..	8 0 0	..	41 6	..	..	..	..
North Star ..	30 0 0	2	9	..	..	..	101 0 0	217 18 0	..	..
Welcome	3 0 0	2	..	78 0 0	..	51 19	..	..	..	..
Just in Time ..	2 0 0	2	..	133 0 0	..	29 0	..	..	..	..
	113 2 20	41	9	1,538 0 0	..	1,971 16	101 0 0	217 18 0	..	..
Hape Creek—										
Consols	29 3 31	17	10	100 0 0	..	100 16	220 0 0	207 19 0	..	..
Souvenir	14 2 10	2	..	52 0 0	..	24 7	..	..	..	..
	44 2 1	19	10	152 0 0	..	125 3	220 0 0	207 19 0	..	..
Puriri—										
Puriri	4 0 0	3	..	142 0 0	..	47 0	..	..	..	..
Puriri Prospectors ..	30 0 0	3	..	121 0 0	..	173 16	..	..	..	..
	34 0 0	6	..	263 0 0	..	220 16	..	..	..	..
Tairua—										
Bonnie Scotland ..	5 0 0	3	..	124 0 0	..	91 19	..	..	..	..
Sundries	..	18	..	..	..	1,343 12	..	..	17,000 0 0	3,981 15 0
Totals ..	945 1 30	568	156	39,331 12 62	21,953	27,461 12	7,865 0 40	4,427 19 0	17,000 0 0	3,981 15 0

Ohinemuri District.

The mines in this district are looking more promising than at any previous period. Both at Karangahake and Waihi large lodes have proved to be highly payable for working; at Komata also a new lode was discovered last year, 6ft. to 12ft. in width, which is said to have an average assay-value of from £5 to £6 per ton. The mines at Maratoto have not turned out according to expectations. Indeed, they have been very disappointing. Some very rich silver was found on the outcrop, but it could not be traced into the hill for a great length; neither did it go down to any depth. Large blocks of stone have, however, been taken from some of the lodes in this locality, which are rich in silver, and probably a payable lode will yet be found. The plant belonging to the Maratoto Company was sold last year, but it is still on the field, which will enable bulk tests of ore to be made if further discoveries are made. There is a number of quartz lodes between Waihi and Whangamata which have never been prospected; and there is also a large field where auriferous lodes may be found between Maratoto and Waitekauri. Mining in this district is only in its infancy, and there is ample room for a large mining population to be employed.

Karangahake.

This field is looking better than it has done for many years. There are not the same number of claims taken up as in former years, but those that are now held are likely to prove remunerative. The Crown Company, which is principally formed with English capital, has at the present time the richest lode, in proportion to its dimensions, there is in the colony. This company induced the Cassell Company to erect a plant to treat their crushed ore by the cyanogen process, which has proved, so far as experiments have been made with the quantity of ore treated, to extract a higher percentage of bullion than any other process hitherto tried in any of the Australasian Colonies. The Crown Company have now purchased the Cassell Company's plant, and are erecting new reduction works and a large cyanogen plant alongside of the Ohinemuri River, about 15 chains lower down than the township.

Some two years ago a new lode was discovered in the Crown Company's property, which was far richer than anything found on their old workings. They are now engaged in constructing three levels, the upper one is termed No. 4, and it is about 120ft. above the No. 6 level. The upper levels on which the company was floated did not yield anything like the quantity of bullion expected from them, and at one time it was almost thought the venture would prove a failure; but some two years ago a new lode was discovered at each side of the gorge of the Waitawheta Creek, about 10 chains lower down than their crushing-plant. This lode showed by assay to contain rich ore, but the financial position of the company when the lode was discovered would not admit of prospecting operations being largely carried on. Last year a considerable amount of work was done on this lode; three levels are being constructed, one about 20ft. above the level of the creek on both sides of the gorge, and one on the southern side of the creek, about 120ft. above the lower level, having an intermediate level between. The lode in the lower level is from 6ft. to 10ft. wide, but only from 4ft. to 5ft. of the lode next the hanging wall is taken out, the portion of the lode next the foot-wall being low-grade ore. On the upper level the lode is taken out from 2ft. to 4ft. wide, but the quality of the ore is not so good here as at the lower level; the deeper they get the ore appears to get richer. Some of these levels are now constructed for a distance of 200ft. on the south side of the creek, and 70ft. on the north side, the lode having a northerly and southerly direction, and dipping at an angle of about 55° to the westward. At the time of my visit gold could be freely seen in the stone in any face, in these levels; and the manager, Mr. McConnell, informed me that the value of the ore treated by this company during the three months prior to my visit averaged £15 per ton.

The present crushing-plant consists of two Lamberton mills which crush from twenty tons to twenty-five tons of ore per week, working two shifts of eight hours each; and the value of the bullion extracted for the three months previous to my visit was £1,550, £1,500, and £1,250 respectively, making a total value of £4,300 worth of bullion extracted from about 288 tons of ore. The lode consists of hard compact quartz having scarcely any mullock mixed with it, this makes the ore easily treated by the Cassell process. The greatest difficulty in treating ore with cyanogen solution is the question of filtration, as ore producing much slime makes filtration a slow process. The company have commenced to erect a new plant on the flat alongside the Ohinemuri River, about 15 chains below Karangahake Township, and have constructed a tramway through the gorge of the Waitewhata Creek to connect the mine with the new plant. Judging from the present appearance of this company's mine it is likely to form one of the best mining properties in the colony.

Woodstock and Kenilworth Company.—This company's ground adjoins the Crown Company's western boundary; but the lode is entirely different, and the ore is also of a different character, there being far more silver than in the Crown lode, and it is not nearly so large, being only from 6in. to 2ft. in thickness. For two years previous to last year, the mine was let on tribute, and two hundred tons of ore was taken out, which Mr. McCombie, the manager, informed me had an assay-value of £12,000, but it only realised about 50 per cent. of this value. At the time of my visit six men were employed in the mine, and the lode they were working on had a thin clay seam or parting in the centre; on one side of this seam the ore was greatly oxidized, and the manager stated that the assay-value of this was from £15 to £20 per ton, while on the other side of this parting the ore contained a great deal more mineral, and had an assay-value of from £40 to £50 per ton. The company have a small plant of their own, where they treat some of the oxidized ore, but the refractory ore is stacked waiting the erection of the new plant belonging to the Crown Company, which is being erected as partially a custom plant. There is little doubt that when this new plant is erected, many of the former claims that were previously given up will be taken up again and made pay for working.

Ivanhoe and Truro Mines.—These were formerly two distinct mining properties, but they are now amalgamated and held by Mr. C. Percy Cox, who has been carrying on prospecting operations only for some time. The same line of reef passes through this ground as that now being worked by the Crown Company, and yielding bullion to the average value of £15 per ton for the last three months' work. The same lodes also that are being worked in the Woodstock Mine pass through the ground. Large boulders are found on this property very rich in bullion, but the lode has not been yet discovered where these boulders have come from. The only lode worked in the Ivanhoe Mine is that termed No. 2, which has an average thickness of about 4ft. It has been worked to a depth of 200ft., and about £18,000 worth of bullion taken from it.

Waihi Company.—This company since my last visit have sunk a new shaft alongside the battery building, to a depth of about 50ft., and have opened out at this depth on the Union lode, connecting the level with the drainage tail-race to the Ohinemuri River. After cutting the lode, they have driven on it to the eastward for 186ft., and to the westward about 70ft., but the quality of the ore is much better on the eastern end, where stoping is being carried on, and the quality of the ore seems to improve towards the surface. The lode varies from 2ft. to 5ft. in thickness, and averages from 1oz. to 2oz. of gold per ton. The bullion contains about 4oz. of silver to, say, 1oz. of gold. Very little can be said yet in reference to this lode, as it is not prospected for a great distance, but there is certain to be a considerable quantity of ore between this level and the surface, and some very rich ore was found in the surface workings in the Union and Rosamond Mines, which now form portion of this company's property. They cannot, however, test the lode to a greater depth until pumping machinery is erected, and there is likely to be a considerable quantity of water to contend with, judging from the flow in the present level.

In the Martha Mine the whole of the lode has been stoped out between the smithy and intermediate levels, as far as the shot of rich ore continued, and the workings are now above the intermediate level, and also on the surface, where they are quarrying out the lode in a face. A winze has been sunk from the smithy level, and at a depth of 40ft. a cross-cut was made through the lode, which proved to be 24ft. wide, containing good ore. A low level is in course of construction, and was in for a distance of 700ft. at the time of my visit. It will, however, require to be constructed for

another 750ft. before it will cut the lode. When this level is completed it will give 55ft. of backs to the smithy level. After the lode is taken out to this depth further workings will have to be carried on from a shaft, as this is the lowest level that can be constructed to bring out the ore on a natural gradient to the calcining-kilns.

During the year ending the 31st March last 11,319 tons of quartz have been crushed, yielding 18,408oz. of bullion, which is said to have an average value of £1 4s. 11d. per ounce. This would represent a value of about £23,002. But according to the returns published in the Thames *Advertiser* in April last, the value of bullion produced from July, 1889, to April 8, 1892, was £55,513, and, taking the figures from April, 1891, to 8th April, 1892, the value of the bullion produced for this period was £28,525, which is £5,523 more than the estimated amount already shown for last year. The return is now, however, increasing largely, the value of the bullion obtained in May last being £5,000; also, during the same period an average of ninety men have been employed in the mines, and sixty men in connection with the crushing-battery and surface.

Since my last visit an additional crushing-battery of thirty heads of stamps (American pattern) has been erected and used as a wet-crushing battery, while the thirty heads formerly erected are still used for dry crushing. Before giving the comparative results of dry and wet crushing, a description of the new additional plant may not be out of place, as the process of treatment of the pulverised ore, and methods used, are entirely different from those adopted at any other crushing-plant, with the exception of the one recently erected by Mr. Russell at Waitekauri, which is a fac-simile of the plant in question.

The stamps are 900lb. each, making ninety-two blows per minute, with a drop of six inches. The gratings are made of brass-wire gauze, 60 mesh, or 3,600 holes to the square inch. The water and pulverised pulp falls into a narrow chute, which runs along the whole width of the battery, close up against the stamp-mortars. This chute conveys all the water and pulp outside the building, where an elevating iron wheel is erected having buckets on the inside of the rim. The chute delivers the sand and water into the buckets, and the wheel, which is 26ft. in diameter, and about from 12in. to 15in. in width, in breast conveys the material up to a height of about 24ft., the wheel making two and a half revolutions per minute. This elevating wheel is far preferable to the common elevators, and the wear and tear is almost *nil*. This elevating wheel delivers the water and pulp into a chute, which conveys it away to a series of settling-tanks.

The settling-tanks are erected on heavy framing, so that a truck can pass underneath the trap-doors, from which the sand and sludge is discharged when the tanks are full. There are seven large tanks, each 16ft. by 14ft. and 14ft. deep, placed alongside each other; three of these tanks are used for settling the coarse sands, and four for the settlement of the sludge and slimes. The tanks for the coarse sands have an inverted Λ bottom, having two cast-iron doors on each side of each tank, from which the sand is discharged into a truck; but during the time the water and pulp is filling the tank, the cast-iron door is held fast against an indiarubber joint with set-screws. The four tanks for the settlement of the fine sludge and slimes have a V-shaped bottom, with valves which can be opened to allow the slimes to fall into trucks; these trucks, when full, are run on to a cage and hoisted up to the level of the floor where the combination-pans are placed, by a hydraulic lift. The water after leaving the last tank is tolerably clear, and flows away in a chute, and is used again with a little additional water in the battery, so that as far as possible any loss of gold in the water is prevented.

The process for extracting the gold is exactly similar to that described in my last report—namely, amalgamation in combination-pans and settlers, only; no sulphate of copper is now used, but to every charge of 1,600lb. of wet ore 8lb. of salt is added, and 150lb. of mercury; steam is used in each pan, and the temperature kept up to about 180°. About four hours is necessary for each charge. The charge of dry ore in each pan is 1,800lb., being 200lb. more than that of the wet ore. The fine slimes from the wet-crushed pulp are of too thin a consistency to amalgamate in the pans; these slimes have to be mixed with either dry pulverised ore, or the coarser material from the wet-crushed pulp, before a satisfactory result in the extraction of the bullion is obtained.

In regard to the comparative results of treating the dry-crushed ore and the wet pulp, the percentage of bullion obtained is in favour of the dry-crushed ore. In treating the dry-pulverised ore from the Union mine about 85 per cent. of the gold is obtained, and from the wet pulp about 75 per cent. The Martha does not give quite so high a percentage, about 70 per cent. and 60 per cent. respectively, but the silver saved from the dry ore is said to be 40 per cent. of the assay-value, whereas from the wet pulp only about 25 per cent. is extracted.

When the wet crushing-battery was first started the ore was crushed in its raw state as it came from the mine, the grating used being 60-mesh, the same as that used for dry-crushing; but it was found that this mesh of iron- or steel-grating got clogged up very quickly, and consequently would not discharge the pulp. Brass-wire gauze gratings were then used and found to answer very well, but it was found that no larger quantity of ore could be crushed by the wet battery than by the dry one, while the ore was not pulverised so fine. This led to an experiment being made with calcined ore, which increased the crushing capacity of the wet battery about 30 per cent. The whole of the ore is now calcined previous to crushing, and the result is that about 30 per cent. more ore is crushed by the wet battery than by the dry one, while the bullion extracted from the dry ore is fully 10 per cent. more than is obtained from the wet pulp.

The whole of the shafting for driving the crushing-battery, pans, and settlers, is connected and driven by six Pelton water-wheels, each 6ft. in diameter, three of which are supplied with water from the Ohinemuri River, and three from another creek and reservoir. The rock-breaker—one of Wheeler's—the movable jaw of which has an eccentric motion, and produces a squeezing and grinding action at the same time, is driven by a 3ft. Pelton wheel, the steam-engine only being used for driving the battery when water is scarce.

This company are now constructing a plant to treat their pulverised ore by a cyanogen solution similar to the Cassell process in some respects, but by an entirely different method of application. The process is known as "Bohm's patent." Mr. Bohm was at Waihi constructing his plant at the time of my visit. Instead of the pulverised ore being placed in large vats or agitators, as is done

by the Cassell Company, it is placed in cast-iron cylinders, having hollow trunnion axles in the centre, similar to the cylinders of an oscillating steam-engine. These cylinders are placed in an upright position on a frame. The tank containing the cyanogen solution with other salts is placed adjoining the cylinders, and a force-pump is used to force the solution up through the ore and return it into the tank; thus the same solution is used over and over again, and if it is found that the slimes tend to make the ore too compact, the cylinder is reversed on its trunnions, and the solution again easily forced through the ore. Mr. Bohm has kindly given me tracings and descriptions of his plant, which will be found in this report under the heading "Mining Machinery."

Silverton Company.—This company has purchased the crushing plant formerly belonging to the Martha Company. They have altered the crushing-battery so as to make a battery of five stamps act as a stone-breaker. There is a very coarse grating in this battery, to admit of the quartz being reduced to the size of small peas. The reduced ore passes into a battery of ten heads of stamps, and there pulverised to sufficient fineness for amalgamation, the ore being treated by a similar process to that used by the Waihi Company.

The mine which adjoins the Waihi Company's property has an entirely different lode from that either going through the Martha or the Union and Rosamond Mines. At the time of my visit they were quarrying the lode on the surface, where it is in some places 12ft. in width, and suddenly narrows in to 3ft. in other places; but where the lode widens out there is generally a large portion of it containing very low-grade ore. They were, however, getting very good ore at the time of my visit. The lode is stoped for a considerable distance up from the level first constructed; but, as the outcrop of the lode contains a great many loose boulders, the manager considered it more prudent to quarry the top portion instead of stoping it from the level. They have also commenced to construct a new level 75ft. below the present one, but this will take a good while yet to complete, as they have about 1,800ft. to drive before cutting the lode.

Waitekauri.

Mining operations have not been carried on here successfully during last year. It was anticipated, when Mr. Russell purchased the crushing-battery and affected such alterations as to make it similar to the wet-crushing plant constructed by the Waihi Company, it would revive mining in this locality; but the result has proved very disappointing. It is evident from the returns of the crushed ore last year that Mr. Russell had not tested the value of the lode in his Waitekauri property before commencing to expend money on his crushing-plant, as during last year 1,500 tons was crushed for a yield of 131oz. 11dwt. of gold, which would be an average of about 1dwt. 18gr. of gold per ton. This ore had to be brought about two miles by tramway to the battery. The loss on working, therefore, must have been very considerable. During last year a new lode was discovered at Komata by some of the former students of the School of Mines at Thames, and it is said that Mr. Russell gave them £3,000 for their property. The lode varies from 3ft. to 12ft. wide. A level has been constructed about 120ft. below the outcrop, and about 70ft. driven on the lode. Mr. Russell estimates the average assay-value of the ore will be from £5 to £6 per ton. He constructed a sleigh-track, and brought 100 tons of the ore over the range to his battery, which yielded 450oz. of gold, being an average of 4½oz. of gold per ton. He is now constructing a tramway to connect the mine with the battery, at an estimated cost of about £2,000.

Te Aroha District.

The mining industry in this district has not been in a prosperous condition for the last few years. Nevertheless, it is a goldfield that promises yet to come to the front and be capable of supporting a large mining population. The Te Aroha Gold and Silver Company suspended operations, about three years ago, and owing to their holding a large area of ground, it was virtually kept locked up for a considerable time, until all their property was sold by the liquidators. This prevented the mining population which was then in the district from carrying on work on the land held by the company, but which was afterwards thrown open to the public by the purchaser of the company's property. When once a state of depression in a district sets in it takes in many instances several years to recover. There is not a goldfield in the colony that offers better facilities for prospecting, but to carry on prospecting operations systematically would entail a large capital.

Several years ago, when Messrs. Firth and Clarke held the Waiorongomai crushing-battery, and mines in that locality, Mr. Firth prepared a scheme to test the ground, and one which there was every reason to believe would prove a successful venture. This scheme was to drive an adit-level on the main lode, which can be followed on the outcrop for a distance of about three miles. This adit was to be started a little distance above the level of the Waiorongamai Flat, and to be carried on along the lode, with uprises here and there at certain distances apart. The Te Aroha Gold and Silver Company also proposed another scheme before they suspended operations, which was to construct a cross-cut from the level of the tramway to cut the main lode, and afterwards to drive along it for about 2,000ft.; but before undertaking this work they wanted a subsidy from the Government of about £15,000, which was declined, consequently the work was never undertaken. The greater portion of the gold got in the district has been obtained from this main lode, and in some places the whole of it, for a width of 12ft., was taken out and sent to the crushing-battery. Shots of gold have been found in this lode in several of the mines, and a considerable distance apart; and there is every reason to believe that if systematic prospecting operations were carried on further rich discoveries would be made.

There were four gold-producing claims in this district last year, in which twenty-one men were employed, exclusive of eight tributers. There were 1,597 tons of quartz crushed, which yielded 670oz. 7dwt. gold; and 1,125 tons of tailings were treated, for 308oz. 5dwt. gold.

The following is a statement showing the number of tons of quartz crushed in the Ohinemuri and Te Aroha Districts during last year by the several companies, with the area of ground held by each, and the quantity of gold obtained:—

Locality and Name of Mine.	Area.	Average Number of Men employed.		Owners.			Tributers.		Tailings treated.		Value of Ore sold.
		Wages-men.	Tributers.	Quartz crushed.	Gold obtained.	Bullion.	Quartz crushed.	Gold obtained.	Quantity.	Gold obtained.	
	A. R. P.			Tons.	Oz. dwt.	Oz. dwt.	Tons.	Oz. dwt.	Tons.	Oz. dwt.	£
Ohinemuri County—											
Maratoto—Maratoto	30 0 0	4	..	135	..	629 0	..	..	..	..	..
Karangahake—Ivanhoe and Truro ..	42 0 0	6	..	136	119 0	..	..	..	..	..	..
" Woodstock.. ..	30 0 0	6	..	98	280 0	..	..	..	..	..	2,431
" Crown	116 0 0	55	..	202	..	1,186 10	..	..	..	..	..
" Adeline Amalgamated	36 2 34	..	3	..	..	..	21	77 13	..	..	..
" Imperial	10 2 14	1	..	3	12 0	..	..	..	..	..	..
Owharoa—Smile of Fortune ..	12 3 2	..	6	..	..	..	341	333 15	..	..	..
Waitekauri—Waitekauri	9 2 23	20	..	1,500	131 11	..	..	..	..	..	..
" Jubilee	103 0 15	12	..	10	..	..	..	..	..	..	150
Komata—New Find	13 0 0	10	..	100	..	450 0	..	..	..	..	..
Waihi—Waihi	294 0 0	160	..	11,319	..	18,407 15	..	..	..	..	..
Sundries	..	45	..	..	68 0	..	..	..	..	..	..
Totals	697 3 8	319	9	13,503	610 11	20,673 5	362	411 8	..	..	2,581
Piako County—											
Te Aroha—Waiorongomai	..	..	..	..	..	..	..	..	..	..	..
" Te Aroha	20 2 32	10	..	640	331 8	..	..	..	1,125	308 5	3
" Ferguson's Special ..	66 0 0	..	4	..	..	..	806	251 7	..	..	..
" Werahiko	..	..	2	..	..	..	22	12 17	..	..	..
" Warrior	..	..	2	..	..	..	89	40 19	..	..	..
Sundries	..	12	..	40	33 16	..	..	..	..	..	..
Totals	86 2 32	21	8	680	365 4	..	917	305 3	1,125	308 5	..

Summary of Results of working the Mines in the North Island during the Past Year.

The annual statement will show that during the last year the whole of the mining properties in the North Island goldfields on which a fair amount of work was done comprised an area of 2,398 acres. There were 1,148 wages-men and owners employed, and 209 men working on tribute, making the total number of men employed in connection with the mines, exclusive of those prospecting at Puhipuhi, 1,357. About 75,256 tons of quartz and 21,953 tons of mullock were crushed, which yielded 45,628oz. 18dwt. of gold, and 30,537oz. 12dwt. bullion. Also, 18,660 tons of tailings were treated, which yielded 4,434oz. 13dwt. gold, making the total gold produced last year to be 50,063oz. 11dwt., representing a value of about £139,641. The value of the bullion produced is estimated at £33,849; and the value of ore sold last year being £2,581, making the total value of the produce of the goldfields last year £176,071; the estimated value of the produce for the previous year being—gold, 49,747oz. 14dwt., representing a value of £128,416; bullion, 42,574oz., valued at £26,325; value of ore sold, £4,598, making a total value of £159,249. The results of working the mines in northern districts last year show the produce to have a value of £16,822 more than for the previous year, while there have been thirty-three men less employed. Taking the number of men employed on the Hauraki Peninsula last year, and the value of the produce, their average earnings have been about £129 16s. 6d. a man per annum.

Name of County.	Area of Ground held.*	Number of Men employed.		Owners.			Tributers.		Tailings treated.		Bullion.	Ore sold.
		Wages-men.	Tributers.	Quartz crushed.	Mullock crushed.	Gold obtained.	Quartz crushed.	Gold obtained.	Tons.	Oz. dwt.	Oz. dwt.	£
	A. R. P.			Tons cwt. lb.	Tons.	Oz. dwt.	Tons cwt. lb.	Oz. dwt.	Tons.	Oz. dwt.	Oz. dwt.	£
Coromandel ..	668 0 23	240	36	12,203 1 40	..	11,170 16	391 10 0	875 15	435	144 13	..	..
Thames ..	945 1 30	568	156	39,331 12 62	21,953	27,461 12	7,865 0 40	4,427 19	17,000	3,981 15	9,864 7	..
Ohinemuri ..	697 3 8	319	9	13,503 0 0	..	610 11	362 0 0	411 8	..	..	20,673 5	2,581
Piako ..	86 2 32	21	8	680 0 0	..	365 4	917 0 0	305 3	1,125	308 5	..	..
Total ..	2,398 0 13	1,148	209	65,717 13 102	21,953	39,608 3	9,535 10 40	6,020 5	18,660	4,434 13	30,537 12	2,581

* The acreage is for mines on which a fair amount of work has been done, and not for mines that have been unworked.

Estimated Value of Total Returns.

	£ s. d.
Gold	139,640 18 0
Bullion..	33,849 0 0
Ore sold	2,581 0 0
Total	176,070 18 0

The following statement shows the whole of the quartz-crushing machines and appliances for treating auriferous and argentiferous ores in the Hauraki Mining District for the year 1891–92:—

Locality where Machine is situated.	Name of Machine.	Number of Rock-breakers.	Number of Stamps.	Number of Ore-crushers and Lamberton Mills.	Number of Berdans.	Number of Pans.	Number of Settlers.	Number of Mortars.	Number of Retorts.	Number of Furnaces for Gold-melting.	Number of Furnaces for Assay Purposes.	Number of Plants for Cyanide Treatment.	Concentrating Plant.	Driven by Steam-power.	Driven by Water-power or Hand-power. W.	H.
Coromandel County—																
Coromandel	Kapanga	..	10	..	2	..	..	1	2	..	..	..	..	1	..	
"	Telephone	..	15	..	1	..	..	1	2	..	..	..	..	1	..	
"	Corby	..	9	..	8	..	..	1	2	..	..	..	..	..	1	0
Tokatea	Tokatea	..	15	..	2	..	..	1	5	..	..	..	..	1	..	
"	Kelly's	..	..	..	..	..	..	1	1	..	..	..	..	..	0	1
Opitonui	Langford's	..	..	..	..	..	..	1	..	..	..	..	..	..	0	1
"	Lanigan's	1	10	..	2	..	..	1	2	..	..	..	..	..	1	0
Owera	Owera	1	10	..	4	..	..	1	2	..	..	..	..	..	1	0
Kuaotunu	Try-fluke	..	11	..	3	2	..	1	2	..	..	..	..	1	..	
"	Great Mercury	..	10	..	1	4	2	4	1	..	1	..	..	1	..	
"	Red Mercury	..	10	..	1	4	..	1	2	..	..	..	..	1	..	
"	Curtis's	..	10	..	2	4	..	1	2	..	..	..	..	1	..	
Thames County—																
Tapu Creek	Pepper's	..	15	..	3	..	..	3	3	1	..	..	..	..	1	0
"	Bulls's	..	6	..	2	..	..	1	1	..	..	..	..	1	..	
Waiomo	Monowai	1	..	..	1	4	2	1	1	..	..	..	..	..	1	0
Karioi	Bone-mill	..	3	..	..	1	..	1	1	..	..	1	..	1	..	
Tararu	Sylvia	..	10	..	1	..	..	1	1	1	1	1	1	..	1	0
"	Dixon's	..	28	..	7	2	..	1	1	..	..	..	..	..	1	0
"	Norfolk	..	14	..	6	..	..	1	4	..	..	..	..	..	1	0
Karaka	Claremont	..	..	..	1	..	..	1	1	..	..	..	..	..	1	0
"	Taylor's	..	6	..	3	..	..	1	1	..	..	..	..	..	1	0
"	Lovatt's	..	..	..	20	4	..	1	3	1	..	..	..	..	1	0
"	Karaka	..	5	..	2	1	..	1	1	..	..	..	..	..	1	0
Mount Pleasant	Day's	..	..	..	..	..	..	1	..	..	1	..	..	..	0	1
Otunui	Eureka	..	12	..	4	..	..	2	1	..	..	..	..	1	..	
Puriri	Puriri	..	6	..	2	..	..	1	1	..	..	..	..	..	1	0
"	Gillon's	..	16	..	4	..	..	1	1	..	..	..	..	..	1	0
"	Cooper's	..	4	..	1	..	..	1	1	..	..	..	..	1	..	
Tairua	Bonnie Scotland	..	10	..	4	..	..	1	1	..	..	..	..	1	..	
Thames Borough	Brown's	..	..	..	4	8	4	..	2	..	..	..	..	..	1	0
"	Climo's	..	..	..	..	..	..	1	..	..	1	..	..	..	0	1
"	Berry's	..	1	..	3	..	..	1	2	..	..	..	..	..	1	0
"	Horne's	..	..	..	1	3	1	1	1	..	..	..	..	..	1	0
"	Kuranui	..	20	..	10	..	..	1	1	..	..	..	..	..	1	0
"	Moanataiari	..	41	..	21	1	..	3	4	..	..	..	..	..	1	0
"	Onslow	1	..	..	2	9	..	..	..	1	..	..	..	..	1	0
"	Comer's	..	20	..	5	..	..	1	2	..	..	..	..	..	1	0
"	Bawden's	..	..	..	2	13	..	..	1	..	1	..	..	..	1	0
"	Saxon	..	33	..	8	3	..	2	3	1	1	..	..	..	1	0
"	Cambria	..	21	..	13	1	..	1	2	..	..	..	..	..	1	0
"	Waiotahi	..	21	..	5	..	..	3	2	..	..	..	..	1	..	
"	Fame and Fortune	..	21	..	16	..	..	1	2	..	..	..	..	..	1	0
"	Hematite	..	1	..	..	2	..	..	..	..	..	..	..	..	1	0
"	School of Mines	..	2	..	1	1	1	1	2	1	1	..	..	..	1	0
"	Bank of New South Wales	..	..	..	..	..	..	1	..	1	1	..	..	..	0	1
	H. P. Stark	..	..	..	..	..	..	..	..	..	1	..	..	..	0	1
"	Bank of New Zealand	..	..	..	..	..	..	2	..	1	1	..	..	..	0	1
"	M. von Bernewitz	..	..	..	..	..	..	..	..	..	1	..	..	..	0	1
"	Pahau Street	..	..	..	3	2	..	..	1	..	..	..	..	..	1	0
"	Peel's	..	..	..	..	..	..	1	..	1	..	..	..	..	0	1
"	Bulls's	..	23	..	14	..	..	2	6	1	1	..	..	..	1	0
"	Fairmile	..	..	..	1	..	..	1	..	1	..	..	..	..	0	1
Ohinemuri County—																
Maratoto	Maratoto	..	..	..	..	2	1	1	2	1	..	..	..	..	1	0
Paeroa	C. Rhodes	1	..	..	..	..	..	2	1	1	1	..	..	..	0	1
Karangahake	Crown	1	..	3	..	..	..	1	2	..	..	1	..	..	1	0
"	Ivanhoe	..	4	..	..	2	1	1	2	1	..	..	..	..	1	0
Owharoa	Smile of Fortune	..	15	..	2	..	..	1	2	..	..	..	..	..	1	0
Waitekauri	Waitekauri	1	30	..	..	6	3	1	4	..	..	..	..	..	1	0
"	Jubilee	..	10	..	5	2	1	1	2	..	..	..	..	1	..	
"	Mangakara	..	9	..	3	..	..	1	2	..	..	..	..	..	1	0
Waihi	Waihi	2	60	..	..	16	8	2	6	1	1	..	..	1	1	0
"	Silverton	..	15	..	1	2	1	1	3	..	..	..	..	..	1	0
Piako County—																
Waiorongomai	Te Awha	1	20	..	30	6	..	2	4	1	1	..	..	..	1	0
City of Auckland—																
"	Young's	..	2	..	..	2	2	1	2	..	1	..	..	1	..	
"	Bank of New Zealand	1	..	..	..	1	1	2	6	4	2	..	..	..	0	1
"	Stanley Street	..	..	1	1	2	2	2	2	1	1	..	..	1	..	
		11	614	4	218	110	30	77	117	21	19	3	1	17	38	12

Marlborough District.

Waikakaho.

There has been a considerable amount of work done on the quartz-lodes in this district by the Ravenswood Company. The mine on the Waikakaho side of the range has been opened out on three levels. The upper level has been driven on the lode for 157ft., having 180ft. of backs. The second level is in 329ft., and 235ft. under the upper level, and the lower level is 159ft. under the second, and in for about 160ft. In constructing the lower level a new lode was cut carrying gold, running parallel with the main lode. These two lodes run in a northerly and southerly direction, and dipping to the eastward at about ¼ to 1. An uprise has been constructed from the lower level to the surface for about 100ft., which is connected with a chute from the second level, but there is no connection yet made with the upper level. Several hundred tons of stone are stacked at the mouths of the levels ready to send to the crushing-battery as soon as the aërial tramway is completed. The manager (Mr. Turner) and managing director (Mr. Logan) are very sanguine as to the payable results of the stone, which, they state, has been carefully prospected; but, judging from the appearance of the stone in the paddocks, rich returns need not be expected. Still at the same time, with the large quantity of stone available, and a good crushing-plant, low-grade ore will pay for working.

At the Mahakipawa licensed holding, which is about 30 chains from the saddle, on the Mahakipawa side of the range, an adit has been constructed for 400ft., where it cut some quartz, but no payable stone has yet been struck in this level. The lode on the surface does not appear to have gone down, or else there has been a break, and it is not cut yet. They are still continuing the adit, and are getting water in the face, which would indicate that they are near a quartz lode, or some watercourse. Even if payable stone be struck here it will take some time before it can be worked, as another tramway will have to be constructed to connect with the one from the lower level on the Waikakaho side of the range.

Aërial Tramway.—An aërial tramway has been constructed from the lower level on the Waikakaho side to the crushing-battery in the Waikakaho Valley for a distance of three miles, the fall being about 1,700ft., or 1 in 9·3. This fall is found to be sufficient to make the tramway self-acting. An overshot water-wheel, 27ft. in diameter and 3ft. 6in. breast, has been erected, to work the tramway at the battery end, the water after it leaves the Pelton wheels, which drives the crushing and concentrating appliances, being again used to work the overshot wheel; but after the tramway was completed they found the overshot wheel was not required. This aërial tramway is the longest yet erected in the colony, and, in addition to this, it could not be constructed in a straight line, as all the other tramways are that are in use in New Zealand; at about one mile from the crushing-battery it bends round an internal angle of about 115°. At this point there is one horizontal grooved pulley-wheel on top of the trestles similar to that used at the terminal end, and two pulley-wheels of the same diameter fixed on an incline, so as to form a sort of loop, bringing the rope which conveys the empty buckets about 10ft. under the rope carrying the full buckets, so as to allow the empty buckets to pass under the full ones. The rope coming from the inclined grooved pulley-wheels is again supported by vertical small pulley-wheels of the same diameter as those used for bearing-pulleys on top of the trestles. At the time of my visit they had commenced to put the buckets on the rope, and expected to be ready in about fourteen days from that date to send down quartz to the battery; but, judging from the manner in which the trestles are placed, some considerable alterations will have to be made before the tramway will work satisfactorily. The terminal end of this tramway at the battery, instead of being set at a high inclination so as to take up the slack of the rope, is placed truly horizontal, so that as the rope stretches it will have to be cut and spliced again.

Crushing-battery.—This is really a first-class plant, and well erected. It consists of a stone-breaker, ten heads of stamps, quicksilver-tables, and four Frue vanners. The ore is dumped from the buckets on the aërial tramway into a hopper; thence it passes from the top hopper over a grizzly, made of railway-rails, set about 1¼in. apart, the flat side being upwards. The fine material passing through the grizzly falls into a second hopper, and the coarse pieces of ore fall on to a floor, and thence are fed into the rock-breaker. The crushed material from the rock-breaker falls into the same hopper as the fine material from the grizzly. This second hopper has two doors and chutes, from which the material passes into two Challenge ore-feeders, which in turn feed the stamps. The pulverised material from the stamps passes over quicksilver-tables about 12ft. in length, and thence into different pipes which convey it on to the Frue vanners. The whole of the machinery is arranged so that at every stage of the process the material passes from one to the other by gravitation; no manual labour is required, with the exception of feeding the ore-breaker. The whole of the machinery is substantially erected and well arranged. The stamps and rock-breaker are driven by a Pelton water-wheel 6ft. in diameter with 8in. face, and the Frue vanners are driven with another Pelton wheel of the same diameter having a 6in. face.

Water-supply.—The water for supplying the Pelton wheels and battery is lifted out of a branch of the Waikakaho Creek, and brought for a mile and a half in steel pipes of No. 12 B.W.G., 15in. in diameter, and, having a fall or head at the battery of 250ft., is capable of conveying about four sluice-heads of water. One-half of this quantity will be required to drive the stamps and rock-breaker at their proper speed. The manager has had a great deal of trouble with the water-pipes, sufficient supervision not having been exercised during their construction. They are now tolerably water-tight, but the pipes being laid in a tortuous manner, with a number of bends, will no doubt greatly reduce the head by friction, especially if they are required to convey water up to their carrying capacity.

There is no provision made for storing the tailings, but there is ample room on the battery-site for large pits to be constructed if it is found that there is sufficient gold left to pay for re-working them.

Nelson District.

Collingwood.

Johnstone United Company.—The only quartz company in this locality carrying on active operations is the Johnstone United. During last year they got some very rich stone, which enabled them to pay off their liabilities and declare £1,621 in dividends; but recently they have not been so successful in their operations. The peculiarity of the lode on which they are working is that it runs almost as flat as a coal-seam for some distance, and then dips suddenly off on to another shelf. Wherever these dips occur a small patch of good stone is generally found. Such was the case in the last instance when a rich patch of stone was obtained.

Red Hill Company.—This company has proved one of the greatest failures in mining ventures that has ever taken place in the colony. Some four or five years ago this property was placed on the London market, and one who was supposed to be a mining expert from the Home-country, Mr. Price Williams, reported on it as worth £100,000, which was the price set on it by the promoters. A company with a nominal capital of £150,000 was formed, of which £98,000 was given the promoters in shares and £2,000 in cash. A large quantity of obsolete crushing machinery was sent out and erected, and a water-race partially constructed; but the mine for which the company was really floated to work was never even prospected. They have for the last two or three years been employing about four men sluicing in the gap between the Parapara River and Appo's Gully. They have, however, frittered away about £22,370, and during last year the claim and plant were sold for £600, and the company liquidated. It is really a great calamity to the colony to see foreign capital invested in unsuccessful mining ventures like this; but the London shareholders in this instance have only themselves to blame for acting so rashly on the advice of their supposed mining expert. They could not have found an expert in this colony, outside of those who were directly interested, who would have ever led them astray to such an extent.

Reefton District.

This is one of the largest quartz-mining districts in the Middle Island, where lodes of a payable character have been discovered extending for a distance of forty miles along an auriferous belt of country. The quartz workings may be said to have been, on the whole, carried on successfully during the last year. Calls have been made in different mining companies to the extent of £25,956 10s., while the dividends declared have amounted to £30,743, showing a surplus of dividends in excess of calls to the extent of £4,787, which is equal to over 14½ per cent. on the amount of calls made for the year. The approximate quantity of quartz crushed last year was 35,562 tons, which yielded 23,390oz. gold, representing a value of £93,885. These returns are for the year ending the 31st March last, and the following is a statement of the number of tons of quartz crushed, the yield of gold, and dividends declared for the year ending the 31st of December last, compiled by Mr. Hindmarsh, and published in the *Inangahua Herald* of the 26th of January 1892:—

Company.	Gold.	Quartz.	Dividends.
	Ozs.	Tons.	£
Globe	3,654	8,190	3,600
Big River	3,507	1,512	9,600
Cumberland	2,901	3,300	4,200
No. 2 Keep-it-Dark	2,876	4,360	5,400
Progress	3,452	6,130	2,400
Fiery Cross	2,401	1,818	5,643
Inkerman	1,317	1,908	500
Keep-it-Dark	1,056	3,258	1,000
Golden Lead	448	1,640	...
Energy (private company)	420	912	...
Inglewood	414	600	...
Venus	405	670	...
Wealth of Nations	339	1,155	...
" " tailings	116	...	...
Hercules	214	383	...
Homeward Bound	159	45	...
A1 Lease	124	6½	...
Gallant	93	221	...
Royal	90	114	...
Welcome	84	28	...
Golden Treasure	66	140	...
Golden Point	36	3	...
Hard to Find	17	60	...
Result Lease	15	15	...
	23,204	36,468½	32,343
Alluvial gold—			
Purchased by Banks	4,113		
Other sources	900		
Totals	28,217	36,468½	32,343
Totals, 1872 to 1891	517,302	540,324	509,051

The total value of gold produced since 1872 is £2,020,500.

It will be seen from this statement that from the commencement of this field in 1872 to the 31st December, 1891, there were 517,302 tons of quartz crushed from this district, the yield of gold being 510,324oz.; also, that dividends paid amounted to £509,051. The Warden, in his annual report for the year ending the 31st March last, states that 542,119 tons of quartz was crushed, which yielded 407,413oz. gold, valued at £1,586,019; and that the yield of gold from alluvial workings amounted to 109,392oz., representing a value of £401,101, which would make the total yield of gold 516,805oz., and the value £1,987,120, which is £33,380 less than the estimate given by Mr. Hindmarsh; also, that the dividends paid amounted to £515,849. It is very difficult to get a correct statement of the returns of companies long out of existence, and therefore any statement given as to the total produce of the field must only be taken as a close approximation of actual returns. Mr. P. Brennan, of Reefton, who has been connected with the management of many of the mining companies in this district, sent me a compiled statement of the returns from the commencement of the field up to the beginning of 1887. Taking this statement, and the returns given by the Warden since then, the following table will show the number of registered quartz-mining companies that have been on the field since its commencement, with the amount of calls made, dividends declared, the number of tons of quartz crushed, the yield of gold, and the value:—

Name of Company.	Calls made.			Dividends declared.			Stone crushed.	Yield.	Value.		
	£	s.	d.	£	s.	d.	Tons	Oz.	£	s.	d.
All Nations	400	0	0	...			...	...	...		
Alston	100	0	0	...			...	...	...		
Alexandra	600	0	0	...			394	168	651	0	0
Argosy	1,687	10	0	...			...	...	...		
Argus	500	0	0	...			34	48	191	13	10
A1	300	0	0	...			6	124	484	0	0
Ajax	...			2,504	0	0	6,890	6,441	24,958	17	6
Anderson's Creek	...			475	0	0	6,791	5,363	20,780	12	6
Big River	3,500	0	0	...			700	350	1,363	10	8
Big River Extended ...	2,400	0	0	9,600	0	0	2,497	4,792	18,075	7	0
Bannockburn	450	0	0	...			...	...	...		
Britannia Extended ...	104	3	4	...			...	...	...		
Blue Sky	300	0	0	...			...	...	...		
Britannia Quartz Company	416	13	4	...			...	...	...		
Band of Hope	...			...			390	25	96	5	0
Boatman's Creek	...			...			138	122	472	15	0
Chicago	600	0	0	...			...	...	...		
Cumberland	2,400	0	0	4,200	0	0	3,630	3,438	13,907	4	0
Caledonian Extended ...	651	0	0	...			...	...	...		
Caledonian	...			2,250	0	0	546	2,052	7,951	10	0
Dauntless Extended ...	550	0	0	...			...	...	...		
Durham	600	0	0	...			...	...	...		
Dillon	200	0	0	...			...	...	...		
Eureka Extended	10,045	0	0	...			...	...	...		
Eclipse	100	0	0	...			...	...	...		
Empress...	1,850	0	0	...			...	...	...		
Exchange	1,400	0	0	...			...	...	...		
Energy	...			...			3,628	1,637	6,405	11	9
Edinburgh	100	0	0	...			...	...	...		
Energetic	...			21,900	0	0	59,080	30,811	119,322	7	8
Eldorado	...			...			478	653	2,530	7	6
Great Eastern	1,103	0	0	...			...	...	...		
Fiery Cross Extended ...	4,018	5	0	9,243	0	0	8,222	7,595	30,229	13	4
Fraternal	300	0	0	...			...	...	...		
Frying-pan	187	10	0	...			...	...	...		
Gallant	3,200	0	0	600	0	0	1,757	587	2,335	10	9
Globe	14,775	0	0	37,300	0	0	50,736	26,826	106,106	0	0
Golden Treasure	17,800	0	0	4,300	0	0	9,179	5,858	22,773	14	1
General Gordon	1,200	0	0	...			...	...	...		
Golden Point	7,350	0	0	...			1,005½	333	1,295	16	10
Golconda	200	0	0	...			...	...	...		
Golden Hill	1,500	0	0	...			...	...	...		
Guide	100	0	0	...			...	...	...		
Golden Lead	4,600	0	0	...			2,571	700	2,789	11	3
Golden Bar	300	0	0	...			...	...	...		
Golden Arch	...			...			149	139	538	12	6
Golden Ledge	...			...			1,831	552	2,039	0	0
Golden Fleece Extended ...	6,773	0	0	55,000	0	0	24,877	31,371	121,542	12	0
Hercules...	2,900	0	0	1,700	0	0	1,281	1,204	4,706	8	6
Homeward Bound ...	8,450	0	0	...			45	158	639	15	11
Happy Valley	3,150	0	0	...			127	29	110	19	1
Hudson	100	0	0	...			...	...	...		
Hard to Find	1,650	0	0	...			60	17	67	0	0
Hopeful Extended ...	2,103	2	6	40,425	0	0	12,898	21,129	81,698	0	7
Heather Bell	...			...			60	10	40	0	0
Inkermann	16,938	13	4	4,000	0	0	28,099	11,803	45,658	6	6
Inglewood Extended ...	3,000	0	0	2,700	0	0	8,603	5,359	20,747	0	0

Name of Company.	Calls made.			Dividends declared.			Stone crushed.	Yield.	Value.		
	£	s.	d.	£	s.	d.	Tons.	Oz.	£	s.	d.
Inangahua Low-level Tunnel	5,356	0	0	...			...	...	...		
Independent	...			...			2,345	1,179	4,568	12	6
Italian Gully	...			...			879	512	1,984	0	0
Invincible	...			1,050	0	0	564	657	2,545	17	6
Imperial	...			...			811	468	1,813	10	0
Just in Time	11,667	13	4	15,666	0	0	12,459	15,384	59,832	2	10
Keep it Dark	2,625	0	0	108,033	0	0	110,644	59,126	230,130	6	5
Keep it Dark No. 2 ...	3,500	0	0	7,000	0	0	6,577	4,440	17,632	19	6
Kapai	500	0	0	...			...	...	...		
Lord Edward	1,696	0	0	...			...	...	...		
Lone Star	5,200	0	0	...			220	75	291	12	0
Londonderry	200	0	0	...			...	...	...		
Lone Hand	850	0	0	...			...	...	...		
London	250	0	0	...			...	...	...		
Lady of the Lake	...			...			10	3	11	2	6
Lankey's Creek	...			...			680	73	277	19	3
Merrijigs	1,900	0	0	...			...	...	...		
Maori Chief	100	0	0	...			...	...	...		
Mount Morgan	150	0	0	...			...	...	...		
Multum in Parvo	150	0	0	...			...	...	...		
Mammon	...			...			15	15	60	0	0
Murray Creek	753	0	0	...			...	...	...		
New Era	250	0	0	...			...	...	...		
Nil Desperandum	11,112	3	4	287	10	0	6,858	3,393	13,165	7	7
New Britannia	437	0	0	...			...	...	...		
New Golden Point ...	400	0	0	...			...	...	...		
North Venus ...	200	0	0	...			...	...	...		
National	1,200	0	0	...			...	...	...		
No. 2 South Larry ...	...			...			7,514	4,129	13,999	17	6
O.K.	100	0	0	...			...	...	...		
Oi Polloi	100	0	0	...			...	...	...		
Oriental	...			...			3,360	1,190	44,603	2	6
Prince of Wales	150	0	0	...			...	...	...		
Progress	3,900	0	0	7,200	0	0	25,855	11,700	55,537	18	10
Pandora	1,900	0	0	...			699	364	2,611	3	2
Phœnix Extended ...	700	0	0	4,533	6	0	2,190	2,918	11,272	11	10
Prima Donna	600	0	0	...			...	...	...		
Perseverance	...			...			57	19	73	12	6
Pactolus	...			1,000	0	0	108	498	1,929	15	0
Queen	50	0	0	...			...	...	...		
Reward	250	0	0	...			...	...	...		
Reform	3,090	0	0	...			704	445	2,145	15	6
Royal	1,750	0	0	...			142	115	458	2	6
Resolution	500	0	0	...			...	...	...		
Rise and Shine	150	0	0	...			...	...	...		
Rainy Creek Extended ...	6,739	0	0	...			1,782	209	809	0	0
Sir Francis Drake	9,150	0	0	...			3,990	820	3,088	1	2
Scotia	4,100	0	0	3,000	0	0	594	1,284	5,062	17	6
Specimen Hill	8,353	6	8	...			2,238	1,168	4,073	6	6
Supreme	4,416	0	0	...			...	...	...		
Sir Charles Russell ...	1,600	0	0	...			17	34	119	10	0
South Wealth of Nations ...	1,750	0	0	...			...	...	...		
South Hopeful	4,315	0	0	...			48	52	217	1	9
Stanley	100	0	0	...			...	...	...		
Success	100	0	0	...			...	...	...		
St. George	200	0	0	...			...	...	...		
Southern Cross	...			...			21	43	166	12	6
Triumph	1,150	0	0	...			...	...	...		
United Devonshire ...	1,778	7	8	...			...	...	...		
Union	...			...			600	64	248	0	0
United Inglewood and North Star	...			...			1,591	821	3,181	7	6
United Band of Hope ...	...			...			160	49	187	17	6
Venus Extended	4,000	0	0	3,300	0	0	7,938	5,358	20,770	11	9
Victoria	...			...			1,422	717	2,778	17	6
Venus	...			600	0	0	2,101	1,215	4,708	2	6
Victory	...			...			1,155	905	3,506	17	6
Vulcan	...			400	0	0	919	586	2,077	0	0
Wealth of Nations Extended	4,875	0	0	...			3,356	1,690	6,615	2	0
Welcome	11,100	0	0	110,250	0	0	26,886	63,380	247,477	3	1
Walhalla Extended ...	1,437	0	0	...			238	354	1,396	5	3
Wealth of Nations ...	13,975	10	0	35,100	0	0	47,800	28,756	111,411	18	7
	272,028	18	6	493,696	16	0	522,250	410,902	1,542,350	5	9

This shows that calls to the amount of £272,028 18s. 6d. were made; £493,696 16s. paid in dividends; 522,250 tons of quartz crushed, of a value of £1,542,350 5s. 9d. Comparing these totals with those given by the Warden, there is £22,152 4s. less paid in dividends, 19,869 tons less of quartz crushed, and the value of the gold £43,668 14s. 3d. less than stated by him, while the yield of gold is 2,489oz. more. It will thus be seen that none of the three statements correspond, and they can only be taken as approximately correct.

The large area over which quartz-mining is carried on in the Reefton District, and the rough and broken nature of the country, covered as it is with a dense forest and thick undergrowth, makes prospecting operations difficult to carry on far away from any known line of reef or belt of country in which auriferous quartz is being worked. In the early days of the field it was not difficult to get plenty of capital to prospect the ground and develop the workings of mines. People residing in the large centres of population in the colony invested money in mining enterprises by purchasing shares far above their actual value, thereby losing their money, which in course of time was bound to produce a bad effect on the district. People residing at a distance from the place of actual operations do not now readily invest their money in mining ventures; and the people in the district not having sufficient capital to carry on mining operations so as to thoroughly prospect and prove the value of their properties, companies have had to go into liquidation that otherwise might have been brought to a successful issue. The principle, also, of attempting to work quartz-mines on a system that the yield of gold must be made to pay all expenses of opening out and developing the mine, without making calls, is fraught with disaster. It in many instances entails double the cost of getting the ore and sending it to a crushing-battery, and the result is that many a good mine is rendered valueless by an imperfect system of working.

There is another evil in connection with the working of many mining companies, and that is, a too eager desire to pay away every pound of surplus on the working in dividends, without making a reserve fund. It is patent to every one carrying on mining operations, that when a lode is opened out and stoping carried on is the time when the profits on the workings may be expected, and either a portion of these profits should be held in reserve to open up the ground at a lower level or the work should be carried on at the same time as stoping operations; and there should always be some prospecting going on also, so that if the lode at one place failed to prove payable for working there was another place ready to place men on to keep up the returns of the gold.

Comparing the returns from the quartz-mines in this district with those of 1890–91, there were 4,225 tons of stone more crushed for that year, but the yield of gold was 43oz. less. The extra value of the gold with the duty abolished gives £1,887 more last year than for the previous year. The yield of gold from the alluvial drifts was also 300oz. less last year than for the previous one, but the actual profits on the working of the mines last year was £3,418 more than for the former year. Taking the total number of miners employed in the quartz workings, their average earnings in this district last year was £189 5s. 8d. per man. That is, taking the value of the gold produced last year divided by the number of men employed in quartz-mines, which was 496.

The following statement will show the comparative returns from this district since 1882:—

Year.	Calls made.	Dividends declared.	Number of Tons of Quartz crushed.	Yield of Gold.	Value of Gold.	Yield per Ton.
	£	£	Tons.	Oz.	£ s. d.	Oz. dwt. gr.
1882–83	61,345	32,600	18,928	19,194	74,856 12 0	1 0 7
1883–84	49,456	16,500	23,433	16,547	64,533 6 0	0 14 3
1884–85	29,333	34,100	34,349	23,997	93,588 6 0	0 13 23
1885–86	24,565	14,500	27,198	14,591	56,904 18 0	0 10 18
1886–87	21,596	33,450	23,930	21,143	83,171 15 5	0 17 14
1887–88	30,432	17,550	24,403	16,775	66,030 11 5	0 13 18
1888–89	38,919	16,688	28,564	18,663	72,720 18 0	0 13 4
1889–90	27,531	18,250	32,394	17,780	69,676 12 1	0 10 16
1890–91	20,404	27,325	39,643	23,347	91,998 8 10	0 10 19
1891–92	25,956	30,743	35,562	23,390	93,885 5 1	0 13 3

The workings in the different mines being fully described by the Warden in his report, it is only necessary here to casually refer to the principal mines in the district.

Keep-it-Dark.—This has been one of the best mines in the Reefton District, and one from which a large quantity of gold has been taken. Since the date of registration of the company, about eighteen years ago, up to the 18th of December last, 112,351 tons of quartz have been crushed, which yielded 59,866oz. 13dwt. 9gr. of gold—about 2¼ tons—representing a value of £232,206 13s. 9d. In addition to this the company has received £6,678 10s. 2d. for crushing quartz for other companies, and £2,625 was paid up in calls. The expenditure in connection with this mine has been—for wages, contracts, and timber in connection with mining operations, £87,538; expenses in connection with working the crushing-battery, £29,182; cost of plant, battery, with water-race, &c., £11,767; and other expenses, including rent, taxes, surveys, manager's salary, printing, advertising, &c., £8,174: making a total in round numbers of £136,661. During the same period £105,167 has been paid in dividends. The returns from the mine during the last year have not been so good as formerly, but, nevertheless, it has managed to pay £1,000 in dividends. The quantity of quartz crushed last year was 3,258 tons, which yielded 1,056½oz. gold, representing a value of £4,190, and the proceeds from crushing for other companies amounted to £1,927; making the total receipts £6,117; while the expenditure in connection with working the

mine, crushing-battery, and incidental expenses, &c., amounted to £5,398. The total depth that the workings of this mine has reached below the top of their shaft is 750ft., to the No. 5 level. A winze is being sunk in this level on a block of stone, but there is no certainty of this stone continuing down to a great depth, as it cut out in the face of the level. The average yield of gold per ton of quartz crushed was about 10dwt. 15gr., but taking the returns for the past twelve months the average yield has only been about 6dwt. 14gr. of gold per ton. There are nineteen men employed in the mine in addition to the men employed in connection with the crushing-battery. During the year ending 31st March last 2,738 tons of stone was crushed, which yielded 996oz. gold, representing a value of £3,624, of which £500 was declared in dividends.

Keep-it-Dark No. 2.—The workings in this mine are carried on from the No. 2 level, and the lode has been stoped up for a distance of about 200ft., but at this point the lode is much broken up, the stone carrying less gold. A winze has been sunk from No. 2 level to a depth of 90ft., but at 37ft. down the stone cut out, and no further stone was again found. Stoping is being carried on from the winze, where the lode averages about 18in. in thickness; but above No. 2 level it is about 4ft. There is no crushing-battery in connection with this claim, all the crushing being done at the Keep-it-Dark Company's battery. The total quantity of gold obtained from this mine has been 4,250oz. 8dwt., of a value of £16,873, and the expenditure in connection with the mine, £14,031. The amount of capital actually paid up is £4,600. This enabled dividends to be paid to the extent of £6,400. During the six months ending the 21st March last 1,824 tons of quartz were crushed, which yielded 996oz. 17dwt. of gold, representing a value of £3,986. The expenditure in connection with the mine for the same period was £3,155, and £1,200 was paid in dividends. There has been about sixteen men employed in connection with the mine. Taking the returns for the year ending the 31st March last, 4,295 tons of quartz was crushed, yielding 2,482oz. of gold, representing a value of £9,928, out of which dividends were declared to the extent of £4,200.

Hercules.—The work done in this mine has been the extension of the main level for a distance of 212ft., or within 12ft. of the boundary of the No. 2 Keep-it-Dark Company's ground. Two blocks of stone were cut through, and 165 tons were crushed at the Wealth of Nations Company's battery, which only yielded 56oz. gold, or about 6½dwt. per ton. The No. 2 Keep-it-Dark Company have been trying to arrange with the Hercules Company to make a connection from their winze to the Hercules main level, and to get the quartz taken up the latter company's shaft, which would be an advantageous method of working the stone below the No. 2 level, and also give better ventilation in both mines; but no arrangement has yet been come to. The total value of gold obtained from the mine since the formation of the Hercules Company amounts to £1,645, while the expenditure in connection with the mine has been £4,556, and £300 has been paid in dividends. The actual capital paid up and money received from another company amounts to £3,028, which leaves a deficiency of about £183. The value of gold obtained during the six months ending 26th February last was £226, and the calls paid amounted to £768, making the total receipts £994; while the expenditure for the same period was £987. During the year ending the 31st March last there was 238 tons of quartz crushed, which yielded 145oz., representing a value of £584; and during the same period calls were made to the extent of £1,200.

Energy Mine.—This was purchased from the Energetic Company who for many years carried on the workings receiving but very little profit. There are several lodes in the claim, which enabled them to employ a large number of men. It was always looked on as a good wages-claim, but nothing else. After working down to water-level, the company sold the mine to the present proprietors, consisting of a party of six working miners, who have made fair wages ever since they purchased it. They have recently been working on what is known as No. 1 level, on the Snowball reef, which averages about 3ft. 6in. in thickness, and yielding about 14dwt. of gold to the ton. There is one wages-man in addition to the shareholders at work in the mine. During last year 780 tons of quartz was crushed, which yielded 460oz. gold, representing a value of £1,835.

Wealth of Nations.—A great deal of work has been done in this mine, and a systematic method of prospecting has been carried on for several years, without meeting with much success. Indeed, the company has been kept afloat by the profits derived from crushing the tailings which were run to waste in the early days, when the company used to pay regular dividends. The manager is now sinking a winze, which is down 150ft. on the underlie from No. 1 level; this level being 200ft. below the battery level. A shaft is likewise being sunk from No. 1 level, to a depth of 100ft., from which it is intended to work a block of stone about 5ft. in thickness, which gives an average yield of from 5dwt. to 6dwt. of gold per ton. There are seventeen men employed in the mine and crushing-battery. The manager of this company deserves the highest credit for the manner in which he has managed to keep the company afloat under the adverse circumstances, and the systematic and workmanlike manner in which prospecting and mining operations have been carried on. During the last year calls have been made by this company to the extent of £1,625. They crushed 609 tons of quartz for a yield of 216oz. gold, and 130oz. gold was obtained from tailings, representing a value of £1,383.

Big River.—This mine has been giving good returns for the past year. The shaft is now down for a distance of 440ft. An adit was constructed which cut the shaft at 220ft., and at 200ft. below this level the lode was opened out on, and stoping commenced. These stopes are now up for about 120ft. on the lode, and have about another 100ft. to go to the next level, following the inclination of the lode. As the stoping goes upwards the lode seems to get more broken and disturbed, and the reef is very narrow, consequently a large quantity of stone cannot be obtained. The Lord Edward Company, who hold the adjoining ground, have made arrangements with the proprietors of this mine to continue the sinking of the shaft for another 150ft., and to open out a fresh level at this depth, each company paying half the expenses in connection with sinking the shaft. The Lord Edward Company have also paid the Big River Company £250 to be allowed to have the use of their shaft for winding when they do not require it themselves. The total quantity of gold obtained by the Big River Company up to 16th December last amounted to 3,507¼oz., representing a value of £13,981,

and the expenditure for the same period in connection with the crushing-battery and mine was £5,301; dividends having been paid to the extent of £9,600. During the half-year ending the same period 1,242 tons were crushed, yielding 2,831oz. of gold, representing a value of £11,285, the expenditure for the same period being £3,348; and £7,800 was paid in dividends. Taking the returns for the year ending March last, 1,652 tons of quartz was crushed, which yielded 3,704oz. gold, representing a value of £14,807, out of which dividends were declared to the extent of £9,600. About twenty-eight men are steadily employed by this company.

Lord Edward.—A considerable amount of prospecting has been carried on in this mine, but no quartz has yet been crushed. Arrangements have been made with the Big River Company to get the use of their shaft for winding purposes, and it is intended to work the same lode that passes through the latter company's claim. Although the Lord Edward Company has been registered since 1883 very little work was done until within the last eighteen months. The total amount paid up in calls to the end of last year was £1,338, while the actual expenditure on the mine was in round numbers £731; the other expenses in connection with the company during the time it has been in existence amounting to £723. During the six months ending the 22nd of December last the expenditure in connection with mining operations amounted to £538.

Cumberland.—A considerable amount of work has been done in this mine, and some very fair stone has been met with. Although there was a good body of stone in the lode above No. 1 level, it does not seem to go down to any great depth. A low-level adit was driven to cut the reef at about 125ft. under the No. 1 level. This adit has been constructed for a distance of about 450ft., but failed to cut the lode. At 280ft. the track of a lode was passed through, and since then it has been followed up, and small blocks of gold-bearing stone have frequently been met with. A winze was put down on the lode from the No. 1 level for some distance, and an up-rise was constructed from No. 2 level to connect with the bottom of the winze. An intermediate level has been constructed from the winze, about 50ft. under No. 1 level, and at 20ft. west from the winze a good lode was struck about 4ft. 6in. in thickness, carrying payable auriferous quartz; and since then it is reported as being 13ft. in thickness. There are seventeen men employed in connection with the mine.

The Company have erected an aërial tramway about 72 chains in length, said to have only about 540ft. of fall between the receiving paddock and crushing-battery. In this distance it has to go over a low saddle, which may be about 200ft. higher than the upper terminal. There are fifty-eight buckets on the two miles of rope, which gives twenty-nine full buckets and the same number of empty ones, spaced about 2½ chains apart, the carrying capacity of each bucket being 2 cwt. This tramway is self-acting, and works remarkably well; although it has only an average gradient of about 1 in 8·8, hitherto it has been considered that these tramways require a gradient of about 1 in 7 to make them work satisfactorily. The cost of this tramway was £900. The company have also erected a crushing-battery at Deep Creek, consisting of fifteen heads of stamps, and the ordinary appliances for saving gold, the machinery being all driven by steam-power. The cost of this plant has been £3,500. This company was formed in February, 1890, and up to the 31st March last they have paid £2,400 in calls, and have obtained gold to the value of £13,907; while the expenditure in connection with the mine, aërial tramway, and machinery has been £13,905, and £4,200 was paid in dividends, the amount of contingent liabilities being £2,234. During the six months ending 31st March only 752oz. of gold was obtained, representing a value of £3,048, while their expenditure for the same period was £5,996. The mine is now, however, looking very well, and it is expected that the whole of the liabilities will soon be paid off, and regular dividends paid for some time to come.

Golden Lead.—When gold was first discovered in this mine it was thought that it would prove a highly-payable venture for the company who took it up. Gold was obtained from sandstone mixed with small veins of quartz, and, as this deposit was lying nearly horizontal on the outcrop, it was thought at first there would be a very large body of this material. A crushing-battery and aërial tramway were constructed, and crushing operations commenced about June last year, but the quantity crushed only yielded about 5dwt. of gold to the ton, which was considerably less than what was anticipated. A winze could not be sunk, owing to the influx of water, to test the lode-stuff any depth, so that an adit is now being constructed which will give about 60ft. of backs to the upper level. The workings have recently been carried on at or near the corner boundaries of the O.K. and Northumberland Claims, which are said to be now amalgamated with the Golden Lead. There are eighteen men employed in connection with the mine, exclusive of those employed at the crushing-battery. The gold is said to be in small leaders of quartz that traverse the country rock, but most of it has been got from one particular leader. Since the formation of the company, in 1890, to the end of March last the amount of money paid in calls has been £3,865, the quantity of gold obtained being about 611oz., representing a value of £2,443; and the expenditure in connection with the mine, plant, and crushing-machinery amounts to £7,435. For the year ending the 30th March calls have been paid to the amount of £2,245, and gold has been obtained to the value of £2,443, while the expenditure for the same period has been £4,867. Most of the dead-work is completed, and the company now expect to reap the benefit of their labours.

Gallant.—This company has been in existence since February, 1888, and it was thought at one time that some very rich stone would be obtained from their mine. A considerable amount of prospecting and other work has been done, without, as yet, any return to the shareholders for their outlay. Up to the 18th of December last the total yield of gold was about 199oz., representing a value of £761, while over £3,000 has been paid in calls. The total expenditure in connection with this company up to the same date has been £3,834. The returns for the last six months of the period referred to was 55oz. of gold, representing a value of £220; calls have been paid to the amount of £388, and the expenditure for the same period amounted to £578. Latterly the company have been more successful in their undertaking. They are getting about 300 tons of

stone per month, with gold showing here and there through it. The lode is however very small at present, but there are better prospects of the company being reimbursed for all their outlay—which amounts to £3,120—than was previously the case. During the year ending the 31st March last there was 1,083 tons of quartz crushed, which yielded 446oz. gold, representing a value of £1,749, out of which £600 was paid in dividends; and for the same period there was £500 paid in calls.

Progress.—This company was formed in 1886, and since then there has been paid in calls £4,500, and dividends to the extent of £7,200 have been paid. There has been a total of 26,350 tons of quartz crushed by this company, which yielded 11,700oz. gold, representing a value of £46,537. During the last year the main shaft has been sunk from No. 2 level to about a depth of 140ft., the lode intersected at this depth by a cross-cut, and a connection made with a winze sunk from the No. 2 level for the purpose of giving good ventilation. The lode on the lower level is from 8ft. to 10ft. in thickness, and considered to be all of a payable character for working. A compressed air winding-plant has been erected in No. 2 level for winding, and six additional berdans, for the treatment of the tailings has been added to the crushing battery. Last year there was 4,750 tons of stone crushed, which yielded 1,901oz. gold, representing a value of £7,719, and during the same period calls were made to the extent of £600.

Globe.—The mining operations of this Company last year have been carried on between the No. 3 and No. 4 levels. At the latter level the lode is considerably broken, but from this level a winze has been sunk to a depth of 70ft., the lode cut at this depth being about 12ft. in thickness, which showed the stone more solid in character. On the eastern lode there is a large body of stone on three levels, with comparatively little work yet done, so that the future prospects of the mine are very encouraging. During last year 8,980 tons of stone was crushed, which yielded 4,536oz. gold, representing a value of £18,370, which gives the average value of the ore as £2 0s. 11d. per ton; also during the same period £7,200 was paid in dividends. The total returns from this company's mining property are 50,736 tons of stone crushed with a yield of 26,826oz. gold, valued at £106,106, which gives the average value of the whole of the stone crushed as £2 1s. 10d. per ton. Comparing the average value of the ore with that obtained last year it shows that the lodes are very uniform in value. The total amount of dividends paid is £37,300, while the paid-up capital amounts to £14,775.

Inkerman.—This company was formed in 1876, and has expended a paid-up capital of about £18,833, while the dividends paid only amount to £3,500. During last year a considerable amount of work was done; but on getting down on the No. 3 level the lode got small, and pinched out, after driving about 50ft. northwards from the main shaft. A winze has been sunk 58ft. below the No. 3 level, but the lode at this depth is only found in small blocks. In their eastern mine the lode averages about 8ft. in thickness, but the stone is of very low grade, only averaging about 4½dwt. of gold per ton. During last year there was 1,088 tons of quartz crushed, which yielded 894oz. of gold, representing a value of £3,291; and calls were made to the extent of £1,000.

Fiery Cross.—This is one of the successful mining companies in the Reefton District. The company was formed in 1889, having a paid-up capital of £11,019, while up to the end of December last dividends were paid to the extent of £24,169. The workings in this mine are carried on to a depth of 960ft. below the level of the top of the main shaft. This shaft is down to a depth of 600ft., and another shaft is sunk down from the main-level at this depth for another 360ft. On the lowest level at the present time there is a break in the lode, but prospecting operations are being carried on with a view of again intercepting it. The block of stone they have been working on during last year varies in length and value in different levels, its length being from 100ft. to 200ft. Last year 2,431 tons of quartz was crushed, which yielded 2,818oz. of gold, representing a value of £11,435. The total quantity of quartz crushed by this company is 26,469 tons, which yielded 29,662oz. of gold, representing a value of £116,568. The amount of dividends declared last year was £5,643.

Lyell.

The principal company engaged in quartz-working here is the United Alpine, who have been carrying on operations since 1874. They have a nominal capital of £48,000, of which £16,000 was paid to the promoters in scrip for the property of the old company. The actual paid-up capital is £24,933, and the dividends paid up to the end of last year was £48,867. The workings are now carried on from the No. 7, or lower level, which is over 1,000ft. in depth from the place where the lode was first worked. According to the company's balance-sheet for the year ending the 31st October last, there was 9,205 tons of stone crushed, which yielded 4,797oz. of gold; and there was also some other gold in hand. The total value of the gold obtained for that year was £20,318 10s., of which £6,400 was paid in dividends. It may be interesting to show the cost of minfng and crushing the quartz by this company. The quantity of quartz taken out of the mine for the period referred to was 9,297 tons, the cost of wages, timber, and goods in connection with the mine being £8,784 16s., which is equal to 18s. 10d. per ton; and the cost of wages and goods in connection with the crushing-battery was £1,144 1s. 8d., which is equal to about 2s. 6d. per ton, or, taking mining and crushing, the cost has been £1 0s. 10d. per ton.

In the other mines in this locality, namely, Crœsus, Tyr Connell, and United Italy Companies, there has been very little work done. About 20 tons of quartz was crushed from the Crœsus, which yielded 5oz. of gold. Some very good stone is still got in the Tyr Connell mine, from leaders, averaging about 3oz. of gold per ton. In the United Italy Mine some tributers are now engaged in prospecting, the leader they were previously working on having cut out. The Lyell Creek Extended Company are also continuing their adit-level, which is now in considerably over 3,000ft., with the hope of cutting the Alpine reef.

Cedar Creek.

About seven years ago an auriferous quartz-lode was discovered in the bed of Cedar Creek, from which very rich specimens were obtained. Licensed holdings were taken up in every direction near the new discovery, and a good deal of surface prospecting was done on every small quartz-vein found in the locality. Companies were formed to work the ground, and for a time those who considered themselves fortunate enough to hold an interest in claims thought that a new Eldorado was discovered which would prove amazingly rich. The William Tell Company, who held the ground of the prospectors, constructed an adit to cut the reef somewhere between 50ft. and 60ft. under the outcrop, but this adit, being constructed at right-angles to the line of reef, cut the lode at a considerable distance to the north-west of the outcrop in the creek. The lode was driven on for some distance, and several tons of quartz taken out to test before going to further expense. A small five-head-stamp battery was erected, and portion of the stone was crushed, but the result proved very disappointing—only a few pennyweights was obtained per ton. The crushing-battery having been erected in a very crude manner, every one supposed the gold was lost in the crushing, and no doubt a considerable portion of it was. A good deal of fine gold could be seen in the stone before crushing, but the quartz being of a very white colour, and the gold in a free state, most of it would readily be seen. After this trial-crushing work was suspended for some time.

Another start was made and the lode driven on towards the creek, where rich stone was obtained on the outcrop, and some fairly-payable stone was struck, the lode being from 2ft. 6in. to 3ft. in width. A winze was sunk on the lode at a point about 84ft. distant from the original adit to a depth of 70ft., having, it was stated, a good lode all the way down with richer stone at the bottom of the winze, and greater thickness than it was at the top. A new adit was now constructed 86ft. below the top of the winze; but in the meantime a crushing-battery, consisting of ten heads of stamps and four berdans, driven by a Pelton water-wheel, were erected, and an aërial tramway constructed to convey the quartz from the hoppers at the mouth of the low-level to the battery.

On the completion of the new adit the bottom of the winze was tapped, but it was then found that the lode cut out at about 22ft. from the top, and there was no sign of a lode below this. However, as there appeared to be a considerable quantity of stone in the upper level likely to pay, it was driven out and sent to the quartz-mill. The result of this crushing proved so disappointing that the company was put into liquidation, and the whole property was purchased by Mr. Perrotti, of Greymouth, who has since removed the machinery to Blackball Creek, and no further work had been done on these reefs up to the time of my visit with Mr. Alexander McKay, F.G.S., in December last. Although a good deal of work has been done in this mine, no systematic prospecting has been carried on, and scarcely any work done to prove conclusively that the lode cut entirely out, or that a throw had taken place. On examining the ground in the lower adit, which had been extended for some distance beyond the bottom of the winze, at the end of which a cross-cut was made for about 60ft. in a northward direction, a body of quartz was cut through which has all the appearance of being of the same character of stone where the gold was found on the upper levels, and may probably prove to be a continuation of the same lode. This body of stone has not been driven on, to test whether this is so or not. It is possible that there is no gold in the stone where cut; but this may sometimes occur in a highly payable lode, it is very seldom that the run of gold continues for a great distance, it being more in shots and ledges; at all events, this lode or leader is well worth prospecting, and driving on for some distance, to prove what it is like. The quartz has all the characteristics of being gold-bearing, and the country rock also all favours this supposition.

A few chains higher up Cedar Creek than the William Tell ground, another large quartz-lode is cropping out in the bed of the creek, in what is termed the Swiss Republic Claim. Several fair specimens of gold-bearing stone have been taken from the outcrop, and a good deal of surface prospecting has been done, and also some small drives and winzes have been constructed; but the latter being full of water they could not be examined. The quartz in this outcrop is slightly different in character from that found in the William Tell lode; and has every appearance of being gold-bearing stone. The formation of the country in this locality is somewhat similar to that in the Reefton District, gold being found in all the creeks and streams, holds out inducement for prospecting for auriferous lodes in the locality. Mr. Halligan, of Ross, who accompanied us to the reefs, informed me that it was intended to drive an adit from the low level in the William Tell ground to cut the lode in the Swiss Republic; and since my visit a subsidy has been authorised to carry on prospecting drives in this direction.

West Coast District.

Blackball.

Hitherto there has not been any auriferous lode worked in this locality. Some prospecting has recently been done on a lode on the western side of Blackball Creek, where a little gold was found, but not sufficient to warrant any expenditure in the erection of crushing machinery. This lode was traced across the creek to the eastern side, and an adit driven for some distance, which proved it to be gold-bearing, and which with crushing machinery would probably yield from 3dwt. to 4dwt. of gold per ton. A winze was then sunk from this adit on the lode for about 40ft., which Mr. Perrotti, who accompanied me, stated showed the gold to increase going down. The water became so heavy that they had to suspend sinking, and they drove into the lode for 22ft. from the bottom of the winze without finding the opposite wall of the lode. Mr. Perrotti stated the quartz taken from this winze will average at least 10dwt. to the ton. As the winze was full of water there was no opportunity of seeing the lode here; but the outcrop on the western side of the creek shows it to be about 6ft. wide, the quartz being white, with bluish veins, and greatly laminated, having all the appearances of gold-bearing stone. A ten-stamp

battery is now being erected near the claim, and when completed will soon prove whether the stone is payable or not. There is no doubt if a lode averaging 10dwt. of gold per ton were in the vicinity of Reefton it would be looked on as a valuable property; but at present, and until such time as the quartz has been thoroughly tested at a crushing battery, the Reefton mining men will not invest any capital in the concern.

Otago District.

Old Man Range.

White's Reef.—This was formerly the property of the White's Reef Company, but when the company went into liquidation Messrs. Syme Brothers became the purchasers. As they had both been mining-managers for White's Company, they were well acquainted with the ground, and, as there were few buyers for the property at the time, the whole of it, including the claim, a five-head stamp-battery, chilian mill, one of McQueen's patent grinders and amalgamators, with all mining tools, water-rights, buildings, &c., was sold for £250. During the first twelve months after their purchase they got gold to the value of £1,000. They employ two men beside themselves—in all, four men—on the works. A winze has been sunk from the adit level, and a considerable portion of the reef stoped out. They now contemplate constructing a new adit level about 210ft. below the present one. This will have to be constructed for about 800ft. through dead ground before the reef is cut. As far as the lode has been traced down it maintains the same character as on the upper level; the quartz resembles that found in the Golden Crown claim at Terawhiti, being a soft, decomposed, loose mass, varying from 9in. to 3ft. in thickness. This requires no blasting, the lode being much softer than the foot and hanging-walls. Still, there are occasionally small blocks of solid stone, but these are very rare.

Wakatipu.

Notwithstanding the rich deposits of gold found in the alluvial drifts in this district, and in the beds of the Shotover and Arrow Rivers, and also in Skipper's Creek, there has never been a large quantity of gold obtained from the quartz-reefs in this locality. The character of the gold found in the alluvial drifts bears evidence that it has either come from the denudation of the mountains and disintegration of the auriferous lodes, or quartz veins from the quartzose schist rock, which is the principal country rock in the Otago Mining District. Whenever pieces of gold are found that are not rolled flat and broken up in dust, they have generally small pieces of quartz attached to them; but if the whole of the gold found in the alluvial drifts came from a disintegration of the quartz lodes, thousands of ages must have passed away since this action first commenced, and the mountains must have been at a far higher elevation than they are at the present day, the auriferous lodes being richer than we now find them.

Phœnix Company, Skippers.—This company has one of the oldest mines in New Zealand. It was first opened in 1863, and has been in operation ever since. Up to the end of last year the total quantity of gold obtained was 23,917oz., representing a value of about £92,544. During last year 4,932 tons of quartz were crushed, which yielded 3,438oz. of gold, representing a value of about £13,700, while the expenditure is said to have been about £13,500. Three lodes are being worked in the mine, one of which is about from 8ft. to 10ft. wide, and the others from 3ft. to 4ft. wide. In comparing the result of the workings in this mine with some of the mines in Reefton—as, for instance, the Keep-it-Dark, Globe, or Progress, where there are lodes of similar size, it is greatly in favour of the Reefton mines. The mining timber is a little more expensive at Skippers, but the cost of labour is the same. In order to show clearly a complete analysis of the results for the year 1891, the following statement has been prepared:—

Name of Company.	No. of Men employed.	No. of Tons crushed last Year.	Yield of Gold last Year.	Value.	Expenditure.	Cost per Ton.	Cost of getting 1oz. of Gold.
		£	Oz.	£	£	£ s. d.	£ s. d.
Phœnix ...	65	4,932	3,438	13,700	13,500	2 14 9	3 18 6
Keep-it-Dark	...	3,258	1,056	4,224	3,224	0 19 9	3 1 0
Globe ...	...	8,190	3,654	14,616	11,016	1 6 11	3 0 3
Progress ...	...	6,130	2,452	9,808	7,408	1 4 2	3 0 5

By this it will be seen that every ounce of gold obtained from the Phœnix Mine last year cost £3 18s. 6d., and every ton of quartz taken out and treated cost £2 14s. 9d. Taking the average of the other three mines in the Reefton District, every ounce of gold obtained cost £3 0s. 7d., and every ton of quartz taken out and treated cost £1 4s. 9d. At the time of my visit to the Phœnix Mine the ventilation was very bad, but the company expected to make another connection with the surface in a few weeks. The manager informed me that he had been breaking-out the quartz by contract at 9s. and 9s. 6d. per ton, including timbering and filling-in. If the breaking-out of the quartz only cost this amount, there must have been a large number of men employed at dead-work in order to bring up the cost to £2 14s. 9d. per ton. The company's crushing-battery consists of twenty-five heads of stamps, driven by electricity, the dynamo being sufficiently powerful to drive these and the air compressor at the same time, the current being 30 amperes, with an electro-motive force of 1,100 volts, which would be equal to about 44·4 horse-power.

Gallant Tipperary Company.—This company during last year crushed 1,800 tons of quartz, which yielded 424oz. gold, representing a value of £1,632. About nine men have been employed in the mine, and six men about the surface and crushing-battery. The stone crushed last year came from the block above the main adit level, which is now stoped up for about 100ft. and for 70ft. in

length. It requires about eight men in the mine to get sufficient stone to keep the crushing-battery fully employed. The battery crushes from 65 to 70 tons of stone per week with ten heads of stamps.

Premier Company.—This is a company re-formed about two years ago with English capital. Previously to the formation of the new company the want of capital greatly crippled their mining operations, and the cost of getting the stone broken out was far more than it should have been if the mine had been opened out on a proper system. Recently, a low-level adit has been in course of construction, and is now in about 1,400ft. The quartz crushed has been taken from the shaft on the upper level, which is sunk to a depth of about 200ft., the lode being followed on a level at this depth for 354ft. to the westward, a drive having been constructed to the eastward for 406ft. to meet the low-level adit. There are still about 300ft. to drive before a connection is made, but the work at the present time is stopped. The lode is from 18in. to 2ft. in thickness, and about twenty men were recently employed; but very little work has been done in the mine last year owing to alterations being made in the crushing-battery, the old over-shot water-wheel being done away with, and a Pelton hurdy-gurdy wheel 6ft. in diameter erected in its stead. During last year 274 tons of stone has been crushed, which yielded 76oz. gold, being an average of 5dwt. 13gr. of gold per ton, which cannot be said to be payable for working a small lode in hard country such as exists in the Premier Company's mine.

The following is an extract from the *Otago Witness* of the 18th February last, of the report of their London correspondent in reference to the remarks of the chairman of the Glenrock Company, respecting the Premier Mine, which is portion of the company's property:—"I may now tell you that we lost no time last year in starting the necessary works in New Zealand on the Premier Mine. We had all the properties registered under the name of the Premier Consolidated Gold Company. Up to that time all workings had been carried on from the main level or No. 1 adit, and from these workings 5,081oz. of gold had been obtained from 5,000 tons of stone, taken from No. 1 lode, as also from No. 2 or vertical lode. The opinion of Professor Black, and of Mr. L. O. Beal, was strongly in favour of driving the low-level adit 200ft. below the old workings. Professor Black and Mr. Beal said the result would be that we should certainly strike rich gold-bearing stone. The rock, however, through which we have had to go is very hard, and dynamite was the only stuff to deal with it, and progress has been very slow. We continued to receive hopeful reports, but we regret that the last crushing has not borne out the confident forecasts expressed by Mr. Farrel in his advices of 12th August, which were conveyed to the shareholders in the Board's circular of 24th September. The mortification of the Board was great, and the directors could imagine how the shareholders also felt on the subject. The crushing of 275 tons, however, is believed to have come from a new reef on the upper level, and not from the low-level adit. The directors, I may say, contemplate taking immediate steps which will effectually preclude any further misadventure on account of reports which are not borne out by results, and they will communicate to the shareholders on the subject as early as possible. Professor Black and Mr. Beal are gentleman highly spoken of in New Zealand, and they swore to their reports being accurate, and it is hard to think that they would peril their reputation in such a manner. We hope that we shall yet achieve the results we have been striving for, and which they say can only be done by cutting a tunnel right through from east to west."

It is to be hoped that the mine will yet prove a payable investment, and that rich gold-bearing stone will be got at the low levels; but even if the lode proves to be of low grade, the low-level will enable the company to work the mine on the upper levels far more economically and systematically.

Sunrise Company.—This company's mine is at a higher elevation than any other mine in the colony, being about 5,000ft. above sea-level. Very little work can be done at this elevation for several months in winter; and it is only during the summer months that the quartz can be taken down to the crushing-battery, which is erected at the foot of the range on the side of Macetown Creek. A low-level adit has been constructed for 530ft., but this level did not cut the lode previously worked. At the end of the low level an uprise has been constructed for 50ft., and a drive made from this uprise towards the bottom of a winze sunk on the old lode for a distance of 80ft., where the lode is from 2ft. to 3ft. in thickness. A considerable quantity of stone is lying on the surface ready to send to the crushing-battery. There has been 214 tons of stone crushed since the beginning of the present year, which yielded 173oz. of gold, representing a value of £672. Only about four men have been employed in the mine.

Mining Returns.

The following statement will show the mining companies who have complied with the Act last year and published a statement of their returns, in compliance with "The Mining Companies Act, 1886," as amended by "The Mining Act, 1891." It will be seen that there are a great number of companies which have not published their statements, and the Inspectors of Mines have been instructed to compel them to comply with the Act:—

STATEMENT of AFFAIRS of MINING COMPANIES as published in accordance with "The Mining Companies Act, 1886," and Amendment Act, 1890.

AUCKLAND DISTRICT.

Name of Company.	Date of Registration.	Number of Shares.	Number of Shares allotted.	Nominal Capital.	Subscribed Capital.	Value of Scrip given to Shareholders.	Amount of Capital actually paid up.	Amount paid up per Share	Number of Shares forfeited.	Arrears of Calls.	Amount of Dividends paid.
				£	£ s. d.	£ s. d.	£ s. d.	£ s. d.		£ s. d.	£ s. d.
New Bendigo	20 Sept., 1890	42,000	42,000	21,000	21,000 0 0	..	496 17 6	0 0 4	..	203 2 6	..
Woodstock United	14 Jan., 1890	55,000	52,568	27,500	26,284 0 0	10,513 12 0	..	0 4 0	500	..	..
New Alburnia	10 Sept., 1885	50,000	50,000	25,000	25,000 0 0	2,500 0 0	3,000 0 0	0 0 6	..	..	500 0 0
Silverton	4 Feb., 1886	40,000	40,000	20,000	20,000 0 0	..	1,000 0 0	0 0 6	..	..	600 0 0
Norfolk	24 April, 1889	50,000	4,995	25,000	24,997 10 0	12,500 0 0	3,338 6 8	0 6 4	500	52 8 9	..
Saxon	2 Dec., 1884	50,000	50,000	25,000	25,000 0 0	750 0 0	7,083 6 8	0 2 10	..	393 12 8	15,416 13 4
Success	4 Nov., 1890	60,000	57,000	15,000	14,500 0 0	..	..	0 0 1	..	95 6 3	..
Little Nell	26 Sept., 1890	40,000	36,000	10,000	9,000 0 0	2,400 0 0	185 0 0	0 1 3	..	265 0 0	..
Lone Hand	22 Mar., 1889	30,000	30,000	15,000	14,500 0 0	500 0 0	1,430 6 8	0 1 0	..	19 3 4	..
Puhipuhi Prospectors'	18 July, 1890	53,360	52,028	26,680	26,014 0 0	10,005 0 0	5,672 18 0	0 6 4	150	413 19 10	..
Trenton	4 Sept., 1885	36,000	36,000	18,000	18,000 0 0	..	8,986 17 6	0 5 3	..	164 6 0	..
May Queen	4 Mar., 1889	50,000	50,000	25,000	25,000 0 0	625 0 0	1,666 13 4	0 0 8	..	..	..
Vizard's	8 Sept., 1890	40,000	40,000	10,000	10,000 0 0	..	101 1 3	0 0 1	..	65 12 1	..
Red Mercury	22 April, 1890	30,000	30,000	7,500	7,500 0 0	937 10 0	1,687 10 0	0 1 9	62	..	..
Pride of Karaka	21 Oct., 1890	50,000	28,050	12,500	8,000 0 0	2,000 0 0	906 2 6	0 2 0	..	18 5 0	..
Try Fluke, S.M. Company	10 April, 1891	50,000	40,000	12,500	10,000 0 0	2,000 0 0	583 6 8	0 0 1½	..	..	..
Mariposa	28 Feb., 1890	50,000	50,000	12,500	12,500 0 0	..	911 1 11	0 0 5	922	130 11 5	..
Occidental	2 Oct., 1890	100,000	100,000	25,000	25,000 0 0	..	..	..	..	..	..
New Manukau	10 Feb., 1883	30,000	30,000	30,000	30,000 0 0	..	2,232 3 9	0 1 6	..	17 6 3	..
Caledonian	7 Feb., 1889	50,000	50,000	12,500	12,500 0 0	..	4,911 0 0	0 3 0	..	39 0 0	..
Prosperity	22 Sept., 1890	35,000	30,000	8,750	7,500 0 0	1,500 0 0	178 15 0	0 1 3	..	383 15 0	..
Hazelbank	13 Sept., 1890	42,000	42,000	10,500	10,500 0 0	2,100 0 0	1,823 15 0	0 2 0	..	276 5 0	..
Magnolia	16 Feb., 1883	50,000	45,500	50,000	45,500 0 0	2,625 0 0	1,586 17 6	0 2 9	..	100 12 6	..
Dives	12 Aug., 1889	45,700	40,700	9,000	8,140 0 0	..	644 2 6	0 0 6	125	367 12 6	..
Victoria	2 Sept., 1890	120,000	117,183	24,000	23,823 18 0	7,323 18 9	3,964 15 9	0 1 3	..	..	..
Consols	16 Sept., 1890	50,000	50,000	50,000	25,000 0 0	750 0 0	2,083 15 6	0 1 0	..	416 4 6	..
Cambria	4 Jan., 1884	44,700	44,700	44,700	44,700 0 0	12,851 0 0	1,181 5 0	..	..	..	79,357 10 0
Wairoa	18 Aug., 1890	40,000	40,000	10,000	10,000 0 0	..	394 4 1	0 0 2½	8,563	44 2 1	..
Perseverance	15 Sept., 1890	36,000	36,000	9,000	7,500 0 0	..	65 18 2	0 0 1	..	54 18 6	..
Victory	..	50,000	45,000	12,500	11,250 0 0	..	5 12 6	..	..	85 6 3	..
Kuaotunu Bonanza	18 April, 1890	50,000	45,620	50,000	45,620 0 0	22,810 0 0	584 13 1	0 10 5	1,157	96 3 6	..
Young Colonial	13 Oct., 1890	30,000	20,000	15,000	10,000 0 0	..	1,500 0 0	0 1 0	1,950	..	..
Puhipuhi No. 2	28 Nov., 1890	33,300	22,200	8,325	5,550 0 0	..	591 0 8	0 1 3½	2,450	10 4 2	..
Waiotahi	1 Aug., 1871	6,000	6,000	18,000	18,000 0 0	..	15,000 0 0	2 10 0	..	..	26,250 0 0
Kuaotunu	24 Sept., 1890	50,000	50,000	12,500	12,500 0 0	..	462 1 0	..	..	170 13 4	..
City of Dunedin	6 May, 1890	50,000	46,550	25,000	23,275 0 0	11,637 10 0	457 1 8	0 5 3	..	124 15 10	..
Kuaotunu Quartz-crushing	24 July, 1890	10,000	5,155	5,000	2,577 10 0	..	2,422 15 9	0 10 0	..	154 4 3	..
Hauraki	17 Oct., 1890	45,000	45,000	11,250	11,250 0 0	..	240 0 0	0 0 2	6,350	75 2 6	..
Silvia	16 June, 1890	100,000	100,000	100,000	100,000 0 0	82,500 0 0	13,150 0 0	0 16 6	300	7 10 0	..
Kapai	17 Sept., 1890	50,000	50,000	12,500	12,500 0 0	..	1,041 13 4	0 0 5	..	200 3 0	..
John Bull	4 Sept., 1890	50,000	50,000	12,500	12,500 0 0	..	416 13 4	0 0 2	5,699	83 2 4	..
Calliope	8 Sept., 1890	50,000	50,000	12,500	12,500 0 0	..	416 13 4	0 0 2	..	199 3 4	..
Carbine	21 May, 1890	50,400	50,400	25,200	25,200 0 0	..	450 0 0	..	..	..	..

STATEMENT of AFFAIRS of MINING COMPANIES as published in accordance with "The Mining Companies Act, 1886," and Amendment Act, 1890—*continued*

AUCKLAND DISTRICT—*continued.*

Name of Company.	Date of Registration.	Number of Shares.	Number of Shares allotted.	Nominal Capital.	Subscribed Capital.	Value of Scrip given to Shareholders.	Amount of Capital actually paid up.	Amount paid up per Share.	Number of Shares forfeited.	Arrears of Calls.	Amount of Dividends paid.
				£	£ s. d.	£ s. d.	£ s. d.	£ s. d.		£ s. d.	£ s. d.
Golden Age	10 Sept., 1890	25,000	24,200	6,250	6,050 0 0	..	..	0 0 1	..	16 3 4	..
Freedom	18 Mar., 1890	24,000	24,000	6,000	6,000 0 0	..	800 0 0	..	..	12 1 8	..
Waihi	7 Dec., 1887	150,000	150,000	150,000	150,000 0 0	53,333 0 0	74,330 0 0	1 0 0	..	252 10 0	..
Emminence	13 Aug., 1891	50,000	49,000	10,000	9,975 0 0	1,225 0 0	204 3 4	0 0 7	..	..	..
Irene	— Mar., 1891	50,000	36,000	12,500	9,000 0 0	..	291 13 4	0 0 2	..	..	..
Prospectors No. 3 S.M. Company	17 April, 1891	40,000	38,000	25,000	16,925 0 0	1,692 10 0	957 2 2	0 1 1	4,150	41 14 5	..
Hilda	8 Dec., 1890	90,000	90,000	22,500	22,500 0 0	7,500 0 0	317 17 5	0 0 3	..	330 15 11	..
Souvenir	11 Sept., 1890	50,000	40,000	12,500	10,000 0 0	..	416 13 4	0 0 2	..	113 4 0	..
Flying Cloud	8 Sept., 1890	50,000	50,000	12,500	12,500 0 0	..	625 0 0	0 0 3	..	40 18 4	..
Otama	25 Mar., 1890	40,000	39,912	20,000	20,000 0 0	..	498 18 0	0 0 3	1,985	81 1 9	..
Junction	21 June, 1890	30,000	30,000	7,500	7,500 0 0	..	750 0 0	0 0 3	..	144 15 10	..
Orlando	2 April, 1890	40,000	40,000	10,000	10,000 0 0	..	1,000 0 0	0 0 6	5,570	78 11 6	..
Owera	8 Sept., 1890	50,000	50,000	12,500	12,500 0 0	7,500 0 0	1,875 0 0	0 3 9	750	529 14 8	..
North Star	21 Feb., 1890	50,000	45,000	10,000	9,000 0 0	2,741 13 4	..	0 0 4	..	..	..
Pride of the Hills	17 Sept., 1890	50,000	50,000	12,500	12,500 0 0	..	80 8 4	0 0 1	..	127 8 4	..
Try Fluke	3 Dec., 1889	50,000	50,000	12,500	12,500 0 0	..	1,250 0 0	0 0 6	..	..	7,082 8 6
Little Agnes	24 Mar., 1891	50,000	39,000	25,000	19,500 0 0	..	162 10 0	0 0 1	..	..	..
Jetta	5 June, 1891	60,000	50,000	15,000	12,500 0 0	..	38 14 0	0 0 0½	29,072	60 11 5	..
Coromandel Minx	18 Aug., 1891	50,000	27,890	6,250	3,486 5 0	600 0 0	916 7 6	0 1 3	..	162 7 6	..
Juireta	8 April, 1891	52,000	52,000	6,500	6,500 0 0	112 10 0	130 4 2	0 1 1½	5,500	45 16 8	..
Alburnia S.M. Company	12 June, 1891	52,000	30,425	13,000	7,606 5 0	1,521 5 0	38 11 0	0 1 1¼	..	17 17 4	..
United S.M. Company	21 April, 1891	40,000	27,000	10,000	6,500 0 0	1,650 0 0	624 6 9	0 0 1¾	..	27 1 9	..
New Moanataiari	16 Nov., 1888	50,000	49,910	25,000	24,955 0 0	2,670 0 0	9,905 2 0	0 5 0	..	..	..
Alameda	24 April, 1891	60,000	50,000	30,000	25,000 0 0	2,500 0 0	156 5 0	0 1 0¾	..	65 17 8	..
Secret	— Dec., 1890	32,000	32,000	2,000	2,000 0 0	1,000 0 0	297 5 10	..	..	54 8 4	..
Vermont	14 Oct., 1891	60,000	60,000	18,000	18,000 0 0	8,750 0 0	625 0 0	0 0 6	..	..	..
Royal Oak	5 June, 1871	18,000	8,755	34,500	28,734 0 0	..	3,808 7 3	0 4 9	9,245	12 7 6	7,773 19 0
Tokatea	30 Sept., 1869	20,000	9,695	100,000	80,000 0 0	..	9,879 9 10	0 11 0	10,305	..	63,625 0 0
Orient	1 May, 1890	50,000	41,650	12,500	10,412 0 0	..	..	..	..	..	..
Nemesis	25 Mar., 1890	40,000	40,000	20,000	20,000 0 0	..	142 7 11	0 0 1½	7,900	56 6 1	..
Maori Pah	17 Sept., 1890	42,000	42,000	10,500	10,500 0 0	..	..	..	..	..	..
Kapanga	4 Mar., 1872	185,000	185,000	185,000	185,000 0 0	..	185,000 0 0	0 0 1	..	..	4,625 0 0
Ophir	23 June, 1891	50,000	34,000	34,000	5,000 0 0	1,700 0 0	129 9 5	0 1 1½	..	47 12 3	..
Great Mercury Proprietary	19 Sept., 1890	60,000	60,000	18,000	18,000 0 0	7,500 0 0	9,784 2 6	0 6 0	2,850	715 17 6	..
		3,854,460	3,546,086	1,829,145	1,661,825 8 0	290,424 9 1	387,889 14 8	..	106,055	7,762 16 2	205,230 10 10
NELSON DISTRICT (including West Coast).											
A1	12 May, 1891	24,000	24,000	6,000	6,000 0 0	..	270 0 0	..	..	30 0 0	..
Blue Sky	3 Mar., 1891	24,000	24,000	6,000	6,000 0 0	..	300 0 0	..	..	..	..
General Gordon	18 July, 1887	24,000	24,000	12,000	12,000 0 0	..	815 7 4	0 0 10	6,350	184 12 8	..
Keep-it-Dark	2 Mar., 1874	20,000	20,000	20,000	20,000 0 0	10,000 0 0	2,625 0 0	0 2 7½	..	..	105,166 13 4
Supreme	28 Sept., 1888	28,000	26,597	14,000	14,000 0 0	..	3,870 9 4	0 3 3	..	46 4 0	..

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STATEMENT of AFFAIRS of MINING COMPANIES as published in accordance with "The Mining Companies Act, 1886," and Amendment Act, 1890—*continued.*

Name of Company.	Date of Registration.	Number of Shares.	Number of Shares allotted.	Nominal Capital.	Subscribed Capital	Value of Scrip given to Shareholders.	Amount of Capital actually paid up.	Amount paid up per Share.	Number of Shares forfeited.	Arrears of Calls.	Amount of Dividends paid.
OTAGO DISTRICT.											
				£	£ s. d.	£ s. d.	£ s. d.	£ s. d.		£ s. d.	£ s. d.
Bluespur and Gabriel's Gully	1 Feb., 1888	130,000	90,000	130,000	90,000 0 0	30,000 0 0	30,000 0 0	1 0 0	..	..	..
Island Block	23 Nov., 1888	60,000	56,917	60,000	56,917 0 0	..	..	1 0 0	..	..	..
United Hercules	13 Aug., 1888	12,000	12,000	12,000	5,500 0 0	..	3,854 0 0	0 14 0	..	..	6,000 0 0
Phœnix Water-race	12 Oct., 1867	1,000	1,000	1,500	1,500 0 0	1,500 0 0	1,500 0 0	1 10 0	..	..	5,425 10 0
Longwood Sluicing	15 Oct., 1888	300	250	3,000	2,506 0 0	1,887 12 3	1,887 12 3	£2/10–£10	..	46 4 0	..
Rise and Shine	22 July, 1890	10,000	10,000	3,000	3,000 0 0	1,500 0 0	1,401 10 0	0 6 0	..	98 10 0	..
Amalgamated Waipori Deep-lead	20 Dec., 1889	12,500	12,050	12,500	12,050 0 0	6,150 0 0	5,783 16 0	1 0 0	..	116 4 0	..
Roxburgh Amalgamated Sluicing	2 Mar., 1889	60,000	59,130	30,000	29,565 0 0	15,000 0 0	12,783 1 0	0 9 0	..	325 9 0	..
Barewood	4 Dec., 1890	12,000	7,500	12,000	7,500 0 0	7,500 0 0	..	..	..	..	..
Sew Hoy, Big Beach	9 Dec., 1889	60,000	54,000	120,000	108,000 0 0	72,000 0 0	8,484 5 0	1 10 0	..	515 15 0	1,350 0 0
Shotover, Big Beach	29 Mar., 1880	300	300	3,000	3,000 0 0	..	3,000 0 0	10 0 0	..	..	600 0 0
Jutland Flat (Waipori)	2 July, 1890	15,000	15,000	15,000	15,000 0 0	3,750 0 0	3,495 0 0	0 7 0	..	5 0 0	..
Lake Rochfort Sluicing	4 Sept., 1891	3,000	2,985	3,000	2,985 0 0	..	35 6 6	0 5 6	..	33 6 0	..
Sandhills	2 Aug., 1889	25,000	25,000	12,500	12,500 0 0	4,000 0 0	7,142 4 0	0 10 0	200	116 0 0	..
Cromwell	14 Nov., 1889	110,000	108,021	110,000	108,021 0 0	97,218 18 0	105,320 9 6	0 19 6	..	195 2 11	..
Dunedin No. 2	29 Aug., 1887	3,000	2,992	3,000	2,992 0 0	..	2,351 16 0	0 16 0	..	40 16 0	..
Pioneer Extended Water-race	13 Oct., 1888	400	340	2,000	1,700 0 0	1,625 0 0	1,625 0 0	5 0 0	..	..	..
Undaunted	— Mar., 1878	120	120	9,600	9,600 0 0	..	9,600 0 0	..	..	..	..
Totals		514,620	457,605	542,100	472,336 0 0	232,131 10 3	198,264 0 3	..	200	1,492 6 11	13,375 10 0
OTAGO DISTRICT DREDGING COMPANIES.											
Roxburgh Gold	20 Aug., 1891	5,000	5,000	5,000	2,500 0 0	..	461 10 0	0 5 0	..	163 10 0	..
Golden Run	29 June, 1891	5,000	5,000	5,000	3,000 0 0	2,000 0 0	777 10 0	0 7 0	..	272 10 0	..
Ettrick Gold	29 Aug., 1890	4,500	4,500	4,500	2,500 0 0	2,000 0 0	1,849 10 0	0 15 0	..	25 10 0	..
Dunedin	1 Sept., 1881	7,200	7,200	7,200	7,200 0 0	..	6,240 0 0	0 17 4	..	..	10,920 0 0
Waipapa	23 Dec., 1890	5,000	3,765	2,500	2,382 10 0	500 0 0	1,574 6 0	0 9 0	..	119 19 0	..
Kawarau Big Beach	25 Sept., 1889	25,000	25,000	12,500	12,500 0 0	4,687 10 0	5,959 12 3	0 9 3	500	429 2 9	..
Perseverance	19 May, 1890	12,000	12,000	6,000	6,000 0 0	2,000 0 0	800 0 0	0 2 0	..	..	..
Miller Creek	11 June, 1890	10,000	10,000	10,000	10,000 0 0	4,000 0 0	4,400 0 0	0 15 0	100	35 0 0	..
Matakitaki	5 May, 1890	600	600	6,000	6,000 0 0	2,000 0 0	3,490 0 0	10 0 0	22	290 0 0	..
White Cliffs	19 June, 1890	20,000	15,000	10,000	7,500 0 0	2,500 0 0	4,445 4 6	0 10 0	..	1,179 15 6	..
Shotover River	29 July, 1889	12,000	12,000	6,000	6,000 0 0	1,500 0 0	4,190 2 0	0 10 0	97	352 8 0	..
Six-mile Beach	22 Oct., 1889	12,000	12,000	12,000	12,000 0 0	2,250 0 0	7,420 18 9	0 17 6	..	79 1 3	..
Frankton Beach	19 Oct., 1889	25,000	23,425	12,500	11,712 10 0	12,500 0 0	5,434 18 4	0 9 6	350	874 9 0	..
Clutha	3 Nov., 1890	8,000	2,220	8,000	2,200 0 0	1,625 0 0	595 0 0	1 0 0	..	7 10 0	..
Enterprise	24 Aug., 1891	1,200	1,200	1,200	1,200 0 0	600 0 0	840 0 0	0 14 0	..	10 0 0	..
Totals	..	152,500	138,910	108,400	92,695 0 0	38,162 10 0	48,478 11 10	..	1,069	3,838 15 6	10,920 0 0

ALLUVIAL MINING.

MIDDLE ISLAND.

MARLBOROUGH DISTRICT.

Mahakipawa.

There are still a number of miners employed on this field, although not so many as there were at the time of my previous visit. The creek claims on Crown lands are gradually getting worked out. Most of them will only last for about six months; but there may be one or two of them that the workings may take another twelve months to complete. There has been a good deal of gold obtained from this field, but the drawbacks by floods in the creeks, and in searching for the gutter, together with the deep, wet ground, have caused a large expenditure to be made in the claims. At the time of my visit, at the end of February last, the claims had been flooded for a period of about eight weeks. Although the creek-claims on Crown lands will soon be worked, those on Mr. Cullen's freehold will last for a number of years; indeed, it is hard to say how far down the flat gold may be found that will pay for working.

Alice Fell Claim.—This is the lowest claim on the flat. The company that owns it has been sinking shafts for the last three years trying to find the gutter, and have only recently succeeded in doing so. They had got a few ounces of heavy coarse gold, up to the time of my visit, from a monkey-shaft sunk in a drive, and were making arrangements to sink the main shaft to a depth of 120ft., in order to be able to work the ground. They have two 9in. draw-lift pumps in the shaft, but these are not able to keep down the water when the creek is high. Indeed, it seems to me questionable if they will keep down the water in ordinary weather when the ground is properly opened out. These pumps are worked by an overshot water-wheel, which is not of sufficient power to drive them at their maximum speed. When this claim gets in proper working order, and payable gold found, there is no doubt other claims will be taken up lower down the flat, but they will require larger pumping plants than any that have yet been erected on this field to work them.

Golden Gate Claim.—This claim is situate in the Township of Cullensville. The gutter or lead of gold is running under the road or street, as it may be termed. The company owning this claim were at the time of my visit sinking a shaft 10ft. square, and were down to a depth of 15ft. Poppet heads were erected, and foundations laid down to erect pumping machinery. They expected to sink to a depth of about 100ft. to bottom the gutter, and they intend to use a 10in. draw-lift pump. The pump and winding-gear is to be worked by a small portable steam-engine, having two cylinders 6½in. in diameter, which would be equal to about eight nominal horse-power. This company have arranged to work the British Empire Claim on tribute as soon as they have a drive into the ground.

King Solomon's Mine.—This adjoins the British Empire and Golden Gate. It has been worked for about two years, with payable results, by a company, who have during the last year paid £120 in dividends and placed £400 to the credit of a reserve fund. At the time of my recent visit the mine was flooded, and the company were constructing a new race and flume to get the water at a higher level on the water-wheel they use for working their pumps, so as to make it an over-shot instead of a breast-wheel.

Davis's and Carr's Claim.—This is a claim on the terrace, on the opposite side of the creek from Cullensville. It has been worked since the commencement of the field by tunnelling and sluicing. Some idea of the value of the ground may be gathered from the fact that recently the owners of this claim have let it on tribute, and are said to be receiving 35 per cent. of the gross yield of gold obtained. The terrace where the claim is situate appears to be portion of a slip from the main range; and no doubt other ground higher up the range will be found payable for working by sluicing, but this mode of working the ground cannot be adopted to any large extent until all the creek claims are worked out, and even then it becomes a question whether Mr. Cullen will allow tailings to be sluiced into the creek that passes through his land.

Hibernian Claim.—This claim adjoins King Soloman's Mine, and is situate at the mouth of the gorge of the Mahakipawa Creek. It is owned by a public company, which has been one of the most successful on the field. Although the claim has been held and partially worked since the opening of the field, very little gold had been got until last year. According to the company's balance-sheet for six months ending the 31st December last, the value of the gold obtained was £2,452, and the expenditure during that period was £898, leaving a clear profit of £1,554. At the commencement of the half-year they had a balance of £106 brought forward, and this, together with the profit on the workings, enabled them to pay £1,584 in dividends, and leave a balance in the bank of £74. The quantity of wash-dirt taken out during last six months was, as nearly as can be ascertained, 600 cubic yards, the area worked being 20yds. by 15yds., and the wash-drift was taken out for a depth of 6ft. The value of gold in the material, therefore, was £4 1s. 8d. per cubic yard. The width of the lead on this claim, so far as has been worked, varies from 30ft. to 60ft. They have still about 430ft. of the lead to work, but as the gutter or lead in the next claim above them is only from 6ft. to 8ft. in width, they may come up to this gutter or gorge any day, which will cut off the rich wash-drift. The underground workings in this claim are carried on systematically, and every precaution taken for the safety of the workmen, the ground being carefully timbered and stowed up with stones.

The next claim adjoining the Hibernian is Nelson and Johnston's, who happen to have taken up the gorge portion of the creek. There is no gold on the side of the deep gutter that would pay for working; and as the gorge in this claim is only about from 6ft. to 8ft. in width, with the bottom rising very rapidly, very little gold is left in the gutter, it having been swept through by the force of the

stream, hence the rich ground where the lead widens out at the foot of the gorge in the Hibernian Claim, but no doubt a portion of the latter claim will be in the same gorge or gutter.

The following is a list of the principal claims working from shafts on the field :—

Name of Claim.	Number of Men employed in each Claim.	Name of Claim.	Number of Men employed in each Claim.
On Mr Cullen's Freehold.		*On Crown Lands—Creek.*	
Alice Fell	6	Te Oriori	4
Golden Gate	4	Downie's Mistake	3
British Empire		Never Surrender	4
King Solomon	10	Long time	8
Hibernian	10	Just in Time	6
Nelson and Johnston's	8	Boys' Own	5
Luckey Hit	4	Golden Hope	4
Davis and Carr's (sluicing claim) ...	4	Wairarapa	6
		Open workings in creek, about ...	30
		Total, about	116

All the claims mentioned in the above list, with the exception of Davis and Carr's, were flooded out from Christmas up to the time of my visit, owing to the influx of water in the creek during rainy weather, some of them being only pumped out so as to enable the men to go to work on the day of my arrival.

Duncan's Gully.

Gold was found in Duncan's Gully by Messrs. E. Marks, F. Henderson, W. Carr, C. Beckett, and W. Allnutt, on the 13th of February last, when they got 2oz. 16dwt. The gold resembles that found in Mahakipawa Creek, being of a heavy character. One piece was 1oz., another 11dwt., and one piece 7dwt. in weight. The gully runs up to a narrow saddle, on the other side of which is the left branch of Mahakipawa Creek. This branch was prospected at the commencement of the field, but as the ground was deep and wet very little work was actually done to prove whether there was payable gold or not. Duncan's Gully was prospected at the same time, and nothing at that time found to justify the belief that payable gold would be got. It was only after the Mahakipawa Creek began to get worked out that another attempt was made to prospect the gully; and this time they have been successful in finding what is considered payable wash-drift.

The Prospectors' claim is situate in the valley of Duncan's Gully, about three miles up from the road leading from the Grove to Mahakipawa, or about three and a half miles from Anikiwa Jetty. The present road goes through Mr. Duncan's freehold, branching off the main road at his woolshed. At the time of my visit, the 26th of February last, the following claims were taken up and work commenced:—

Above the Prospectors' Claim.		*Below Prospectors' Claim.*	
Oliver and party	3 men	Renton and party	6 men
Nelson and party	5 "	Barry and party	5 "
Draper and party	3 "	McIntyre and party	5 "
O'Malley and party	6 "	Oliver and party	6 "
Luben and party	8 "	Ross and party	4 "
Mason and party	6 "	McMillan and party	10 "
Prospectors	5 "	Cavanah and party	3 "
		Total, about	77 "

The ground of the Prospectors' Claim is 27ft. in depth; they have brought up a tailrace to drain the ground to a depth of 24ft., and intend to drive at this level up the gully, when they expect to soon be able to get on the bottom. The formation of the surrounding country and character of the wash-drift resemble that in the vicinity of Mahakipawa, being the old quartzose schist formation found in Otago. There is little doubt but that some of the claims that have been taken up will be abandoned, as the whole of the ground below the prospectors will be deep and wet, requiring machinery to work them; and, indeed, it is likely that the water may be too great to allow the shaft being bottomed by manual labour. There is no doubt, from the character of the gold, that some good claims will be found, and this discovery will be an incentive to other gullies being prospected in the same locality.

The workings in this gully are easy of access as compared with Mahakipawa when it was discovered, but before much work is done here some expenditure will have to be made in making a passable track up the gully, so that men can get their provisions and tools packed up. All the claims taken up at the time of my visit were on Crown lands, but if gold is traced down the creek, as it likely will be, it will go into Mr. Duncan's freehold. The prospector's claim is about one mile and a quarter up the gully or creek from the freehold land. Mr. Duncan has got business sites surveyed on a low terrace where the gully joins the flat, and several of them were applied for at the time of my visit. The present outlet through Mr. Duncan's land is only on sufferance. There is no road, and as soon as any vehicles begin to travel it will soon cut up into a quagmire, especially in wet weather. From the place where the township is laid off to the workings is, however, the worst part of the road, and something should be done to this part at an early date. All that is required at present is

the timber and scrub to be felled and cleared for, say, 20ft. wide, and the soft places corduroyed with fern-trees, which could be done for about £60. This would allow the miners an opportunity of testing the ground before incurring any further expenditure in the construction of a proper road or track.

Nelson District.

Collingwood.

This was the first alluvial goldfield opened in the colony, and a considerable quantity of gold has been obtained from it. Some very rich deposits have been worked, but in general the gold is distributed through the wash-drift, and can only be profitably obtained by working the ground by hydraulic sluicing with a large supply of water. In the beds of the different gullies, creeks, and rivers, gold was found richly disseminated through the wash-drift by the process of concentration performed by flowing waters carrying away the light sands and material, and leaving the denser particles behind. Therefore, in all auriferous drifts we find the heaviest deposits of gold in beds of streams and ancient watercourses; but, in order to make the general auriferous wash-drift deposited on the hills and table-land pay for working, the same principle of concentration has to be adopted.

There is a belt of country covered with auriferous drift, extending from the Quartz Ranges to the ocean beach near the mouth of the Parapara River, having a large fissure or slide filled with auriferous drifts to a great depth in some places. This slide crosses the Rocky and Slate Rivers, and passes through the head of Golden Gully, Lightband's, Appo's, and Glengyle Gullies, crossing the Parapara River, and the Parapara Flat on the east side of the mud-flat. Indeed this slide, or fissure, seems to be the principal source from which the auriferous drifts in the different gullies have come, and from which a great deal of gold will yet be obtained; at the same time, although there is a large area covered with these drifts, the ground is by no means rich. But, with a good supply of water, and a properly constructed hydraulic plant, the ground can be made to give handsome returns.

Notwithstanding that Collingwood is the oldest goldfield in the colony, no improved appliances have ever been used in working the alluvial drifts. The reason of this is obvious. The other goldfields as they were opened up gave such large returns at first that they absorbed the whole of the mining population in the colony. Only those who had either highly payable claims or had not sufficient means to follow up the new rushes would stay on the field at this time, for even in the most palmy days of the goldfields there were amongst the miners men who would give away or spend the money as fast as they made it, and sometimes had they not the means to go to new fields especially when the distance was considerable and passage-money by sea-going vessels in those days expensive. Be that as it may, the fact remains that there does not appear to have been any men left in the Collingwood District with energy, perseverance, and sufficient capital to bring in a large supply of water to work the ground in a systematic and economical manner. Neither have those persons who have been employed on this field for many years had an opportunity of visiting other portions of the colony where improved hydraulic sluicing is carried on.

Some three years ago Messrs. Adams, Logan, and Gilmer took up some ground on the Parapara Flat, a portion of which is leased from the Natives. Adjoining this they hold a special claim of 100 acres, which has since been amalgamated with some freehold land belonging to Mr. Travers, and a strong influential company has recently been formed to work the ground with a working capital of £20,000. A survey of a water-race has been completed from the Onakaka and Paramahou Creeks at an elevation of 700ft. above the flat. It is reported that at least ten sluice-heads of water can be got from these creeks in the driest weather. This race-line is about fifteen miles in length, and is estimated to cost with hydraulic plant about £25,000. Since the survey has been completed the present company have purchased the water-rights and claim belonging to a private party working at Glengyle Gully, for £2,300. This gives them the second water-right from the Parapara River for twelve heads of water. Since this purchase they have bought the whole of the Red Hill Company's properties and water-rights from the Parapara River, which now gives them the first right to about twenty-four sluice-heads of water, which will make their mining property an extremely valuable one.

There is a large supply of water in the Parapara River for about eight months of the year, but during the middle of summer in a dry season there would not be above from fifteen to twenty sluice-heads of water available. The company having now purchased the first and second rights of water from this river they intend to lift the water from this source, and bring it on the ground. Another survey will now be made with the view of having this done, in order to ascertain at what elevation the water can be brought in.

The payable nature of this ground depends entirely on the supply of water that can be brought on to it and the elevation that the water-race is constructed at. The greater the elevation the more valuable the water-supply will be; but in any case it should not less than from 300ft. to 400ft. above the ground proposed to be worked, as the greater portion of it will have to be lifted with a hydraulic elevator. Some portion of the top material can be sluiced off in the ordinary manner, but this only forms a small portion of the auriferous drift in the company's ground. Therefore, to insure good returns a large supply of water is required at a high elevation. Several prospects—the results of tin-dishfuls of drift said to be promiscuously taken from the ground—were given to me, and according to the quantity of gold from these prospects, the ground should be highly payable for working by a systematic method; but in taking prospects from the ground, it is almost the same as sending auriferous and argentiferous ores to be assayed. It may be said to be almost impossible to test samples where the appearance of metals or minerals does not exist; and in taking a tin-dishful of stuff here and there through the ground, it is hardly possible to get those who are directly interested in the venture to wash material where gold is not likely to be found, hence the average of prospects given to a disinterested person to weigh and

calculate the quantity of gold per cubic yard is, in many instances, valueless; but if only one-twentieth part of the gold be found distributed in the material that was said to be in the samples shown me, the venture will be very remunerative. The following shows the weight of gold got from the samples given me from the prospects referred to:—

	Grs.
No. 1 prospect, from Native lease	0·50 gold.
No. 2 prospect, from Native lease	0·35 "
Mud-flat prospects	0·27 "
No. 1 Tunnel, from Parapara River	0·70 "
No. 2 Tunnel, " " "	1·30 "
No. 3 Tunnel, " " "	1·10 "
No. 4 Tunnel, " " "	1·20 "

These were each said to have been obtained from a tin-dishful of drift, which could not be more than 15lb. weight; therefore the average of the whole of these would be equal to over 7dwt. per cubic yard. This shows that these prospects were not promiscuously taken, for this yield would pay for driving-out the ground, and also pay for carting the drift some distance to water to wash it. The present company will do a great deal in opening out this field afresh, and thus some further valuable mining properties are likely to be taken up in this district.

West Coast District.

Westport.

There are a good many miners employed on the ocean beaches on the north of the Buller River, who depend entirely on the state of the ocean-beach. Sometimes it is covered with a heavy deposit of shingle and sand, and at other times this beach is bare, and covered with nothing but a thin layer of black sand; it is only when this occurs that the miners can make fair wages. On the south side of the Buller River, there are four localities where extensive gold-mining operations are being carried on—namely, Addison's Flat, Croninville, Charleston, and the ocean-beach between the Totara River and Charleston.

At Addison's Flat, there is a large area of auriferous drift. Some of the leads in this locality have been worked for the last twenty-six years, and very rich auriferous deposits have been found. The whole of this flat, as well as Croninville and the Charleston Flat, has at one time been under sea-level, as the gold is found in ancient sea-beach sand and drift. The general character of the workings are sluicing, with water-balances to haul up the stone and tailings, while the muddy water is carried away in underground tail-races. Two claims—the Fair Maid and Gladstone, and Mace and Bassett's—were worked on the hydraulic elevating principle; but the Gladstone Company, during last year, was put in liquidation, and the whole of their valuable plant, reservoir, and water-races were sold to Messrs. McDonald and Lampfert, of Westport, for £400, no work has been done here since. Mace and Bassett are still carrying on hydraulic-sluicing operations, it is said, with payable results.

Carmody and party are said to have one of the best claims on the flat. This party have been working here for the last seventeen years, and it is stated in a prospectus, recently issued by the Shamrock Lead Company, that gold has been sold by the shareholders of this claim to the value of £25,709, the claim is still continuing to give good returns for working. During last year they have been shifting their plant forward and repairing their water-races, &c., having erected a set of Guthrie's gold-saving tables, they are now commencing mining operations again. They are working on what is termed the town-lead, from which a large quantity of gold has been obtained.

Shamrock Company.—The syndicate who own the mining property under the name of the Shamrock Lead are trying to form a company with a capital of £12,000 of £1 each, of which five thousand shares fully paid up is to be given to the syndicate, the balance of the capital being for completing a water-race and erecting a hydraulic plant. A water-race has been constructed from the Totara River for about three miles, and there is yet about one mile twenty-six chains to complete the race to the ground proposed to be worked. When this race is completed it will be at an elevation of about 350ft. above the workings. This lead, which is a continuation of the same one on which Carmody and party are working, was worked in the early days as far as the water would permit; but as the lead got into deep ground the water became too heavy to contend with, and to drain this ground a tunnel tail-race was constructed for a long distance, but when completed it was found to be too shallow to be of any use; it was likewise badly constructed, portions of it caved in, and were never repaired. This led to the abandonment of the ground for many years. It is said that the depth of the ground is from 30ft. to 80ft., and it is intended to work it on the hydraulic elevating principle. Judging from the large amount of work done in trying to get into this ground in the ealry days, there seems to be a fair prospect of it being made to give fair returns with a good systematic method of working. There are several parties of miners working on the different leads, all of whom are said to be making fair wages. Some new ground was opened up about three years ago by Minogue and party between the old leads and the ocean beach, about two miles nearer Westport than Mace and Bassett's claim. It is said that the claims being worked on this lead are giving very good returns.

At Croninville there are some very fair claims, but they are not giving such good returns as formerly. At Charleston the ground is gradually getting poorer; but great expectations are formed that there are still large areas on the flat which will pay for working with a good supply of water, which is being brought in by the County Council, to which body the Argyle Water-race was handed over by the Government.

Blackball.

Gold has been found in this locality for a number of years, but the difficulty of access has prevented the place being properly explored. A horse-track has now been constructed from Kinsella

Hotel, in the Grey Valley, up the Blackball Creek, for about nine miles. This ends about one mile and a quarter from the head of the workings. A portion of the constructed track, over what is known as Smoke Hill, has extremely steep grades, which will prevent the track ever being made into a passable road. At the same time trollies are being used on it, and recently the machinery in connection with a crushing-battery has been conveyed over this road. There are thirty-seven men at work on the terraces, principally hydraulic-sluicing, and, as far as can be ascertained all are making fair wages. A small paddock was shown me by Mr. Perrotti, of Greymouth, which was taken out by the Minerva Sluicing Company—of which he is a director—where two hundred pounds' worth of gold was obtained. Judging from the small area of ground sluiced away, it must be very rich. The difficulty here is the large quantity of stones in the ground, which have all to be shifted by hand. The Minerva Company have constructed a water-race from the Roaring Meg Creek, said to have a carrying capacity of from twenty to thirty sluice-heads, and there is about 600ft. of fall between the termination of this water-race and the claim. The company are now cutting up a tail-race at a deeper level to get sufficient fall to work their ground, and when this is done, Mr. Perrotti informed me, they intend to erect two high derricks, to be worked by water power, to lift and stack the stones.

The ground on the terraces alongside the creek is from 50ft. to 70ft. in depth. In some instances there is a little gold all through the drift, and in other places the gold is found through it for from 20ft. to 30ft. from the bottom. Were it not for the excessive quantity of loose stones, this ground should pay extremely well for working; and it will take many years to work out. The ground is principally held in extended claims from 2 to 5 acres in area. The only parties having larger claims are the Minerva Company (12 acres) and Marshall and party (11 acres). Sluicing-operations are carried on in a very primitive manner in most of the claims, owing to the difficulty in getting iron pipes brought on to the ground. Those who use iron pipes have very small ones, and none of the parties, with the exception of the Minerva, have sufficient water to work the ground economically. Indeed, when it is considered that everything has to be conveyed on men's backs from the end of the present track to their claims, the miners deserve the highest commendation for the energy they have displayed and the amount of work they have done in this locality. It is a place where gold is likely to be found in the terraces higher up the creek, and when the present track is extended it will afford far greater facilities for prospecting.

Greenstone.

The country in the vicinity of Greenstone resembles to some extent that about Kumara, only the stones are not so large and there is a much larger percentage of granite boulders. All the stones are greatly rounded, which indicates that they have been carried for a considerable distance by the action of a flowing stream. Judging from the formation of the country and the character of the gravel-deposits, there appears to have been at one time a large river flowing in a northerly direction at nearly right angles to the present course of the Greenstone Creek. Where the present gold-workings are carried on the gold is obtained on a false bottom; but there is a little gold distributed through the whole depth of the wash-drift, which is from 40ft. to 50ft. on Duke's Terrace, on the opposite side of the creek from the township. In the workings in the bed of the creek large quantities of greenstone blocks, or boulders, were found in the early days, and it was in this district where the Maoris in the early times used to come for greenstone—*pounamu*—to make into axes and adzes for weapons in time of war, and also for constructing their canoes. The same description of greenstone is found amongst the wash-drift at Kumara, but none of this rock has yet been found *in situ*. Large blocks of greenstone were also found in the early days of the goldfields near Kanieri, but this seems to be the southern limit where boulders of greenstone have been found, and the northern limit would be set down as the New River. There are indications clearly visible between the New River and the Totara River that enormous quantities of material have been deposited by glacial action, the whole of it being more or less auriferous. It would be difficult to sink a shaft in this moraine matter and not find the colour of gold. In many places the large stones are quite angular, and sharp on the edges, indicating that they have been left near the place where they were brought by the ice; while in other places the boulders and stones are rounded in a more or less degree, showing that they have been rolled about by the action of a violent stream. The latter appears to have been the case with the auriferous deposit of gravel-wash all along where the gold-workings are situate, from Kanieri to Greenstone.

The greenstone boulders found amongst the wash-drift at Kumara, as well as at Greenstone, would indicate that the original material came from the same source; but as there is a far greater proportion of granite boulders amongst the wash-drift at Greenstone than at Kumara it would lead one to suppose that, although the material might have originally come from one locality, the glaciers bringing it from the mountains also brought the gold found at Greenstone from the northern side of those glaciers which deposited the morainic matter in the vicinity of Kumara. But, be that as it may, it is evident the whole of the gold leads or runs are formed by the concentration of the morainic matter by the action of a flowing stream. The claims on Duke's Terrace, where the present workings are situate, are far from rich. The manager of the Greenstone Sluicing Company informed me that in some of their washings the ground had not averaged 1gr. of gold to the cubic yard, and yet they could make this yield pay all working-expenses; the reason being that they had an excellent supply of water—about sixty sluice-heads for fourteen hours per day. All the gold-workings in this locality are on the recent deposits. No bed-rock is found for two miles down the creek from the township, where the sandstone begins to appear. Intermixed with this sandstone there are layers of marine gravel, in which very fine colours of gold are found, but not sufficient to pay for working. If the prospecting-shaft at Kumara should show gold at the deep levels, there is equally as good a field for prospecting operations at Greenstone; and if a deep lead be discovered here it will be found to be of a much older formation than the one from which most of the gold has hitherto been obtained.

Greenstone Sluicing Company.—This company took up an old water-race formerly belonging to the Hohonu Water-race Company, but which had been broken down and out of repair for a number of years. The race gets its supply from the Hohonu Creek, where there is plenty of water at all seasons of the year. They have also a reservoir near the workings capable of storing the water during nights and Sundays, so that, with the extra supply from the reservoir, they have a pretty constant supply of sixty sluice-heads for from twelve to fourteen hours per day. The company only use portion of water under pressure; they have a wrought-iron pipe 16in. in diameter coming from their flume which gives about 50ft. of head, and from the end of this 16in. pipe branches are laid, to which are attached nozzles varying from 4in. to 7in. in diameter; the remainder of the water flows over the face, and down the tail-race, the sluice-boxes being 3ft. wide, laid on a gradient of 3ft. 6½in. to every 100ft., or 5in. to the 12ft. box. The tail-race is about 2,800ft. in length; portion of the race is paved with wood blocks, and portion with steel rails. At the underside where the steel-rail paving terminates there, is a grizzly, made by having the bars placed crosswise in the sluice, and about a quarter of an inch apart. The water and sand going through this grizzly flow over under-current tables, covered with cocoanut-matting. There are eight men employed in the claim, and they hold 30 acres of ground.

King's Claim.—This claim is situate on the front of the terrace, which is of similar character of wash-drift as that found in the Sluicing Company's ground. Mr. King holds a claim of 4 acres, and employs three men, using about five sluice-heads of water for four hours per day. Dwyer and party and Simmons and party also hold claims on this terrace, but neither of them has a constant supply of water; each having about twenty-five sluice-heads for about a week after rain, but it gradually diminishes as fine weather sets in. The former party consists of five men and the latter of four men.

A few parties of men are working on the south side of the creek, about two miles below the township, where the wash-drift becomes of a different character, belonging to an older deposit; but portion of this deposit is covered with concentrated material from the more recent glacial deposits covering the surface of the terrace as it gets down to near the junction of the Greenstone Creek with the Teremakau River, known as the Westbrook Diggings. A few Chinese are also working in the bed of the Greenstone Creek, which they do by constructing dams, turning the water down one side whilst they work the other. Whatever may be said against the Chinese as colonists, they are a hard-working and ingenious race. They are able to construct cheap embankments, which serve the purpose they are intended for; and in the matter of successfully working the beds of streams for gold they, in many instances, set an example which it would be well for Europeans to imitate.

Kumara.

This is by far the largest hydraulic-sluicing field on the West Coast, and one which will continue to support a large mining population for many years to come. The ground is generally not now so rich as when the field was first opened, but the miners are now using a more economical method of working it; more water is used, and less labour. Some of the claims are giving very good returns; but the field may be termed one where the miners are able to make fair wages. No doubt some of them are working very poor ground; but this is the case on any field. Still, with a good supply of water very poor ground can be made to pay.

Since the main tail-race has been handed over to the miners, the parties using it have come to an arrangement among themselves, and have made stringent rules for its use. Persons having much fall in their tail-races are limited to a small supply of water to sluice with. The arrangement is that no sluice running tailings into this main channel shall have a higher gradient than 1 in 18, or 3ft. 8in. to the chain. Such rules will enable work to be carried on with a much less chance of blocking; but, so long as the channel was the property of the Government, such an arrangement could never have been made. The cost of maintenance, the miners informed me, was 11s. per shift of three hours each for each claim; and as there are, on an average, five men employed in a claim, the cost of maintaining it would be about 13s. 2d. a man per week, whereas the Government only got 7s. 6d. per man, equal to 6s. 3d. per shift.

The tailing-fluming outside the tunnel is laid on a gradient of 1ft. 7¼in. to the chain, and even with this flat grade the tailings scarcely ever block in the boxes. The only place a blockage takes place is inside the tunnel, where the miners' tail-races join the main channel with a high gradient not being connected to the main tail-race in a proper manner. If these tail-races were brought in with a proper curve, so that the velocity of the water in the main channel would not be retarded, a blockage would hardly ever take place. Since the construction of the deviation of the main tail-race the tailings-site has considerably filled up, and, although a large quantity of ground will yet be worked into this main channel, the time is not far distant when the tailings-site will be again filled up, and the bed of the river raised to such an extent that it cannot be used.

Several new claims are opened out on the flat alongside the road from Kumara to Larrikins', some of which are payable for working, while others cannot be said to be so. As far as the field has been tested, the richest ground was about what is termed Dunedin Flat, and the nearer they get towards the Kapitea Hill the poorer the ground seems to get. The miners state that where the ground does not contain a large percentage of stones and boulders they never expect to get much gold. The reason of this is evident: the stream of water, which was undoubtedly the means of washing away the light sands and gravel, concentrated the material so that these layers contained all the heavy portion of the drift, which also contained most of the gold. If this had not taken place all the original material could not have been made to pay for working on the present system.

There are seven leads of gold in this locality, six of which start from, as it were, a line drawn from the upper end of Dillmanstown to the head of Larrikins' Flat, near the junction of the branch and main Kumara Water-race. Commencing at the edge of the terrace fronting the Teremakau River there was a shallow lead, then the Shamrock, Dunedin Flat, Ross Terrace, Scandinavian, Mignon-

nette, and Larrikins'. These leads tail out in the shape of a fan as they go down the flat; but, should a deep lead be found, it will cover a much larger area of ground than either of the leads of gold-bearing gravel which have yet been worked. There are three claims at the head of Larrikins' all giving good returns. The wash-drift in these is full of large angular boulders, some of which havenot travelled far after they were deposited by glacial action. However, this will be fully referred to again in describing the action taken in connection with fixing the site of the prospecting-shaft on this field. The following statement will show the principal claims at work on the field, with the number of men employed in each, the fall or gradient of their sluices, and the number of sluice-heads of water used from the different water-races on the field.

KUMARA WATER-RACE.

Name of Party.	Number of Men employed in the Claim.	Fall to 12ft. in Tail-race.	Number of Sluice-heads of Water used.	Name of Party.	Number of Men employed in the Claim.	Fall to 12ft. in Tail-race.	Number of Sluice-heads of Water used.
No. 2 Channel — Water from Kumara Race—				*Private Tail-races—Water from Kumara Race—*			
Holst and party ...	4	6	12	Davidson and party ...	6	12	8
Watson and party ...	5	8	10	Seater and party ...	5	6	10
Morris and party ...	2	5	11	Blake and party ...	6	6	10
Hughes and party ...	4	6	12	Henderson and party ...	6	7	10
Palmer and party ...	6	8	10	Lee and party ...	7	7	12
Harvey and party ...	3	5	10	R. Anderson and party...	6	10	10
Rodgers and party ...	3	8	8	Schroeder and party ...	4	12	10
Ireland and party ...	4	5	12	Stennard and party ...	5	14	10
Pascoe and party ...	6	8	10				
Bauke and party ...	4	4	10	*Water from Holmes's Race—*			
Corrigan and party ...	3	6	10				
				Collins and party ...	4	8	10
No. 3 Channel — Water from Kumara Race—				Brown and party ...	5	7	10
				Payne and party ...	5	7	10
O'Sullivan and party...	5	9	8	Dinan and party ...	6	7	10
Harris and party ..	6	8	10	Evenden and party ...	4	10	10
Rothwell and party ...	5	9	8	Burke and party ...	5	10	10
Anderson and party ...	5	5	10	Bowden and party ...	6	10	10
Hillier and party ...	4	9	8	Johnson and party ...	8	12	10
Rizzie and party ...	4	8	8	Ames and party ...	5	9	10
Williams and party ...	3	8	8	Jones and party ...	3	8	10
Carew and party ...	5	9	8				
Light and party ...	5	6	10	*Water from Private Water-races—*			
Thomas and party ...	6	8	10				
O'Connell and party ...	5	9	8	Pearn's lease ...	6	10	15 to 20
Moynihan and party ...	4	8	8	Long Tunnel Gold-mining Company ...	6	7	10 to 15
Rochford and party ...	4	8	8				
McNeil and party ...	4	8	8				

Prospecting-shaft, Kumara.—In accordance with the instructions of the Hon. the Minister of Mines, Mr. A. McKay, F.G.S., Assistant Geologist, Mr. S. Gow, Inspector of Mines, and myself, selected a site for a prospecting-shaft in Larrikins' Flat, with the view of testing the deep levels. Previously to so doing, we had to gather all local information as to the direction of the different runs or leads of gold in the flat, and also as to the probable run of deep ground. From all the evidence we could obtain, the blue reef which is seen on the side of the terrace fronting the Teremakau River appears to dip gradually towards the Kapitea Hill. In the Long Tunnel Company's tail-race, where it cut through the blue reef it was dipping slightly in the direction mentioned, and from what could be gathered from persons working in it during its construction there was a little rounded wash and pebbles met with on the top of this reef; and the desription of the clean-washed stones and pebbles indicated that a large body of water had at one time passed over this reef, and must have had an outlet towards the ocean. We examined the ground down for some distance along the front of the terrace facing the river, below the township, to see whether an outlet could be discovered, but we failed to find any. We then directed our attention to the country above Dillman's to see if we could trace the direction the stream had come from which had deposited the gold in the flat.

From the evidence obtained, and the formation of the country surrounding Kumara, there is little doubt that a large stream of water has passed through the flat, and possibly may have cut a deep channel in the blue reef; but this must have been prior to the moraine deposits, which now cover the country on both sides of the Teremakau River, and abut on to the marine gravels found on the Kapitea Hill. These morainic accumulations seem to have been travelling in a northerly direction, and across the ancient river-bed, damming it completely up, and causing the water for some period to pass through Bruce's paddock, and into Lake Brunner. The immense barrier that must have been across the present channel of the river at one time is clearly indicated by the remains of the ridge at the head of Larrikins', the high terrace on the Westbrooke side of the river, and also the high land or ridge passing from Dillman's towards the junction of the

Christchurch and Loopline Road. Between this ridge and the marine gravels on the Kapitea Hill there are the remains of a lake filled up with glacial mud-deposit, extending up the Kapitea Valley for some distance.

The present runs of gold worked at Kumara are entirely due to the concentration of the morainic deposits, by the action of a running stream carrying away the light material, and leaving the denser deposits behind; and, from the direction in which these runs or leads of auriferous wash-drift are found, going at an angle across the flat towards the Kapitea Hill, they indicate that the original channel of the river or deep ground is not a great distance from the northern side of the Kapitea Hill. We had ample evidence that gold is found in the morainic deposits in small quantities. Some shafts at the head of Larrikins' have been sunk in this material, where nothing but sharp angular stones are found, and in each of these gold is found, although not in sufficient quantities to pay for working. That being the case, the water from the lake that had been formed by the morainic barrier at length managed to cut away a small channel, and commenced to sluice away the material in the same manner as the miners do at the present day, only on a gigantic scale, concentrating it, and leaving the gold in layers where the concentration took place. The deep ground being towards the Kapitea Hill, the stream would naturally trend slightly in that direction, and then gradually break up into several branches as it got into the flat. This would account for the runs of gold tailing out in a fan-like shape.

How long the river might have flowed over the high barrier is a question that cannot be determined, it is like unknown quantities in an equation; but we can, by the rounded character of the stones in the workings lower down the terrace near the river, see that the water must have brought them some distance from the place where they were first deposited by glacial action. From the direction in which the glacier has travelled it would seem to have come from the mountains between the Arahura and Taipo Rivers. Boulders of the same character are found at Kumara as are seen in the bed of the Taipo River, but there is no olivine rock found at Kumara which Mr. McKay states exists in the watershed of the Arahura.

The inference to be drawn from this is that it is not likely that the leads or runs of auriferous wash-drift found on Larrikins' and Dunedin Flat will be traced on the east side of the morainic ridge; but there is a probability of leads of gold being found between Larrikins' Flat and the ocean-beach. If a rich lead of auriferous drift is found across the ridge from Larrikins' in an eastward direction, it is likely to be of a much older formation, and in the same character of drift that may be expected to be found in the deep run of ground, on the blue bottom, where the prospecting shaft is being sunk.

The leads or runs of auriferous wash-drift in the Kumara field are the Larrikins', which is the most southerly one; next comes the Mignonette, the Scandinavian, the Ross Terrace, the Dunedin Flat, the Shamrock, and, lastly, Shallow Lead. The general trend of these leads are nearly parallel with each other, but all crossing the flat at a slight angle, and finally tailing out in the shape of a fan; the greatest width between the most southerly one and the most northerly being not more than about 60 chains.

The site selected for the prospecting shaft was on the Larrikins' Lead, in Williams and party's claim, that being, as far as we could ascertain and determine, somewhere about the deepest ground on the flat. We do not pretend to have fixed the site of the shaft accurately as being in the deepest run of ground, but as near thereto as possible, as far as the surface and other indications show; judging by the upper-drift strata, the shaft may possibly be very slightly more to the Kapitea Hill side of the deep ground; but as the drift on the slope of the bottom, dipping southwards towards the Larrikins' Lead as far as it had been followed, did not contain a great deal of auriferous wash, it would be better to sink the shaft in such a position that were it not in the deepest ground it would bottom on the opposite slope.

Whether there is sufficient gold to pay for working in the lower drifts is a question that no one can finally determine until after the drifts have been prospected, and although we have, after careful investigation, fixed the site for a shaft where there is a high probability of old auriferous drifts being found, it may, however, turn out that even if the lower drifts are auriferous, and will in places pay for working, the shaft may go down on a spot where there the gravel is poor in gold. There are rich and poor places in any run of auriferous drift that has hitherto been worked, and it cannot be expected that those worked in the future will be different in this respect.

In regard to the probabilities of a lower lead of payable auriferous drift on the Kumara field, all theoretical views with reference to the distribution of gold amongst the lower gravels point to this conclusion. It may safely be assumed that from time immemorial the melting of snow and the collection of rainwater in certain hollows have been the means of cutting away gorges in the mountains, causing large landslips to take place, and, by the concentrating action of the flowing stream, the less dense material got carried onwards to the ocean by the current, while the heaviest particles were partially left in the bed of the stream. It may also be taken for granted that, seeing that the morainic matter in the vicinity of Kumara all contains less or more gold, and that this deposit must have come from the adjoining high land, we may safely assume that previously to those large masses of material being brought down from the mountains, and forming barriers across the then flowing streams, the work of denundation had been going on, and that gold was deposited in the beds of the river from the material sluiced away with the action of the flowing water. In many instances it can be clearly shown that the rivers at one time flowed in a different direction from that in which they flow at the present period; taking also into account the work of denudation which has been and is continuously going on, as well as the large extent of country covered with morainic matter and material brought down by glacial action, subsequently being washed away, and covering large plains, two things are indicated: First, that the mountains must at one time have been at a much higher elevation than at present; and, secondly, that the rivers brought down larger quantities of material than they are capable of now doing. This really means that the streams contained a far larger quantity of water, and this would be a natural sequence if the mountains were at a

greater elevation, especially on the west coast of New Zealand. Owing to the prevailing winds being in a somewhat westerly direction, the current conveying moisture in the atmosphere striking against the mountains would condense the vapour, and cause large bodies of water to flow into the ocean on the west coast. The well-rounded large stones that are met with in the auriferous wash-drift on the West Coast, and in the gravel beds all along from the Grey River to Ross, show that it required larger streams of water to shift and roll the large masses of heavy stones about than exist in that locality at the present day.

The gold found in the gravel-drifts may chiefly be attributed to concentration by the action of streams of water, and where the material has not been subjected to such action we can hardly expect to find gold in quantities sufficient to pay for collecting. The theory that large nuggets of gold can be deposited in gravel-beds in solution although feasible is still open to many objections, and is not conformable to the conditions met with in working runs or leads of gold, as for instance, wherever there is a large depression in a lead or vein of gold, forming as it were a minature lake in the bed of a stream, the gold at this point generally gets less; or if it be found equally as good as in other portions of the lead, it is in a stratum of drift on the same hydraulic inclination as the general bed of the stream, showing that the flowing water carried on the work of concentration at such a level as the current could carry away the light material. In very few instances is rich auriferous wash-drift found on the bed-rock in depressions, or deep large holes in a stream, it is generally found on the slopes. But were the distribution of gold due to its flowing in solution through the drift gravels we should naturally expect to find it deposited where the current is obstructed, and at the bottom of depressions in the runs and leads, whereas the contrary action takes place in reference to its deposition.

It may as a general rule be taken that, wherever morainic matter is brought down by glacial action and cuts across the country, damming up rivers and streams and forming glacial lakes, the surface runs or leads of auriferous drifts will not be found on the up-stream sides of these deposits unless they are found at lower levels and of an older deposit. This particularly refers to Kumara. The large sharp angular stones met with in the drift at the head of Larrikins' Flat, and on the ridge running back from the low saddle, where the water-races cross towards the Christchurch Road, show that they have not been subjected to the action of rapidly-flowing water, and therefore the material has not had the chance of being concentrated by the action of a stream; and, although it may contain a little gold all through it, nevertheless until such time as the natural concentration of the material takes place through the agency of water it cannot be made profitable for working. All surface runs of auriferous gravels on the down-stream side of such deposits will be found to continue for distances commensurate with the force and volume of water used in producing concentration, and the length of time the stream continued in one bed. The older the deposit, and the greater length of time that rivers and streams have been flowing in one channel, the more continuous the runs or leads of gold; for, after all, the rivers and streams only act as ground-sluices. Considering the manner in which the different surface leads at Kumara has tailed out, gradually getting poorer as they got down the flat, it indicates that the channel of the stream was continually shifting, that the water was not confined for a long time in one channel, and therefore there is not a great prospect of finding rich surface leads between the present workings and the ocean-beach unless in the drifts of an older deposit; but if a deep run of auriferous gravel be found in the flat, the wash-drift will be of an older deposit, and leads may be traced along the ancient channels of the streams for long distances.

A considerable portion of the gold found on the ocean-beach southward of the Grey River, and also on the back leads running parallel with the ocean-beach, came no doubt from the Teremakau River, whether from its present channel or ancient course is of very little consequence; but it is probable that when the waters of the Teremakau cut through the immense barrier of the morainic deposit, and carried down a large quantity to the ocean, a considerable quantity of gold, concentrated from such deposit, has from time to time been ground up by the action of stones, boulders, and gravel rushing down with the current, being finally carried down and deposited with the ground-up material on the ocean-beach. No doubt the water of the river at the present time carries down a certain quantity of gold, but this quantity is infinitesimally small compared with that brought down in earlier ages. However, a large quantity of gold found on the ocean-beaches came from a much older deposit than these morainic drifts, possibly from land which has since disappeared to the westward in the ocean. This will be more fully gone into when dealing with the drifts found on the deep levels at Ross.

The question as to the depth the prospecting-shaft may have to be sunk before reaching the bottom cannot now be determined. We could not trace any inlet at a deep level going into this flat from the Teremakau River; but, judging from the manner in which the blue-reef is dipping on both sides, the gravel-deposit is not likely to be of great depth, and probably it can be drained by an adit-level from the Teremakau River. The difficulty in sinking the shaft to prospect the ground is the quantity of water likely to be met with in the lower drifts; for, if an old auriferous drift exists at a great depth and no impervious stratum met with in going down, the quantity of water is likely to be troublesome, and probably may require large pumping-machinery if the ground cannot be drained by an adit-level.

Seeing the probabilities there are of finding a deep lead or run of gold in this flat, and that the whole of the ground is held in mining claims, the owners of each of the claims have agreed to contribute a certain amount towards testing the ground; for should an older run or lead of gold be found here, it will greatly enhance the value of not only all the mining claims on the field, but also all property in the Township of Kumara, the business people being wholly dependent upon the mining community. The Government have agreed to subsidise this undertaking to the extent of pound for pound, but the difficulty has always been the cost of sinking a prospecting shaft, and of finding the means. Some held that the ground should be prospected by an adit from the river, and others by

sinking a shaft: but, as the depth of the ground is unknown, it was not certain that the bottom could have been reached by an adit; besides such adit would have had to be at least 3,000ft. long. On the other hand, it is known that there is a considerable quantity of water in the ground, from shafts that have been previously sunk on this flat; and the cost of pumping appliances being a question of ways and means, it was a difficult matter to get the whole of the claimholders on the flat to agree as to the amount of contribution that each should give, and it was not until after several of the claims began to be nearly worked out on the upper levels that it was finally arranged to test the deep ground.

A shaft is being constructed 9ft. by 4ft. in the clear inside of the timber. A contract was let to sink it to such a depth as the quantity of water to bail would not exceed 500 gallons per hour. Poppet-heads have been erected, and also an overshot water-wheel and winding-gear to lift the water and material. As soon as the water exceeds 500 gallons per hour the contractor is to be supplied with a jet-pump, this description of pump being considered the best under the circumstances—taking the cost into consideration—for the purpose. A tunnel tail-race is to be constructed from the main tailings channel to the shaft, and the pumping operations will commence after getting below the level of this tunnel—that is, if the water becomes too heavy for bailing. An unlimited quantity of water can be got from the water-race to work the jet-pump to a limited depth. It is well known that this description of pump will not give a large percentage of the power employed; but it can be made to lift a considerable quantity of water to a height of at least 20 per cent. of the hydrostatic head, and another jet-pump would have then to be used to lift the water into a tank for the upper jet-pump to lift. This arrangement may allow the shaft to be sunk to a depth of about 170ft. Should the depth of the ground go below sea-level, as is the case at Ross, then this description of pumping appliance, with the available head of water, would be of no service. It may, therefore, be said the jet-pump has been adopted on account of its being within the means of those interested to procure, and, even should the ground become too deep for this pump to be used, the loss incurred in its cost and erection will be very small.

The shaft is now down to a depth of 100ft., and a tunnel tail-race from the main channel constructed for a distance of about 800ft. The cost of the construction of this shaft is borne by every claimholder on the flat, each man gives a certain amount, which is subsidised by Government; and if the claim on which the shaft has been sunk gets payable gold at the deep levels, the holders of such claim have agreed to pay a certain proportion of the expense of sinking the shaft in proportion to the quantity of gold in the wash-drift—that is, if the auriferous drift is 3ft. in thickness, and averages 4dwt. of gold per load for thirty loads, the owners of such claim have to pay one-sixth of the expense of sinking; but if the said thirty loads should average 5dwt. of gold per load, they are to pay one-third of the expense, or at the rate of 20 per cent. of the gross yield of gold from such wash-drift until the money is paid.

Callaghan's.

A few parties of miners have been working on the sideling of the range and in gullies for many years. Some of the runs or leads of auriferous drift were very rich, but as they got into the flat, the ground became deep and wet, and therefore no steps were taken until last year to try and prospect this ground to ascertain whether some of these leads could be traced. The farthest out claim worked towards the flat is Morretti's and party, who are working by hydraulic sluicing, having a tail-race for a long distance to join the Kapitea Creek. The party has a face of about from 70ft. to 80ft. in depth, consisting of extremely good-looking wash-drift, and, in some of the branches leading into their tail-races large specks of gold could be seen, which shows that there must be some good layers of auriferous gravel in the claim. Following a continuation of the direction of the lead of gold coming through Morretti and party's claim, some shafts were sunk further out into the flat where good gold was said to have been obtained, but at this point the bottom on which these drifts lie is said to have dipped off very quickly. This report induced Hyndman and party to sink a shaft a little further into the flat, with the hope of picking up the lost lead of gold.

Hyndman and Party.—During the last year this party sunk a shaft to a depth of 145ft. without reaching the bed-rock. They erected poppet-heads, washing paddock, and horse-whim, and have what the miners would term a very good rig-out to work the deep ground. In sinking the shaft, 90ft. of blue gravel was gone through, and below this was 30ft. of brown wash-drift, containing a little gold all through it, but not sufficient to pay fair wages for driving it out. The water in sinking became too heavy to contend with, and further sinking had to be abandoned. At the time of my visit they were driving from their shaft at about 120ft. below the surface, with the hope of striking the lead near the place where the bottom suddenly dipped off in the former workings; but the main body of the material they went through in their shaft, although it might prove valuable ground to work by hydraulic sluicing, is too poor, the gold being too finely distributed through the material to pay for driving and timbering.

McConnon and party also commenced to sink a shaft a few chains further into the flat than Hyndman and party, near the side of Manuka Creek, and got it down for 70ft., having a few fine colours of gold all through the drift. After getting down to this depth, a granite wash was struck, when the water at once rose 5ft. in the shaft, and they were never able afterwards to contend with it, and accordingly had to abandon the shaft. Both this party and Hyndman and party wish to get a tail-race constructed from Callaghan's Creek, so as to be able to work the ground by hydraulic sluicing. On examining the character of the country, and the fall necessary for such a tail-race, it was found to be of a great length, even for drainage purposes. When Mr. E. J. Lord completed the survey of the extension of the Waimea Water-race to Callaghan's, he took levels, with the view of ascertaining the practicability of constructing a tail-race from four different points: One of these points was from the junction of Callaghan's and Manuka Creek, the fall between the top of Hyndman and party's shaft and the bottom of the creek being 206·5ft., and the distance being

3,115ft.; taking the depth of Hyndman's shaft as 150ft., the total fall from the bottom of the shaft would be 56·5ft., or a fall of 1 in 55·13, or about $2\frac{9}{16}$in. to every 12ft., which is not sufficient fall for a tail-race to carry away drift gravel-wash. A second line was tried from higher up Callaghan's Creek, 35·7ft. of fall from the bottom of the shaft, the distance being 2,739ft.; this is equal to a fall of 1 in 76·7, or about $1\frac{7}{8}$in. to 12ft. A third line was taken from Morretti and party's tunnel tail-race, the distance being 2,046ft., and the fall from the bottom of the shaft 7·5ft. Another line was tried from the bottom of the drop in Manuka Creek; this only gave 133·5ft. from the top of the shaft.

It will be seen from the available fall in the locality that the ground cannot be worked by hydraulic sluicing to a depth of 150ft. at Hyndman and party's shaft. To take the line from the junction of Callaghan's and Manuka Creek, and allow 20ft. of drop for the tailings, and to have only a gradient of 1 in 48, or 3in. to 12ft., the ground could only be worked to a depth of about 101ft. below the surface at the shaft already referred to. Even had it been found that sufficient fall could have been attained for sluicing the ground, the construction of a tunnel tail-race would have been very expensive, as it would have had to go through from 6 to 8 chains of very hard rock containing a large percentage of, apparently, silicate of iron, which would cost about £2 per foot to go through. This character of rock is seen in Morretti and party's tail-race, and, judging from the angle of inclination it is lying at, the distance through it is not over-estimated.

Between McConnon and party's shaft and the Little Kapitea Creek there is a good width of a pakihi or flat. On the edge of this flat, next to the Little Kapitea, two parties have opened out sluicing-claims, but, judging from the character of the granite wash-drift, the ground is not likely to contain rich auriferous layers; but, if a large supply of water were available to work the ground continuously, there is a likelihood of there being some good claims in the locality. The whole of the material of which this flat is composed is of a more recent formation than the wash-drift on the terraces which have hitherto been worked. It resembles to some extent the wash-drift found on Duke's Terrace, at the Greenstone; and is, no doubt, but a mass of concentrated material brought there by the action of water from a glacial deposit. The stones are all greatly rounded, and there is a good deal of fine drift, indicating that the deposit must have been carried for some distance before the amount of attrition would have left so much fine grit. On this hypothesis the ground is likely to contain richer auriferous layers higher up the flat, where, possibly, runs or leads of gold may be discovered similar to those found on the Kumara field. The morainic deposit which has been concentrated and lodged in this flat appears to have originally come from a southern direction, but, be that as it may, it covers the older gravels and abuts on to them at the side of Callaghan's Range.

Waimea.

The ground on the south side of the Waimea Creek is getting pretty well worked out, but there is apparently yet a good many auriferous terraces on the north side of the creek that will pay for working; but there is very little water to be got on that side. On the south side the ground is worked with water from the Government water-race: but the creek-bed is becoming so fast filled up with tailings, and the ground getting a long way back, there is very little fall to be got so as to work it economically. The extension of the race to the head of the Waimea Creek will be the means of opening-up new ground in this locality.

Humphreys Gully.

The only party working in this locality is the Humphrey's Gully Company, who hold a lease of a large area of land from the Hokitika Harbour Board, being one of its endowments. There is a little gold distributed through a great depth of drift gravel; but being poor, it requires large quantities of the material to be sluiced away in order to make the venture remunerative. The supply of water the company has is very limited, and not nearly sufficient for the purpose of working this description of ground. When any breakage takes place, all the profits accruing from working the ground with a small quantity of water are soon absorbed in expenses, as was the case last year. Their head-race broke away in September last, immediately above the hydraulic-pipe line, which not only necessitated repairing the head-race, but also shifting the pipes and laying them down in another place. This took a considerable time; and sluicing operations were not again resumed until the beginning of the present year. The actual loss is not only the cost of repairing the damage, which cost about £400, but the time during which sluicing operations were suspended is a great element in the actual cost.

Owing to the suspension of sluicing operations for a long time, the returns from the ground last year have not come up to previous years. The value of gold obtained last year was £1,351, as against £2,536 for the former year. Out of the proceeds of the gold last year the tributers received £626, or about 50 per cent of the gross proceeds; but as the company pays for race-maintenance, and plant, and all rents, fees, &c., which amounted last year to £641, irrespective of the cost of management, the latter amounting to £283, it will be seen the company's property was anything but a remunerative one; neither can they expect it to become a payable venture until the race is extended to the Arahura River, where an unfailing and constant supply can always be relied on. Considering the great depth of auriferous ground there is over the area this company holds, the water-race should be extended to the Arahura River without delay, and it ought to have a carrying capacity of from 80 to 100 sluice-heads. Were this done, there is some prospect that the venture would be a remunerative one; but it certainly could never be expected to give interest on the whole of the nominal capital, which is £150,000. The directors will have to reduce the capital to something like a reasonable amount before they can expect fresh moneys to be subscribed to construct the contemplated works.

Rimu.

There was no new discovery in this vicinity during last year. It was thought that the lead which was lost in Griffin and party's claim would be again picked up further on; but so far as prospecting operations have been carried on nothing of a payable character has been found. Most of the claims that got gold at the first of the rush are still being worked with success. Many of them are now worked by adit-levels, brought in from the edge of the terrace facing the Hokitika River, instead of from shafts. The ground is not rich, but it gives fair remuneration for working. Prospecting shafts were sunk under the auspices of the Miners' Association, ahead of Griffin's Claim, and a little gold was found in some of the strata passed through. One shaft was sunk near the head of Frosty Creek, about a mile and a half further south than where Stephens and party are getting fair returns from the ground. This shaft is sunk to a depth of 192ft. 6in. At the depth of 132ft. 6in. a stratum 18in. thick was passed through containing colours of gold, and at 171ft. another stratum was gone through which contained from five to six strong colours of gold to the tin-dishful of wash-drift; also, at the bottom of the shaft, a small prospect of gold was got in the drift in the last 2ft. 6in.

No water was met with in this shaft, neither was there any sign of it being near the bottom. The strata passed through down to the depth of about 133ft. was dipping south and west, at the rate of about 3in. to 5ft., or 1 in 20; but below this, the layers of material were deposited about level. The size of the shaft in the clear was 5ft. by 2ft. 7in. down to a depth of 100ft., and below this 4ft. 10in. by 2ft. 5in., being slabbed the whole way down. The miners sinking this shaft stated that they would have liked to have sunk deeper, but as they never expected to go to such a depth, the shaft was too small to continue sinking, as a horse-whim would have to be erected for winding. Annexed is a diagram showing the different strata passed through. The same men who sunk this prospecting shaft were at the time of my visit prospecting at the northern end of the lead, and getting a little gold near Arch Creek.

The President of the Miners' Association at Rimu, under whose auspices prospecting operations were carried on in the locality, in his annual report states that they had sunk thirteen shafts making an aggregate depth of 859ft., the deepest one being 190ft., and the shallowest one 29ft., the cost of sinking being £173 18s., or an average of 4s. 3d. per foot. In addition to this, they constructed 208ft. of prospecting drives, at a cost of £32 7s. 9d, being an average of about 2s. 5d. per foot. It is to be regretted that this association was not successful in finding gold, for their perseverance and the economical manner in which the prospecting operations were carried on deserves the highest praise.

The whole of the country between the Hokitika and Totara Rivers, following the road-line from Rimu to Ross, is covered to a great depth with alluvial drifts deposited in places by glacial action, and afterwards sluiced away by flowing streams. In some places large boulders are found quite angular and with sharp edges, showing that they could not have been rolled about with the action of water; while in other places the boulders are rounded and water-worn. The manner in which the different strata are lying at the southern end of the Back Creek lead, Rimu, would show that the stream had, at least in places, flowed in a south-westerly direction—that is, taking the dip the stratum is found lying at on the upper levels. The evidence, however, is tolerably conclusive that the gold found on this field has originally been brought down from the mountains and deposited in morainic matter by glacial action, and the concentration of the heaviest particles by flowing water has left the gold in layers or bands as now found. A very large area of gravel-drifts in this locality would pay for working, if a good supply of water could be obtained at a sufficient elevation to wash away the ground by hydraulic sluicing.

The bottom on which the more recent gravel-drifts is lying, at the face of the terrace fronting the Hokitika River, is what is termed Brighton bottom, and consists of similar material to that known as old-man reef at Ross, belonging to a much earlier period than the drifts which are now being worked for gold, and also must have been brought from a different direction from that in which the more recent deposits came. This bottom is composed of highly-rounded soft pebbles, and small boulders in some places, showing that it has also been subjected to a stream of water. In some places colours of gold are found, and there is no reason why a stratum carrying payable auriferous drift should not be found in this material, more especially where it joins with the slate or schist rocks; but, as the whole of the coast in this locality seems to have gradually sunk, there may be a great depth of this Brighton bottom to go through in places before the bed-rock is reached. The mere fact of gold not being obtained in places where this deposit is found lying on the bed-rock is no criterion that no gold will be found in certain channels passing through it, the same as now found in more recent deposits lying on the bed-rock.

Craig's Freehold.

This is situated on the south side of the Hokitika River, nearer the ocean-beach than any of the alluvial drifts worked in the vicinity of Woodstock or Rimu. Mr. Craig has thrown his land open for mining, and a sea-beach lead of gold has been found passing through it, which has been giving rich returns for working. Mr. Craig has let a portion of his land on tribute to a party of men, who pay him, it is stated by the Warden, 33⅓ per cent. of the gross proceeds; and he has now got about £2,000 of the proceeds for the short time the tributers have been at work. This land a very few years ago could have been purchased cheaply, and it would never have been valuable, at least for many years to come, had not gold been discovered on it.

Ross.

There are still a good many miners working about the vicinity of Ross, Donnelly's Creek, and Donoghue's; but, with the exception of a few claims, the ground is getting very poor, requiring a large quantity of wash-drift to be operated on to get sufficient gold to pay working expenses.

There are only a few claims where any labour is employed beyond the working shareholders, the principal ones being the Ross United and the Mont d'Or.

The *Ross United Company* have been for years struggling for existence, and still they manage to get sufficient gold to carry on the surface workings, but have not sufficient margin of profit to give them capital to work the deep ground. Time after time have they tried to raise fresh capital, and failed, chiefly owing to the large value set upon the property. There is no doubt the company was overloaded in the first instance. So long as the nominal capital remains the same it is not to be wondered at that they cannot increase their capital to prosecute new works and get more powerful machinery. The directors are now seriously contemplating recommending to the shareholders the desirableness of reducing the original capital to £30,000, and to endeavour to increase it by an additional £30,000, in order to provide money for the erection of a powerful pumping-plant, and for sinking a new shaft, &c. This step is one in the right direction, and it is to be hoped the directors will be successful in getting the required capital, even should they receive it on preference shares.

With regard to the character of the ground in the deep levels, there is without question a considerable quantity of gold which can never be obtained without powerful pumping machinery, as the water will have to be lifted from about 200ft. under sea-level. There is, however, a tail-race constructed from the ocean-beach at as low a level as can be taken up, and the water from the pumps will be carried away in this tail-race. Very rich ground was got in Cassius' claim, the Morning Star, the Excelsior, the Old Whim, and other claims, which now form portion of the Ross United ground; and it is well known by those who were in Ross at the time when all these claims were being worked that there is a very rich block of ground round the Cassius' old shaft which was commenced to be taken out when the drainage-engine was stopped, causing all the claims to be flooded out. In the Morning Star Claim the two faces going out into the flat were, at the time the workings were suspended, averaging about 2oz. of gold to the set of timber, which would cause an excavation 9ft. wide, 7ft. 6in. high, and 4ft. wide, being equal to a capacity of 9½ cubic yards, or 4·1dwt. per cubic yard, the best portion of the wash-drift being within 4ft. of the bottom. Rich gold has also been traced out into the deep ground as far as the water would permit at the foot of Sailors' Gully, and also in German Gully. At each of those junctions rich auriferous deposits are likely to be met with. The great difficulty in starting to work the deep ground again will be to get miners thoroughly acquainted with working this description of ground; and unless the water is pumped out in the old workings in the flat it would not be safe for men to be working any ground connected with openings from the present pumping-shaft. Neither could the workings be carried on systematically, which would entail the irretrievable loss of a large quantity of gold.

The gold obtained by the company during the year ending the 26th January last was about 1,336oz., as against 1,632oz. for the previous year. The value of the gold obtained last year would be about £5,240; of this amount £3,563 went to the tributers, and £1,677 to the company, the tribute paid being on an average about 32 per cent. to the company, the tributers receiving 68 per cent. of the gross returns. The company, however, find all plant, water, &c., which is a considerable item in the expenditure. If the actual expenditure on water-race, plant, rent, fees, and salary of working-manager be deducted, amounting to £1,360, it only leaves an actual profit to the company of £317, being equal to about 6 per cent. tribute of the gross returns.

The gold was obtained from the elevator claim in Ross Flat, and also at the elevator claim at Donoghue's, both of which belong to the company, the former claim yielding about 844oz. and the latter 359oz., and the balance was obtained by sundry tributers working on the upper levels. The actual receipts for the year was £1,615 for tribute and £117 for sales of water, making their income for the year £1,732; while their expenditure in connection with the claim, including the salary of the mine manager, was £1,360, and in connection with the management outside of the claim the expenditure was £425, making the total expenditnre £1,785.

The value of the ground worked is obtained from the yearly report of the mine manager, Mr. Joseph Grimmond, who states there were 67,350 cubic yards of wash-drift treated from the Ross elevators, which yielded 843oz. 12dwt. of gold, representing a value of £3,290 4s. This is equal to a yield of about 6gr. of gold, or nearly 1s. per cubic yard. This must be considered very rich ground, as the face they are working is fully 80ft. in height. The face of the claim at Donoghue's is more variable, and the material is not all taken from one place, so that the manager has found it difficult to give the quantity lifted at this place.

Mont d'Or.—This is a hydraulic sluicing company, and their mining property is the best at the present time in the district. The company has for many years been a regular dividend-paying one, the shareholders having received £18,000 in dividends, and the ground is likely to last for the next thirty years and give equally good returns. During last year 1,332oz. of gold was obtained, representing a value of £5,171. The whole of the auriferous drift in this company's claim is of a much older deposit than upper-drift gravels on Ross Flat, and belongs to the same age as the drift-wash on the top of Mount Greenland, and that found on the lower bottoms in Ross Flat. The gold found in the drift is generally well rounded and water-worn, and in many instances rolled in small scales. All the stones in the wash-drift also indicate that they have been turned over and over by the action of a flowing stream. There is nothing in the locality to lead one to suppose that ever this deposit was the result of glacial action, but there is plenty of evidence to show that the surface of the land is greatly altered since the deposit was made. Fossils of large fish have been found close to Ross, at about 400 feet above sea-level; while the auriferous deposits on the lowest bottom worked on Ross Flat is about 240 feet under sea-level, thus showing that the ground in this locality has been elevated and depressed several times and at different periods. There is a large area of auriferous drift on the range leading towards Mount Greenland, but it is at too high an elevation to get a good supply of water to work it, and it can only be made payable by working the ground on the hydraulic sluicing principle.

The general character of this belt of auriferous gravel-drift is somewhat similar to that found on the deep-levels on Ross Flat, and it is a much older deposit than that found further back in the ranges, and indicates that there is a great deal to be said in favour of the theory set up by Dr. Hochstetter thirty-four years ago when he visited this colony. In his work on the Physical Geography and Geology of New Zealand, chapter xxi., he calls attention by a map of the Middle Island to the position of the Southern Alps, showing the gradual descent of the land on the eastern slope, and the abrupt declivity to the ocean on the western slope of the range, and that there are radiating fissures in the rocks from one common point. He states:—

"Although the joints cross each other in all directions, apparently without order, there are two prevailing systems of joints which have an important influence on the configuration of the surface. These are: first, a system of vertical cross joints at right angles to the stratification, and running in broken lines for great distances, with such regularity that they might easily be mistaken for planes of stratification, were it not for the frequent occurrences of beds of trap-rock, the outcrop of which marks unmistakably the true bedding, not running in parallel planes, but arranged in a series of curves radiating from a common centre.

"The effect of this system of jointing, combined with the strike of the beds or the direction of the axis of folding, is to produce two distinct systems of valleys in the central chain, the direction of which is very remarkable. The one radiates from a common centre situated about 50 miles north of Mount Darwin, in the sea, near Cliffy Head. This system includes all the principal valleys, from the Teremakau on the north to the Makarora on the south, their direction varying from N. 82° E. to S. 30° W., giving the idea that the country has been starred by a violent blow, or as in rock-blasting a set of radiating fissures is sometimes produced by a single shot. To the other system belong the valleys of rivers and watercourses running either on the strike of the beds or in the direction of the cross joints, or in a compound zigzag course following alternately these two directions, like a line struck diagonally across a chess-board, but following the sides of the squares, and giving to the cliffs which bound these valleys a peculiar rectangular appearance resembling ruined masonry on a gigantic scale."

The inference to be taken from this is that at some remote period the land extended a considerable distance further to the westward than at present, and that, through volcanic agency or the sudden generation of gases, violent shocks took place, causing rents and fissures to radiate from the seat of action; and near the epicentrum, or place where this occurred, the land would gradually sink down. Mr. A. McKay, F.G.S., Assistant Geologist, in a map to illustrate his report on the Geology of Marlborough and South-east Nelson, published in the Reports of the Geological Explorations for 1890–91, shows the principal faults and earthquake-rents, which proceed from almost a common centre at a point seawards between Hokitika and Jackson's Bay. The whole of the information gathered by Mr. McKay relating to the fissures and earthquake-rents in the Middle Island indicates that a terrible cataclysm has taken place, and that land extending far to the westward of the mouths of the Totara, Mikonui, Waitaha, Big, Wanganui, and Wataroa Rivers has since been submerged, and at the time when this took place it dragged, as it were, the western side of the main range down for a certain distance with it, which would easily account for the auriferous drifts being found at the deep levels on Ross Flat, at 240ft. below the present sea-level.

If the coast of New Zealand extended for one hundred miles less or more further to the westward than it does at the present, it is likely that very high land existed; and, instead of the older gravel-drifts coming from the present backbone of the Island, they may have come from an opposite direction, and possibly from lands situated some thousands of feet at a higher elevation than the top of our highest mountains, and that these high lands were highly auriferous. Dr. Hochstetter, in the same chapter of his book previously referred to, states, with reference to the auriferous character of the West Coast: "The western slope and part of the central chain consists of crystalline rocks and metamorphic schists, highly auriferous, and resting upon a basis of granite. . . . To the eastward of the crystalline zone, stratified sedimentary rocks appear, such as slates, sand-stones, conglomerates, indurated shales, interstratified with trappean rocks of a dioritic or diabasic nature. These compose by far the greater part of the eastern side of the central chain, exhibiting anywhere these huge foldings. . . . The eastern foot of the mountains is formed by tertiary and alluvial deposits broken through by volcanic rocks. The period of volcanic energy was one of upheaval, and since it closed we have no evidence of there having been any submergence of the Island on the east side, while on the West Coast the evidence derived from the mountains rising directly from the sea, and penetrated by the fiords, indicates rather a gradual submergence."

As to deposition of these auriferous older gravels on the West Coast, they were never brought there and deposited by glacial action entirely. They certainly have been subjected to the action of a flowing stream, as all the stones are highly rounded, and worn greatly. There are very few large stones in the drift, and the whole of them are in a greatly decomposed state. It is very evident from the configuration of the country, and the direction in which many of the old river-channels can be traced, following a totally different course to the present rivers, that New Zealand has undergone many changes; also, there is evidence, by the amount of material in these ancient channels, that it has been moved by a flowing stream, and that the drainage basins of these streams or rivers were of much greater extent than they are at present. If a large area of country to the westward has been submerged, then these older auriferous drifts may have come from the seaward, and not from the denudation of the present mountain-chain. The same character of auriferous wash is obtained in portions of the Mont d'Or and Greenland Claims, which are 3,000ft. above sea-level; but at the time these gravels were deposited on the low lands near the ocean-beach, this land was in all probability at nearly as high an elevation as the top of Mount Greenland is at the present day, and that a gradual subsidence took place to the westward; rivers were formed in different channels following the lines of fissures and rents produced by volcanic or other similar agency, causing sudden shocks to take place; material was brought down from the now main range of the

island, forming a new deposit on the top of the older auriferous drifts on the low-lying lands, while the mountains became denuded and supplied this material.

In the basin of Ross Flat no regular bottom has yet been reached, such as schist or slate; nothing but what is termed in Ross old-man reef, and in other places Brighton bottom. It would be interesting to ascertain the dip of the schist or slate bottom when reached, and its direction. There is no reason that rich auriferous layers of drift should not be found below this on the slate, schist, or sandstone rocks.

Otago District.

Maruwhenua.

Since my last visit to this district there has been a considerable amount of work done on the north-western side of the Maruwhenua River, considering the small amount of water brought on to work this field. The workings are principally on the side of the terraces falling into the gullies which lead down to the land the Government purchased from Mr. Allen some years ago as an outlet for tailings, and also on the other side of the gullies falling into the flat, on which the West Maruwhenua School is situated, where a sludge-channel is constructed on land purchased by the Government some years ago from Robert Campbell and Sons. On this portion of the field there are in all about forty-seven miners working when water is available, which is only in wet weather. Mr. H. Howe has one water-race from the Maruwhenua River, which has a permanent supply of about four sluice-heads of water; and the Pioneer Company has a water-race from the same source, which brings in a permanent supply of about four sluice-heads. Frater Brothers have a small water-race from the small creeks in the vicinity of Ben Lomond, and Mr. Howe and Mr. G. Bailey have each a small race from Sheepwash Creek and Bushy Creek respectively; but in the three last-mentioned water-races there is no water in dry seasons. Mr. T. Smith has also a catch-water-race, but during the last season he had little or no water.

Some of the ground is shallow, being only from 6ft. to 12ft. in depth, but some of the ground is 40ft., and the most of the gold lies on the bottom; so that, with the small amount of available water, the deep ground can in very few instances be made to pay for working. The ground also is hard, requiring a great deal of breaking up; this, together with the limited supply of water, tends to prove that the ground must be very good to enable the miners to make a livelihood. The old system of working with water falling over the face, or a short piece of canvas hose, is rigidly adhered to in many instances. If iron-piping were used, even with the small supply of water, and the whole of the fall from the races utilised, twice the amount of work could be done; but the field will never be able to sustain a large population, as there are very few available streams in the neighbourhood from which a permanent supply could be obtained. There is no doubt that a much larger supply could be obtained from the Maruwhenua River during about six months of the year; and also from the Otakaike a supply of about six or seven heads might be obtained during the summer months, and from twelve to fourteen heads during about six months of the year; but at the present time Robert Campbell and Sons have constructed a race from the river which conveys the most of the water in summer, and is used for wool-washing and irrigation. Any water-race constructed from this stream to command the ground on the Maruwhenua would have to be lifted from about thirteen to fourteen miles up the Otakaike River, from the railway crossing, and at that point the stream is small in dry weather; the nature of the country also through which a water-race would have to be constructed, being rocky sidelings and across old slips, would make it very costly, as in many places the water would have to be conveyed in either iron- or steel-piping, or in flumes.

On the Livingstone side of the river there are about twenty-seven miners working by means of two water-races, both constructed from the Maruwhenua River. One of these belongs to the Musquito Company, which is said to have a carrying capacity of from six to eight sluice-heads; but at the time of my visit the quantity of water in this race was only about two and a half heads. This water-race is leased to Botting and party, who are said to pay £150 per annum for its use, and also keep it in repair. The other water-race belongs to R. Cook, having a carrying capacity of about three heads. As far as could be ascertained the price paid for water on this field is equal to £2 per sluice-head a week for eight hours per day. The water is generally conserved in dams at night, so that the available water for working the ground during the day is equal to three times the carrying capacity of the water-races.

In reference to the quantity of gold obtained from this field, the information supplied me was so variable that nothing reliable as regards the yield of gold can be given. Mr. H. Howe states that in good seasons, when plenty of water is available, he can get between 200oz. and 300oz. of gold; but the last season being very dry he did not get anything like that quantity. Taking the amount of gold-duty paid to the Waitaki County Council before the gold-duty was abolished, the quantity of gold obtained from the field per annum would be about 1,200oz., or, say, the value in round numbers would be about £4,800 per annum. Taking the number of miners on the field (seventy-four), the average earnings would be about £64 17s. 3d. per annum, or £1 4s. 11d. per week. The miners have on this field, however, greater advantages than on any other goldfield in the colony. There is a large mining reserve where they can run cattle and take up occupation-licenses for cultivation when they cannot work in their claims, and by this means some of them are enabled to make a good livelihood. There is very little of the land on this field that is not suitable for cultivation.

With regard to the length of time this field will maintain the present population, there are great differences of opinion amongst the miners. Some assert the ground will last for twenty years, while others place the life of the field at about half that period; but the miners agree that, unless there is a much larger supply of water to sluice away the wash-drift in greater quantities, the ground will soon be getting too poor to work on the present system. Judging by the supply of water in the Maruwhenua River below the place where all the miners' tail-races join the river, there is not the slightest chance of getting more water from this source, unless during wet weather. The water-races already constructed do not appear to be very profit-

able investments. The flood on the 8th February last damaged one of the races to such an extent that the company owning it have agreed to go into liquidation rather than do the necessary repairs. The quantity of water used in working the claims on this field varies from one and a half to two sluice-heads. With this limited quantity very little material can be sent away. There is no doubt the time will come when some of the present claims will be abandoned and the water will be used in larger quantities by fewer individuals, and then poorer ground will be made to pay for working.

Tuapeka.

The yield of gold from this district last year amounted to 15,872oz. more than for the previous one; the yield last year being 39,557oz., representing a value of £118,706, while for the previous one—1890–91—the yield was only 13,685oz., valued at £56,280. This large increase is due in a measure to the gold being held by the banks during the quarter ending the 31st March, 1891, when no gold from this district was entered for duty for exportation; but as this would only account for about 5,000oz. of gold, the balance of 10,872oz. must at least be taken as the natural increase for the year. The yield of gold from this district includes the quantity produced from Waitahuna and Waipori Goldfields, and also from a portion of the Clutha Valley.

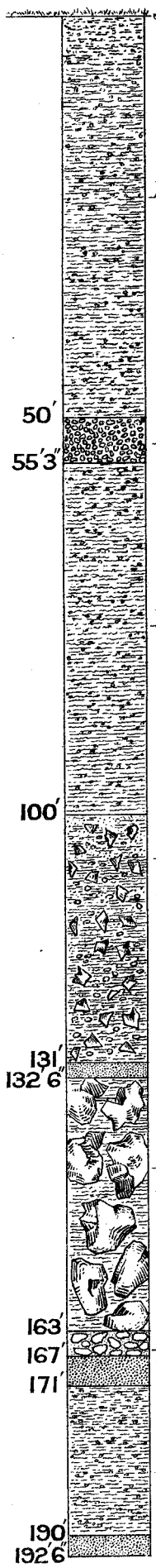
The old workings in the flats below Lawrence, Gabriel's, and Weatherstone is nearly abandoned; a few Chinese still find employment, but they are getting less year after year. A prospecting syndicate was formed to test the deep ground at Weatherstone, near the place where the Weatherstone Gold-mining Company worked the cement successfully for many years. A few years ago a prospecting association sunk a shaft a little distance ahead of the Weatherstone Company's workings, and bottomed on a high reef. From the bottom of this shaft, a drive was constructed for some distance on an incline following the dip of the reef; but the bottom of the dip was never reached. The present prospecting syndicate consists of ten contributing shareholders who paid £10 each, and six working shareholders who received £1 per week each for ten weeks, and after that date contributed the same amount as the other shareholders. They sunk a shaft in the deep ground to a depth of 200ft., and after constructing several drives from the shaft they had to suspend operations for want of funds; but they intend to resume operations again.

At Waipori a good number of miners are employed in hydraulic-sluicing, dredging, and in extended claims, the most of which are making fair wages. There is a large area of auriferous drifts in this locality, some of which are very rich, as in the case of the ground formerly belonging to O'Brien and party, who worked a claim for many years before it was purchased by the present holders, and always got well paid for their labours. This ground is now included in the mining property of the Amalgamated Deep Lead Gold-mining Company, which was formed in the end of 1890, with a nominal capital of £12,000 in an equal number of shares, of which 6,150 shares were allotted to the vendors of this company's property, who also received in addition £3,350 in cash—thus absorbing £9,500 of the nominal capital, leaving only £2,500 for plant and developing the ground. The following is an extract from the report on this company's works and the price paid for the property, in the *Otago Witness* of the 10th of March last. In referring to the price paid to the vendors—£9,500—it states:—

"They were to receive in addition £3,350 in cash, a price which certainly should have more than satisfied their most extravagant expectations. It may be said with truth that all or nearly all the mining properties which have been used as the basis for forming companies in this colony have been greatly over-valued by the original owners, and this circumstance has had not a little to do with the general depression which has for some time existed in the share-market. Concerns which could pay good dividends are made unproductive through undue inflation of capital. The gold-deposit which gave birth to the company was discovered and partially worked about twenty-five years ago. The run of gold was first worked in shallow ground, and yielded fairly good results. The ground gradually deepened, and assumed the appearance of a gutter or deep lead similar to those familiar to old Ballarat miners. The property acquired by the company is 135 acres in extent, and at the time of the purchase consisted of several different claims, the principal of which, so far as its known auriferous character is concerned, being an extended claim of two acres belonging to Messrs. O'Brien. The company also acquired water-rights, supposed to be capable of supplying thirteen heads of water under sufficient pressure to elevate all the gravel in the company's claim. The usual difficulties incident to new enterprises have been met with in carrying out the preliminary works. The water-supply turned out less reliable than was expected, and accidents of various kinds have from time to time occurred to impede and delay the work. Mr. Charles Hilgendorf has managed the works, and, notwithstanding the many causes of delay and disappointment which have arisen, it may be confidently said that he has discharged his duties with skill and ability. The directors also deserve praise for the energy and pluck they have shown in overcoming difficulties and carrying on the work in spite of all discouragement. One difficulty which arose would have proved fatal to the success of nine out of ten companies. Capital ran short, as might have been expected from the fact that far too great a proportion of it was paid for the price of the company's property, and from the circumstance that 450 of the subscribing shares were never allotted. This difficulty was at first met by means of a loan of 5s. per share from the shareholders themselves. In this way £1,960 10s. was raised. In addition to this the directors negotiated a loan of £3,000, to be repaid in three years' time. The difficulty arising through the deficiency in the water-supply was even more serious than the want of funds. Money could be obtained, but water at a sufficient elevation was not to be had if it did not exist. So serious has this deficiency been, that not much more than half the work has been done which could have been accomplished with the full quantity. To remedy this the company is at present engaged in constructing a reservoir, which, at the cost of about £200, will be capable of storing a very large quantity of water, sufficient, in fact, to supplement the deficiency during the driest time of the year, so as to make it effective for five weeks at least, even should there be no rain during that length of time. This work is now on the eve of completion, and it is fully

PROSPECTING SHAFT.

Head of Frosty Creek.



Surface of Ground.

Fine drift with pug and small stones.

50′ — Blue rounded washed boulders, but no gold.

55′3″

Fine drift with pug and small stones.

100′ — Very hard cemented ground with blue clay in places, large triangular stones, and small rounded stones.

131′

132′6″ — Gravel wash with colours of gold.

Large angular indurated sandstone boulders which required blasting.

163′ — Large granite boulders.

167′ — Washdrift carrying 5 to 6 strong colours of gold to a dish.

171′

Puggy ground and small rounded stones.

190′ — Washdrift, small prospect of gold, not payable.

192′6″

Shaft not sunk to bottom. No water. Size 2′7″ x 5′ down to 100ft. below 100ft. 2′5″ x 4′10″. Layers to 80ft. dipped to S.W. about 3″ in 5ft. below 80ft. about level. Shaft about 1½ miles from end of lead.

expected that a full and regular supply of water will be available for the future, except under very exceptional circumstances. From the date on which the company commenced work up to the 22nd of January last, the total quantity of gold obtained amounted to 530oz., of the value of upwards of £2,000. The quantity of wash-dirt from which this has been obtained is estimated at 70,000 cubic yards, making the average per cubic yard 3·65gr., or a little over 7d. This does not include a part of the bottom which, at the date of last report, had not been fully cleaned up, and from which about 200oz. was expected to be realised. Should this turn out as good as expected, it will bring up the average yield per cubic yard to 9d. or 10d. This is a splendid yield, and leaves no doubt whatever about the value of this part of the company's property."

Blue Spur Company.—This company have now got fairly into the cement workings, and will in course of the year be able to see whether the cement can be worked at a fair profit or not. The workings in the old ground—or what may be termed the tailings and headings left in the gully—was all worked in November last, and a commencement made on the cement. At the time of my visit in January last, the manager was experimenting to some extent with the view of arriving at the most economical method of working this class of material. He had two sets of horizontal rollers 2ft. long placed in the sluice-box, the top roller is 2ft., and the bottom one 9in. in diameter, having a clear space between them in the first set of 3¾in. The large rollers have hæmatite iron rings, 4in. thick. As soon as the material leaves the first set it travels with the water for a short distance and goes through a second set of rollers, which are set with an opening of 2⅛in. The water brings all the material down the tail-race, and, before it comes to the first set of rollers, a certain quantity of the fine material and the water passes over a perforated iron-plate and falls into the box below, there being a sudden drop in the sluice-box at this place which is about from 5ft. to 6ft. ahead of the first set of rollers. The fine material and a certain quantity of the water passes underneath the bottom roller, and the rest rushes down on the false bottom and passes through the rollers, the cement getting broken up in pieces about ½in. in diameter; some pieces may be a little larger, but the bulk of the material is tolerably well broken up. These rollers are driven by a turbine water-wheel, and appear to revolve at about one-third the revolutions of the turbine, or about from 130 to 140 revolutions per minute. The quantity of water used on the turbine to drive this roller-crushing machinery is 500in., with a head of 375ft., which would be equal to about 319 horse-power, after allowing 40 per cent. for friction of water in pipes and turbine. The whole cost of this machine is said to be £438.

With regard to the efficiency of the roller crushing-mill, it cannot be said to be a success. In the first place the cement has to be broken up in the face by manual labour to pieces about 6in. in diameter before it is sent into the sluice, which is too slow a process for low-grade cement to be made to pay for working; secondly, there is mixed amongst the cement very hard-rounded stones, which, when they come down the sluice to the rollers, do not break up, but stick in front with the rollers sliding on them, and when perchance one piece gets through the first set of rollers, the same thing takes place at the second set. It ought to be mentioned that the upper roller axle-blocks slides up in a groove, so that when any very hard stone or perchance a hammer were to get into the sluice, it could go through the rollers without anything breaking; the top roller would merely lift up sufficiently to allow it to get through. In addition to the hard stones skidding in front of the rollers, it has the effect of causing a blockage in the sluice. This frequently occurs, and requires a man to be standing continually at a lever to raise the iron plate in front of the drop in the sluice, and allow all the material, coarse and fine, to pass down under the bottom rollers and get away without being crushed up.

It is a difficult matter to design a machine to treat this cement successfully. It can only be made to pay for working by putting a very large quantity through at a nominal cost. Plenty of it only contains a few grains of gold per cubic yard; some portions of it is richer than others; but unless operated upon in a wholesale manner, there is very little hope of success attending the venture. The machine designed and constructed by Mr. Jackson is an ingenious one, and possibly he may yet manage to remedy its defects. The material to operate on is different to any either in this or any of the Australian colonies that has hitherto been attempted to be worked by crushing-machines, and there is no record of similar material being crushed in America. In many of the hydraulic-sluicing claims on the Pacific Slope the ground is loosed by large blasts, but this cement is more like a conglomerate, nearly as hard as stone, and when blasted comes down in large blocks, which does not appear to be affected but to a very slight extent with atmospheric action. It has to be blasted and reblasted before being small enough for men to break it up with picks and hammers to send it away into the sluice. It would be an easy matter to construct a machine to thoroughly disintegrate it, but the important question is at what cost; the value of the gold in the material being so very small, it requires crushing-machinery specially designed to operate on a large quantity of material at a very small expenditure. Having these difficulties to contend with, it is hardly to be expected that a perfect machine can be produced at once to solve the problem of making any low-grade cement pay for working. The whole of the deposit left may be said to be very good ground for sluicing if it could be broken up by the force of water from nozzles.

The yield of gold from this company's claim during the twelve months ending the 31st of December last, was very encouraging—it amounted to 3,470oz. 10dwt., representing a value of £13,330, while the manager informed me that the working expenses only amounted to about £6,000, or, say, the profit on working the claim during this period is in round numbers £7,000, which must be considered highly satisfactory. The average number of workmen employed by this company has been about forty-three.

Sir Walter Buller, in a report to the deputy-chairman of the company (Lieutenant-General Sir John Stokes, K.C.B.), states with reference to the result of last year's working: "We have paid interest at the rate of 8 per cent. on a mortgage of £18,000, and speaking generally we are now in a position to reduce the capital debt by £3,000, to pay 8 per cent. dividend on 7,497 preference shares, and to declare a small dividend on the 80,098 shares of the company." In another portion of his

report he shows that mining companies formed in London are handicapped to a great extent with a large yearly expenditure on the London office, and unless a company is carrying on very large operations or working very rich ground, they cannot expect to even pay a fair percentage on the capital invested. He states, "I have arranged with the banks that the directors shall again take preference shares in lieu of their fees, amounting for the year to £1,250." It will be seen from this that the directors' fees alone are equal to nearly 1½ per cent. on a capital of £87,595.

A local company were, at the time of my visit, laying down a line of pipes on the right-hand side of the terrace facing Gabriel's Gully, looking up towards the Blue Spur. They have leased the Phœnix water-race, and extended it round the side of the range to a point directly above the place where their claim is situated in the bed of Gabriel's Gully, where it is intended to work the ground with an hydraulic elevator. The pipes are 15in. in diameter at the upper end and 13in. at the lower, and they will have about 278ft. of head on the elevating nozzle. There is another party of miners working a claim adjoining the ground belonging to this local company by sluicing it with water from the bed of the gully, and are said to be making the ground pay by this means.

At Munroe's side of the Blue Spur, Kitto and party are working the upper portion of the cement near the top of the hill by hydraulic-sluicing; they get any spare water the Blue Spur Company have to carry on their operations. As the Blue Spur Consolidated Company have the most of the water-races, properties, and water-rights in this locality, they hold the key to all the available ground, which is valueless to anyone without a good supply of water.

Clutha Valley.

Island Block Company.—This company has not been successful with their operations last year. The gold was traced from near the bank of the river for a considerable distance across the flat, towards the main road from Lawrence to Roxburgh, but this was left and a new opening was made near the main road and towards the high land which had at one time formed an island. Since this new opening has been made the quantity of gold obtained has been very little for the amount of material operated on. According to the annual report of the meeting of the company in London, on the 16th of December last, the time given that sluicing operations were carried on for the past year was 6,610 hours, or about 275 days' continuous working, and the gold produced amounted to 2,045oz., representing a value of £7,700; adding this to the value of the gold for the year previous, it makes £12,000 that has been obtained from the claim. The manager, Mr. C. E. Rawlins, informed me that the actual cost of working the ground was about 1½d. per cubic yard, and that the elevator was lifting about 75 cubic yards per hour to a height of 50ft. The quantity of water used to lift this quantity of material being eleven sluice-heads, having a head of about 630ft., and three sluice-heads are used for sluicing the material down to the intake end of the elevator. Eleven sluice-heads of water from an elevation of 630ft. would give 787·5-horse power theoretically; and to lift fourteen sluice-heads of water and 75 cubic yards of material per hour, or 1¼ cubic yards per minute, to a height of 50ft. would require 86·5-horse power theoretically. That is disregarding any allowance for friction. This would show that 701-horse power is absorbed in friction; but, judging from former experiments made with the power required to work hydraulic-elevators and those made by Mr. H. Jackson, manager of the Gabriel's Gully Sluicing Company, the full head of water could not have been used. According to data supplied me by Mr. Jackson, the quantity of water used for lifting gave about 25 per cent. of its theoretical power, whereas this only gave about 11 per cent.

Taking the quantity of material lifted per hour as 75 cubic yards and 6,610 hour's work, would make 495,750 cubic yards of material operated on for 2,045oz. of gold. This is equal to a yield of 1·98 grains of gold to the cubic yard.

The chairman of directors, in referring to the finances of the company, stated: "There was an indebtedness to the bank of over £3,000. If this amount were increased a lien would have to be given over the property. The amount of sluicing done by the company during the past year amounts, practically, to twenty-one hours per day, or 6,610 hours. The result was 2,045oz. of gold, representing over £7,700 in value, making, with the gold of the previous year, £12,000 worth obtained from the Island Block. There was an actual balance, after paying all expenses, of £1,736, but, as nothing had been written off for depreciation, it was deemed inadvisable to pay dividends. There was, in addition, a dead weight of £6,400—the balance of expenditure brought forward, which ought to be materially reduced before contemplating the payment of a dividend. Work in the past had been carried on in a narrow part of the river-bed, and as much as 87oz. of gold had been obtained in forty-seven hours. After passing through this narrow portion of the river it widened out into a very considerable flat, and therefore the trouble has been, during the past few months, in trying to follow the actual river-bed. The working during the past two months has resulted in finding 140oz. of gold after having to remove a top burden of something like 50ft. A telegram from Mr. Rawlins announced this yield of 140oz. at an expenditure of 70 per cent."

At the time of my visit the company was laying down a new 15in. main, and had constructed a new reservoir in the valley of the Fruid Burn of sufficient capacity to hold twelve sluice-heads of water for six weeks. The new main and the old one is connected together on the flat with a new main 22in. in diameter. As soon as this new main is completed the company intend to work two hydraulic elevators, and commence with one at the place where the gold was traced to. Indeed, it seems strange that the gold was not followed up instead of opening out afresh further ahead; but the manager states that he expected to get a rich auriferous deposit at the bend where the new workings are situate. The company employs twenty-one men.

In my last annual report sketches of a hydraulic elevator, which were supplied me by Mr. Rene Proust, of the Island Block Company, were published. My attention has since been directed by Messrs. Cuff and Graham, of Christchurch, agents for Mr. Joshua Hendy, machine-works, San

Francisco, that these sketches are copies of illustrations in Joshua Hendy's catalogue of hydraulic mining machinery. Not having seen this catalogue, and acting on good faith that the sketches supplied me were original, they were published with the intention of affording information to those engaged in that branch of mining of the different appliances used.

Island Block Extended Company.—This company's claim is on Miller's Flat, opposite the head of the Island Block Company's ground. The first paddock was opened out alongside the Clutha River, which gives good prospects of the property being a valuable one; but as the whole of the original capital was absorbed before the gold was struck, it was for some time a question whether the company could continue working. The original capital being £10,000, a new issue was made of 5,000 shares at 10s. each, this giving sufficient capital to test the ground. This company has a right of water from the Minzion Burn, and have constructed a water-race for about six miles, and thence about a mile of steel pipes of 13in. in diamater, of ¼in., Nos. 10 and 12 B. W. G., double rivetted. The intake end of the pipe is 800ft. above the level of the workings; but the full head of water is not utilised; only about 500ft. of head is used. The quantity of water in the Minzion Burn is very little in dry weather. A reservoir has been partially constructed at the mouth of a narrow gorge having a wide flat above it, which will make a capital place for storing water when the work is completed. With this reservoir it is anticipated that the workings can be carried on continuously with one elevator. The ground is from 35ft. to 40ft. in depth, and the profits on working during the past year is said to be about £1,100.

Edie and Kirkpatrick.—These men are still working a claim at the Horse-shoe Bend, alongside the Clutha River. They take their water from the Tally Burn, and bring it across the Clutha River in a wrought-iron pipe 11in. in diameter, suspended on wire rope. The working is entirely confined to hydraulic-sluicing, there being sufficient fall to carry their tail-races into the river. This is said to be a fairly payable claim. About six men are steadily employed.

Hercules Company.—When the hydraulic-elevating was first commenced in this company's claim the yield of gold was extremely good, but as the ground got worked back into the flat it became poorer, or at least, did not pay so well. This might be to some extent accounted for by the whole of the top material having run away level free, and the comparatively small quantity of wash-drift to elevate before getting on to the rich auriferous drift on the bed-rock. There does not appear to have been any attempt to run off any of the top material since this company commenced operations; everything appears to be put through the elevator. Where so grand a supply of water can be got from the Teviot River, by the construction of a dam at the Dismal Swamp, the company should utilise this to its fullest extent, and use a large supply of water, with wide sluice-boxes, and run all the top material off before commencing elevating. It may be asserted that there is not sufficient gold in the top stuff to pay by itself for working; but even this is questionable, as the extra quantity of material that could be operated on by concentrating the whole of the available water in one channel would make far poorer ground pay than by the present method. On the same flat, adjoining the Hercules Company's claim, there is another claim belonging to the Hercules Company No. 2. Each company has a separate supply of water from the Teviot River. In order to run off the top material, these two companies ought to combine and use the whole of the water in one channel, even if they should do so day about. Far more work could be done in one day with double the quantity of water than could be done by either company using its own water continuously. There is also a large quantity of stones amongst top-drift that could be removed before the hydraulic-elevators were used. At present the stones are allowed to stop amongst the drift-ground until the whole of the material is washed away to the bed-rock. Neither of the Hercules Companies have been a financial success during the last year, but it is probable another run or lead of gold will be found nearer the foot of the terrace.

Roxburgh Amalgamated Company.—This company, in order to get a permanent supply of water, had to construct a dam in the gorge in the Teviot River, at the lower end of the Dismal Swamp. This is one of the best sites for a storage-reservoir there is in Otago. As a large number of water-rights are held from the Teviot River, all these were to some extent affected by the construction of this dam. A case was brought before the Supreme Court during last year, and the priority of the different water-rights are now well understood. Any one having prior rights to the Roxburgh Amalgamated Company have to be supplied before they can take any; and this means that a certain number of sluice-heads must always be allowed to flow down the bed of the river from the reservoir. The manager of this company, Mr. Peters, informed me the different water-rights were now determined in the following order of priority:—

Name of Grantee.	Number of Sluice-heads Granted.	Name of Grantee.	Number of Sluice-heads Granted.
Hercules Company	23	Hercules No. 2 Company ...	12
Carlow and party	6	Roxburgh Amalgamated	20
Roxburgh water-race	14	Hercules No. 2 Company ...	5
Roxburgh Amalgamated Company ...	16	Roxburgh Amalgamated Company...	50

It will be seen from this that there are water-rights granted to the extent of fifty-nine sluice-heads, which have to be supplied before the Hercules No. 2 Company can lift any water, and ninety-six sluice-heads before the Roxburgh Amalgamated Company could get any of their last water-right. It would seem that the whole of these grantees are interested to some extent in the construction of a storage-reservoir; but the Roxburgh Amalgamated Company, holding water-rights for eighty-six sluice-heads (of which quantity they have an inferior right for fifty sluice-heads), they are by far the most interested in its construction. It is stated that an accurate survey has been

made of a dam site in this locality, and that an embankment-wall 17ft. high above the bed of the river would dam back the water over an area of one mile square to a depth of 9ft., and that the gorge, being narrow, there would be no difficulty in constructing an embankment to a height of 70ft. or 80ft. at a very small cost. If this is the case, it would be of great importance to the district to have such a reservoir constructed to conserve the water in wet weather so that hydraulic-sluicing operations could be carried on continuously. The difficulty seems to be to get all those interested in the scheme to contribute their fair share of the cost of construction. If the wall or embankment was carried up to a height of 46ft., and the area to be only a mile square, same as stated for a dam 17ft. high, then there would be $5280^2 \times 30 = 836,352,000$ cubic feet, which is equal to a supply of eighty sluice-heads for a hundred and twenty-one days.

The Roxburgh Amalgamated Company constructed the dam wall only about 8ft. high; but this was of very little service, as the first season being very dry weather they had hardly any water. Mr. Perry, who originally introduced the hydraulic-elevating principle at Gabriel's Gully, and at the Hercules Company's ground, is a large shareholder in the latter company, and he is proposing to erect a timber wall on the top of the concrete one constructed by the Roxburgh Company to the height of about 5ft. No doubt such can be done at a small expense; but it must be borne in mind that this system, if adopted, will prevent the dam being raised at any future time, unless the whole of the timber work is removed, and the extra quantity of water gained by raising the dam 5ft. is not sufficient to provide a large enough supply to work poor ground economically.

In regard to the workings of the Roxburgh Amalgamated Company, they use two jet nozzles for elevators, and one small jet for pumping, the head of water on these jets being 550ft.; and at the time of my visit, in January last, the manager expected to be able to work three hydraulic-elevators. The elevating-pipes are 15in. in diameter and have a 9in. throat-piece when new, which wears down to 12in. in diameter. There is a considerable quantity of stones amongst the wash-drift, but not nearly so much as there is in the Hercules Company's ground, which is about one and a half miles further down the river. The company employs on an average about twenty-four men, which takes about 20oz. of gold a week to pay working expenses; and the manager informed me the yield of gold from the claim averages about 200oz. per month, which leaves a good margin of profit for the shareholders. Up to the time of my visit sluicing operations had been only suspended for fourteen days for want of water, but this has been an extremely favourable season for sluicing. During the last year the yield of gold from this company's claim represented a value of £7,464, and the expenditure in connection with their works for same period was £4,080, thus leaving a balance to the good of £3,384. The following is taken from the *Otago Witness* of the 12th May last: "At the commencement of the year there was a balance of £1,281 9s. 9d. to the debit of profit-and-loss account, to which is added the sum of £489 7s. 10d., paid in compensation and costs in connection with the action of the United Hercules Company, and £29 16s. 6d. for witnesses' expenses in an action brought against the company relating to a disputed allocation of shares amongst certain of the vendors. After charging these items, law costs, and the dividend paid in March, there remains to the credit of profit-and-loss account the sum of £893 0s. 7d., out of which the directors recommend that the sum of £200 be applied in reduction of preliminary expenses, and the balance carried forward. As there is a prospect of both elevators being fully employed for the future, the Board hopes to be able shortly to declare another dividend, and pay dividends at regular intervals in future. With a view to the more frequent declaration of dividends, the directors intend to ask the shareholders' assent to a proposal to reduce the present number of shares one-half, increasing the nominal value from 10s. to £1 each. During the twelve months the sum of £730 4s. 9d. has been expended on permanent works and new plant, including the lighting of the claim by electricity."

The Commissioner's Flat Company, referred to in my last report, has gone into liquidation, and the whole of their valuable property, on which they had expended about £8,000 on plant and claim, was sold for about £1,200. It is considered, by those who have a knowledge of the ground in this locality, that this company had a valuable mining property, and that it could have been made to pay handsomely for working with good appliances and economical management.

Mr. Perry, who erected the first hydraulic-elevating plant at Gabriel's Gully, has recently returned from England, from which he brought out some new machinery for mining, which is now in course of erection at the side of the Benger Burn. It is intended to lift the material with a scoop into the sluice-boxes, and pump the water up for sluicing purposes.

At Bald Hill Flat a party of miners have erected a hydraulic-elevator and are working the ground directly at the back of Mr. Kemp's store. The ground has been previously worked, but there not being sufficient fall to sluice it in the ordinary manner, a small hydraulic-elevator was put on the ground; but the quantity of available water in this locality will have to be supplemented before this party can carry on hydraulic working continuously. The plant is very creditably constructed and works satisfactorily, with, it is stated, good results.

There is a considerable area of paying auriferous ground in this locality if there was a plentiful supply of water. There are four water-races now in course of construction, which, when completed, will be capable of supplying about fifteen sluice-heads. The water-race and rights held by the late Commissioner's Flat Company have been purchased by Simmonds and party for £600, who intend to bring the water on to Bald Hill Flat, where they have taken up claims. When all the claims are able to be worked in this locality it is likely to produce a good deal of gold.

Black's.

There are about fifteen or twenty miners still working in this locality, but they are getting very little gold, as the ground is very poor. The drainage tail-race that was constructed a few years ago, and which was expected to open up a large extent of auriferous ground, has not succeeded in accomplishing this object, but the cry still remains the same: "Extend the tail-race, and we will open up a good field." The last extension of this tail-race cost somewhere about £2,300, of which

amount the Government contributed £1,150. It is now represented that it requires to be deepened and extended for a considerable distance; but, judging from the amount of available ground in the locality and the result of the workings on the flat which the last extension admitted of being worked, there is very little prospect of much auriferous ground of a payable character for working being opened out, even with further extension.

Messrs. Flannery, Morris, Sheppard, Dr. Ward and party are constructing a water-race from the Manuherikia River. They are lifting the water about five miles higher up the river from the road-crossing leading from Hill's Creek to St. Bathan's, and intend to work some ground about four miles above Blackstone Hill Station, and in course of time extend the water-race down to Black's, when it is said it will be at about 200ft. higher elevation than the former survey. In constructing this race the party came on some ground which they considered payable, and have decided to give it a trial before proceeding further with the construction.

The water-race that formerly belonged to the Green Reef Company has been purchased by Mr. Pitches for £70, and he is using it for irrigation purposes on his farm.

Tinker's.

This place still continues to be the greatest gold-producing field for the number of men employed there is in the colony, not that the ground is particularly rich, but more owing to the character of the wash-drift, and the appliances used for working it. A great portion of the wash-drift is of old quartz-grit, or, as it is termed, granite-wash. This drift lies within two well-defined walls, and about 150ft., in width, and the depth of this deposit has in no instance yet been ascertained. The same character of wash-drift follows round the foot of the Dunstan Range to near Clyde, and again follows the foot of the range to St. Bathan's in a north-easterly direction, and thence following a general easterly direction to Mount Burster. The dip, however, of this quartz-drift varies considerably at St. Bathan's, where it is dipping to the south-east, while at Tinker's it is dipping to the north-west, being covered on that side by slips from the mountains known as the Dunstan Range. These slips make it difficult to work, as a large quantity of material has to be shifted in which there is little or no gold, on the north-western side, before the quartz-drift can be taken out; and the deeper the workings the more this will affect them. On the south-eastern side of the quartz-drift deposit rich auriferous ground has been worked by several parties holding claims; but the quantity of stones through the wash-drift make the ground far more costly to work, and consequently the same quantity of gold per cubic yard would not meet the expense of working ground where there are stones to contend with as it does to work the quartz-drift deposit.

Sims and Morgan's Claim.—This is situate at the southern end of Tinker's, on the quartz-drift lead; it is held by two men, who have altogether about 40 acres of ground, and employ two men besides themselves. The ground is from 40ft. to 80ft. in depth, which is worked by sluicing in the ordinary way. The quantity of water available for working being from two to six sluice-heads, which is brought in from Blackbush and Devonshire Creeks; the supply from these creeks vary according to the state of the weather. This is a claim that the present owners will never see worked out, except a much larger quantity of water can be got on the field. During this season about 300oz. of gold was obtained.

Ewen and McConnechie's Claim.—This claim adjoins the northern boundary of Sims and Morgan's claim. It was only commenced to be opened out last season, but, it being extremely dry, there was only water for about ten weeks to work the ground, but during this season there has been a plentiful supply, and a very large quantity of material have been sluiced away. The present workings is in the quartz-drift lead, the ground being on an average about 100ft. in depth, composed of quartz-drift, clay, and cemented bands, with but very few stones. Mr. Ewen estimates that there is from 1,400 cubic yards to 1,500 cubic yards of material washed away every twenty-four hours with about ten sluice-heads of water; this is equal to a sluice-head of water washing away 6 cubic yards per hour, which is a very high average, and certainly could not be calculated on were it not that the whole of the material is of a fine character. When the workings get further back into the foot of the range there will be a large quantity of loose rocks, stones, and boulders to contend with, which lies on the western side of the quartz-drift deposit; and as this deposit is dipping into the range, and of a great depth, it will in time become a question as to what extent of the deposit can be profitably worked, seeing that a large quantity of the loose material which has from time to time come away in slips, &c., from the main range, is partially overlying the western side of the auriferous lead.

The hydraulic-plant for working this claim is one of the best on the field, the head or pressure being 470ft. All the ground that can be sluiced off in the ordinary manner will be done before commencing to use a hydraulic-elevator. The material is washed into a tail-race, which is 5ft. in width, paved with stone on bottom; at about 5 or 6 chains down this tail-race there is a drop of about 5ft.; at this point a wooden box is placed in the tail-race, having a perforated plate in the bottom at the lower end with holes $\frac{3}{8}$in. in diameter. The water and fine material coming through the holes goes into a distributing-chute, which is placed at right angles to the line of tail-race, and from this chute the water and material is distributed on to tables covered with cocoanut-matting. These tables have a total width of 24ft. and are divided into eight compartments, each 3ft. wide and 5ft. 8in. long, where there is a well or drop of about 5in., and then another similar set of tables—in all, there are three sets of tables of the width and length as previously stated. During the four months' operations previous to my visit, 80oz. of gold was collected off these tables; the proportion being for every 1oz. of gold got from the two bottom set of tables, 11oz. was obtained from the upper set, thus showing the width of the tables is of far greater consequence than the length with respect to gold-saving. This really means that, in order to save the fine gold, the water and material must pass over the matting in a very thin film, which requires a great width of tables to do so. There are eight men employed in the claim, and if their wages are reckoned at 9s. per day for four months

it would amount to £353 12s., and the value of gold got from the under-current for this time is £320, which nearly pays the wages of the workmen. Before the under-currents was used this character of gold was entirely lost. The total yield of gold from this claim last season was 600oz., representing a value of £2,400.

Mountain Race Company's Claim.—This claim adjoins the northern boundary of Ewen and McConnechie's ground, and has the same run of the old quartz-drift or granite-wash going through it. In former years portion of this quartz-drift was worked, and also the alluvial auriferous drift-wash which joins the quartz-drift and extends into the flat from the range. During last year this company opened out on the southern boundary of their claim on the quartz-wash, which they are working to a depth of about 100ft.; but the quantity of water available, and the head, which is only about 120ft., is not sufficient to break up the cemented portions of the drift, and run large quantities away. The tail-race being cut at as low a level as can be obtained, it does not admit of under-currents being used; but the manager, Mr. Greenbank, informed me that it is the intention of the company to raise the level of the tail-race for some distance back from the face, so as to get sufficient fall for under-current gold-saving tables to be placed. At the time of my visit there were five men employed in this claim. The quantity of gold obtained during the last season was 450oz., representing a value of £1,800.

Undaunted Company's Claim.—This adjoins on to portion of the northern boundary of the Mountain Race Company's ground; but there is none of the quartz-drift lead in this claim. All the ground is composed of the ordinary alluvial drift-wash. The ground on which the Excel water-race was constructed on this claim proved to be exceedingly rich; consequently the company made arrangements with Mr. Ewen to carry the water in his high-level race, and this allowed them to wash away the ground. They formerly had a first right of seven sluice-heads of water for the Excel water-race; but, on shifting this right higher up the creek, the Warden reduced their first right of water to six heads. By having the water carried in Mr. Ewen's race it gives them about 480ft. of head. A less quantity of water, therefore, will do more work at this elevation than the seven sluice-heads they formerly had at the low level. Instead of paying a rent to Mr. Ewen for conveying the water in his race, he is allowed a certain percentage of the available water, he having the second right out of the creek: that is, when there are only six sluice-heads of water in the creek he gets two sluice-heads, and the Undaunted Company gets four; when there are eight heads in the creek Mr. Ewen gets two and a-half heads of the six; and when there are fourteen sluice-heads in the creek he gets the half of the first right of water. The ground they are working is about 60ft. in depth; and eight men are employed in the claim. The quantity of gold produced last year was 700oz., representing a value of about £2,800.

Sugar-pot and Deep Lead Claims.—The Sugar-pot Claim, owned by Reed and party, is about as rich ground as there is at Tinker's; but the supply of water to work it is a very poor one, being only about four sluice-heads, and variable according to dryness of the season or otherwise; as for instance, during the season before last they only had six weeks' water; but the last season being very favourable for supplying water they have had a supply for about from seven to nine months. During last year they amalgamated with the Deep Lead Company, giving the latter company one-sixth share in the claim. This Deep Lead, however, cannot be worked without a good supply of water at a high elevation, as all the material will have to be elevated. There are nine men employed in this claim. The yield of gold last year has been about 500oz., representing a value of £2,000.

Matakanui Company's Claim.—This claim joins the Undaunted Company's ground, and the auriferous wash-drift is similar in character, only the ground, being further into the flat, cannot be worked by ordinary sluicing into a tail-race. The top portion of the ground is sluiced off and about 20ft. in depth of the bottom portion elevated by means of a hydraulic-elevator. There are far more stones in this claim than in any of the others, which have to be shifted and stacked in the worked-out ground, requiring additional labour to be employed. The company have a water-race from the Matakanui Creek, which terminates at about 130ft. elevation above their workings. The supply of about eight sluice-heads of water is tolerably constant, which allows the claim to be worked steadily, with the exception of the winter months during the frost. There are ten men employed in the claim. The yield of gold last season was 800oz., representing a value of £3,200.

There being a fair supply of water last year the whole of the claims at Tinker's have given good returns, the seven principal claims producing last year 3,350oz. of gold of a value of £13,000. The number of men employed in the claims which produced this gold was forty-four, and, taking the value of the produce, it gives an average of £303 10s. 11d. a man per annum. To give an idea of the value of water on this field, the Undaunted Company during last year purchased a water-right for four sluice-heads when it is available from Shepherd's Creek, about six miles from the Matakanui, for £1,250; this is merely for the right of water out of the creek. There will be the expense of constructing a water-race in addition to this to bring the water into Tinker's. The same water-right was purchased a few years ago for £350.

The only other claim being worked in this locality is one by Messrs. Shannon and Barron; but they have very little water, and, having to conserve it in a dam, only continue sluicing during the time the dam is emptying. These men are, however, said to be making wages.

There is a large extent of auriferous ground in the locality of Tinker's and Matakanui, if water could be brought on at a sufficient elevation to work the ground. The number of men that can be profitably employed on this field is governed entirely by the available quantity of water. The claimholders have got a survey of a dam-site made by Mr. R. Brown, the County Engineer for Maniototo, near the head of Thompson's Creek, which, if constructed, would augment the supply considerably. In wet weather there is a large quantity of water in this creek which cannot be utilised, and if conserved would give a tolerable steady supply to all those who hold water-rights from the creek. The plans were shown me at the time of my recent visit, but nothing definite was settled whether a reservoir would be constructed at this place or not.

Dam in Thompson's Creek.

The claimholders at Tinker's are proposing a scheme to conserve water in Thompson's Creek, at a point about half a mile above the head of Mr. Ewing's head-race. Two sites have been surveyed and plans prepared by Mr. R. Brown, Engineer for Maniototo County Council, for two alternative reservoirs, one in the left branch and the other below the junction of the two creeks. The one in the left branch shows an embankment 120ft. in depth, having a length on the top of 395ft., and this shows a storage capacity of 168,300,000 cubic feet of water. The embankment for the reservoir at lower site, if constructed to a height of 100ft., would have a length of 388ft. on the top and a storage capacity of 88,725,188 cubic feet of water; but if the embankment at this point were raised to 150ft., the length on the top would be 540ft. and its storage capacity 294,510,688 cubic feet of water. The estimates of cost being given as follows: 100ft. embankment, £7,000; 120ft. embankment, £11,950; 150ft. embankment, £17,000.

Sufficient details were not given me so as to form an idea whether these estimates are reliable, but the plans show that a large quantity of water can be stored during wet weather. Allowing 40 per cent. for evaporation and leakage, the 100ft. dam would supply twenty-five sluice-heads for twenty-five days continuous working. The 120ft. dam would supply twenty-five sluice-heads for fifty-two days and a half; and the 150ft. dam would supply twenty-five sluice-heads for eighty-seven days, if there were no water coming into the reservoir. It is well known that there is plenty of ground in the vicinity of Tinker's which would pay for working if water were available, and also that there is far more water-rights granted from Thompson's Creek than there is water to supply in ordinary weather. The construction of a reservoir in Thompson's Creek would only be an advantage to the present claims on the field; it would not allow fresh parties to come in and work new ground unless some arrangements were made with the present claimholders as to the quantity of water they were willing to accept for the rights they actually held.

Although there is very little water in Thompson's Creek in a dry season, it is a very large stream during wet weather, and it is only then and in time of flood that water could be conserved; but such a reservoir would have the effect of giving the claimholders who have water-supply from Thompson's Creek a constant supply. When hydraulic-mining is carried on, every available spot should be utilized for the construction of reservoirs, and the water conserved; but the difficulty is, there is so many who have interests in the water, that it becomes a serious matter to make satisfactory arrangements to get each party interested to contribute towards the construction of such a work. The interest that each one has in the creek is so varied, that is as regards the rights they hold, being the first, second, or tenth right, as the case may be; as, for instance, a person holding the first right from the creek may say, "This scheme does not affect me; I hold a certain right, and am bound to be supplied so long as there is water in the creek before any one else takes out any water." So that each party is affected, therefore, in accordance with the priority of their rights.

The manner in which it is proposed to construct the embankment of the reservoir is to sluice material in and form an enbankment, which would, no doubt, lessen the cost considerably; but the question is, although a low embankment can be cheaply constructed in this manner, and be thoroughly watertight, will an embankment of 150ft. high be equally successful in resisting the pressure. It is true that the force of resistance should be equal whether the embankment is only 20ft. high or 150ft., if constructed in proportion to its height; and that being the case, if a low dam can be effectively constructed by merely sluicing in the material, it should be equally as effective whatever height the embankment is, so long as there is sufficient sediment and clay in the sluiced material to form a close compact mass. It is a question with engineers at the present day as to where a puddle-wall in an embankment for a dam should be; the generality of them prefer the puddle-wall in the centre of the embankment, while others state that the wall ought to be on the inner slope directly under a coating of sand, where stone-pitching is generally laid. Embankments 70ft. and upwards in height have been made in America on the latter principle, and have stood for many years; the arguments in favour of the latter mode of construction being that the puddle-wall being in front of the ordinary earthwork embankment prevents the water percolating through, and therefore the material is in a drier state, and has a much greater resisting force than it would have if partly saturated with water. When the puddle-wall is in the centre all the ordinary earthwork in front of the puddle-wall is liable to be saturated with water, and, if so, the resisting force of that portion of the embankment—which is always the largest in cubic contents—is considerably reduced; indeed, it becomes a question, if saturated with water, whether any resisting force can be calculated; on the other hand, if the earthwork embankment in front prevents the water from reaching the puddle-wall, then the latter is of no use.

The construction of an embankment for a reservoir by sluicing proper material into its position has the effect of making the whole of the embankment impervious to water, or acts the same as a puddle-wall in front. Care will have to be taken in constructing it to get proper material, and to remove all rocks and large stones to the outside. The manner in which Mr. Browne shows the mode of construction as regards stone-facing is objectionable, and contributes to the cost; but even omitting this, the estimated cost of construction of either of the embankments, taking outlet, tunnels, and by-wash into consideration, appears to me to be considerably under-estimated; but not having seen the site nor the place where the material will come from for the embankment, but merely the plans, Mr. Browne's estimate may probably be correct.

Apart from the cost of construction, if the reservoir can be constructed at this point so as to insure a constant supply of water to the present claims, it should be undertaken, as the known richness of the ground in this locality will soon repay the cost of construction even should it cost a few thousand pounds more than is estimated.

St. Bathan's.

Cambrians.—There has been a considerable quantity of gold obtained at this place, but the best portion of the ground is, no doubt, worked out, at the same time it is believed by a number of miners that there is a considerable area of good ground that would pay well for hydraulic-sluicing if properly carried on. The want of a good supply of water here is the great drawback, the same as in many other localities; indeed, there is not a field in the colony where a plentiful supply of water has been brought on to the ground. There is only one party of Europeans—Fordam and party of three men working in the gully—who use three sluice-heads of water. They are working ground higher up than the former workings, and getting much coarser gold than was formerly obtained. The same quartz-drift wash occurs here as at Tinker's, Matakanui, and St. Bathan's. In the lower end of the gully there are some parties of Chinese at work, who are said to be doing very well, but they have a very indifferent method of working.

Vinegar Flat.—There are four parties of miners working in Vinegar Flat—namely, Watson and party, three men; Morgan and Hughes, two men; Morgan and party, three men; and Davis and party of three men. Each of these parties have water-races of their own; but, with the exception of Watson and party, who are said to have averaged about £5 each per week, the rest have only made small wages. The average depth of ground worked here last year was about 18ft.

Vinegar Hill.—The only claim being worked here is that of Mr. John Ewen, who makes mining a specialty, and uses all modern appliances to work the ground to the best advantage. Every mining claim he is interested in is carefully prospected before laying out any money on plant; but after this is done, and he is satisfied with the results, no expense is spared in placing a good hydraulic-plant on the ground, and he is always careful to see that a fair supply of water is available. The consequence of this is that every claim he takes up, where he can superintend the working of it, he has made it a successful mining venture. Since my last visit to Vinegar Hill he has purchased the water-race he formerly used to rent, and cut it at a higher level, so that now he has about 280ft. of head or pressure at his workings. He has also substituted a new line of pipes, 15in. in diameter, for the former one, which was only 11in. in diameter, and has a supply of water equal to about ten sluice-heads. The ground he is working is about 70ft. in depth, consisting of a greenish clay mud full of small spiral shells and vertebræ of fishes. It is an exceedingly tough substance when first broken down, but after lying exposed to the atmosphere for some time it crumbles and melts away with the water. The whole of this 70ft. of overlying deposit on the auriferous wash-drift has to be removed before any gold is obtained, the wash-drift consisting of from 6in. to 1ft. of quartz-gravel, Anyone looking at the face of these workings, and seing the ground stand in a perpendicular face, if they were not acquainted with the character of the material, would think it almost impossible to dispose of it fast enough to be able to get a sufficient area of the auriferous wash-drift to pay for the expense of running off the top stuff. The tail-race is not sufficiently deep to be able to run away the material in the ordinary manner; it has to be lifted for 25ft. by a hydraulic-elevator. In order to prevent any rubbish or large stones from getting into the elevator, there is a grating round the end of the pipe. The elevator used is fitted with Robinson's patent atmospheric nozzles, which leaves an equal space all round the end of the elevator, and not the same as those used in the Valley of the Clutha and elsewhere, with the opening all at one side. From the time of commencing to work, after the frost in winter, to the time of my visit in January last, Mr. Ewen had obtained 180oz. of gold, but he has not been able to wash up the main paddocks this year. The only gold obtained has been from the tail-boxes. There is about one acre stripped in each paddock, ready to take up the wash-drift, where it is expected to yield 800oz. of gold. There are eight men employed in connection with the work.

St. Bathan's Sludge-channel.—This channel has been in course of construction for the last six years, and is still a good way from being completed. During the last year they have been working at the head of the channel, running off the top stuff; all the material is washed down a tail-race and over a wide set of tables covered with cocoanut matting. They have taken out the upper portion to a width of 200ft., and after this season the different companies at St. Bathan's will be able to utilize this tail-race, but it will yet take some years to construct it to the proper depth. In its present state it will allow the claims to be worked to about 25ft. deeper level than formerly. About 350ozs. of gold has previously been obtained in the construction of this channel, in addition to 450ozs. for this season. The channel is being constructed jointly by the claimholders, but as each of these have different interests, a company was formed in a certain number of shares, and the shares allotted to each individual according to the interest he held, and to the extent he was considered to be benefited. The year's returns of gold last season are very encouraging to those who hold claims in this basin, and it is important to state that, out of the yield of 450oz., over 100oz. were got from the tables at the lower end of the tail-race, which would have been entirely lost if these tables had not been used.

The St. Bathan's Water-race Company.—This company have a fairly good supply of water, but they have been working extremely poor ground, and may be said to only have earned about wages for the number of men employed after paying other expenses. They have about eight sluice-heads of water, and employ five men. The yield of gold last season was about 110oz.

Eagle and Gray.—These gentlemen have a good claim if they had a good supply of water, but as they only hold an inferior water-right, they were scarcely able to do any work the season previous to the last one; it is said that they had not more than one month's water in two years. When such a state of things exist the ground must be extremely good to hold on to under these conditions.

Gallagher and Party.—This party has a very good claim. They are elevating the material to a height of 28ft. The ground on top of the wash-drift consists of a very tough clay mud, which, being highly compressed, breaks down in cubical blocks, and is hard to break up with the water; but the atmospheric action, when the broken-down material is allowed to lie for some time

disintegrates it, and then it freely runs away. This party got 150oz. of gold for the previous season, and had at the time of my visit a large paddock stripped ready to lift the wash-drift.

John Ewen.—This gentleman also holds a claim at St. Bathan's. He is elevating the material 46ft., and at the time of my visit was making arrangements to put in another elevator in the bottom of the present paddock, and lift the material to a further depth of 45ft. The whole of the material sluiced is composed of old quartz-drift, but there are certain layers in it where most of the gold is found. When this drift was deposited it underwent a process of concentration by the action of running water, and where the river-bed had for a good period remained at or nearly the same level, one can see the layers of material correspondingly; instead of fine drift, pieces of quartz are found in these layers 10lb. in weight, and sometimes larger. The structure of the quartz is extremely crystalline, but greatly foliated, and has every appearance of being auriferous stone, and no doubt it was, or else there would not be so much fine gold amongst the pure quartz-drift. Whatever convulsions of nature has altered the surface of the country since this deposit was made, it is no doubt the denudations from the high mountains which at one time existed that were carried onwards by the action of a large river which underwent certain changes at places; the layers of large washed quartz pebbles indicates that the current was moderately swift, while at other times slips appear to have blocked up the channel, and formed a lake of water, as deposits of beds of pure leaves from trees are found 5ft. and 6ft. in thickness, also indicating that the whole of this country, where no tree is now to be found, was at one time a dense forest.

Mr. Ewen uses a 2½in. nozzle for elevating under a head of 440ft. The elevating-pipe is 14in. in diameter, with a throat of 5in. in diameter. As the elevator is sunk in the quartz-drift for the whole of the distance, it was difficult, so long as the ordinary flume joined on to the top of the elevator, to keep it entirely water-tight, and the small leakage coming down the pipe used to bring the quartz-drift away and caused endless trouble to protect the bank; this has now been got over by having a wrought-iron bend bolted on to the top of the elevator, and a horizontal pipe on the other end of the bend discharging into the sluice-box. Since this was done the place is always thoroughly dry and no leakage occurs. There are two elevators—one lifting the material 45ft., and below this there is another lifting 30ft., but pipes are on the ground to increase the bottom lift, so that the ground can be worked to a depth of 90ft. The main supply-pipes are 18in., 15in., and some of them for supplying the breaking-down nozzle are only 9in. in diameter The yield of gold for last season was 850oz., representing a value of £3,400. It may be mentioned that 750oz. was produced for seven weeks' work. The rest of the season was devoted to stripping the top material, in which there is very little gold. A large portion is now stripped ready for washing-up after winter, when a large yield is expected.

M. and E. Company.—This company holds two claims, one at St. Bathan's and the other at Surface Hill or Muddy Creek. They have two water-races and a supply of about fifteen sluice-heads of water. They were washing-up in the Muddy Creek claim at the time of my visit, but, until the sludge-channel is ready for use at St. Bathan's, they cannot work their claim in that locality. They have washed- up in one of their claims this season and got 180oz. of gold, being the result of two years' work.

Scandinavian Company.—This company has also a claim at Surface Hill, where they work by sluicing in the ordinary manner, employing six men. They have a water-race from the western branch of the Manuherikia River, where they get about twelve sluice-heads of water. They sell water to the miners at £2 per head per week for day-water, and £1 10s. per head per week for night-water. What they cannot sell is used in the claim. The yield of gold from this company's claim for the last two years was 430oz. They did not wash-up for the season previous to the last one.

Otago Company.—This is a company of working miners, but they have a very inferior plant, and do not work the ground to the best advantage. This is held to be the case by those acquainted with working this description of material. They have a water-race of their own from the Manuherikia River, and being under no expense in deepening the Muddy Creek channel which they now use, enabling them to work the ground to a much greater depth than formerly, one is inclined to believe that, if the ground were worked to the best advantage, a good return ought to be the result.

Hill's Creek.

At Blackstone Hill, R. Johnstone has been working a claim for a number of years, he having two water-races which he has brought on to the ground, one of them from what the miners term the right branch of the Manuherikia River, that is, looking up towards its source; and the other from the Ida Burn. Each of these water-races in ordinary weather lifts about five sluice-heads or water from these streams, which gives him a good supply of water at his claim. Portions of the water he sells, and uses the rest. His claim is on the left-hand side of the road going from St. Bathan's to Hill's Creek, on the top of the saddle, and although workings has been carried on here for these last twenty years, there is not a great deal of ground yet shifted. The wash-drift is old quartz-drift, similar to that found at Muddy Creek and St. Bathan's, but it is lying in some places on a puggy bottom, which, when exposed to the atmosphere, gets very soft and spews up, causing the hill-side of the ground to slide away. Very little labour is required in this claim. The water is directed on to different portions of the ground from time to time, and all the material broken up with a jet of water from a nozzle and carried away down the tail-race. If ever a large area of auriferous ground be discovered on the range which divides the watershed of the Manuherikia and Ida Valleys, Mr. Johnstone's water-races would become valuable property, as they are at a high elevation, and could command all the ground on either side of the range.

The Maniototo County Council had, at the time of my visit to this district, completed the valuation of the mining property within the county, which, it states, is only £50,000. This will bring in a very small revenue at 1d. in the pound, which is the extent of their rating powers under "The Gold Duty Abolition and Rating Act, 1890."

Mount Ida.

There is still a large quantity of auriferous ground that would pay fair wages for working if a constant supply of water could be obtained, but this is so very irregular that the ground has to be rich to pay for the expenses of opening-out and contingencies in connection with bringing water on to it. There are a few small water-races brought in, but the great majority of the miners are wholly dependent on receiving a supply of water from the Mount Ida Water-race. In very wet seasons there is a tolerably steady supply for eight or nine months of the year, but in other seasons there is only three or four months' constant supply. This water-race is so constructed that every small fresh in any of the creeks it crosses washes away a portion of the race, and has again to be repaired before any water can be sent down. When it is taken into consideration that this water-race is seventy miles in length, and the ditch cut across all the shingle-beds of creeks, the low side being banked up, and that considerable leakage is always taking place amongst the shingle, it can easily be understood the difficulty there is in keeping up a constant supply. In mid-winter there is always two or three months that no workings can be carried on, owing to the hard frost at this altitude, as the water, if allowed to run in the open conduit in winter, would get completely frozen up. This, together with scanty supply in dry weather, and the numerous breaks in wet weather, shows that there cannot be in an ordinary season more than about six months' constant supply.

On my recent visit to this field many of the miners complained to me about the irregular supply, and stated that several would open out new ground if water was available, but the ground in the district being as a rule very poor, the miners have to be constantly employed in order to make wages. There is a large stretch of country that the water-race commands, having the same character of quartz-drift, or what is termed in the locality granite-wash, as that being worked about St. Bathan's and Muddy Creek, in one place on the low side of the water-race, between Old Hut Creek and Pierce's Gorge, where some prospecting was done a number of years ago, and where it is stated gold was obtained; but there seems to be no inducement held out for any one to prospect the country in this locality. It is a place where free water could often be given if the water-race was kept in proper repair, and constructed in a different manner across the shingle-beds of creeks. The workings are all confined to within a radius of about one and a half or two miles from Naseby.

During these last four or five years there has been a considerable improvement in the method adopted for working the ground on this field. Several parties are now getting wrought-iron pipes to replace the antiquated canvas-hose; but there are still a good many yet who are content to break down the wash-drift from the bank with picks before allowing water on the material. This is done in many places where a considerable head of water could be got if iron-piping were used. There are some claims at the head of Home Gully which are being worked close up to the level of the race, and in this instance the ground has to be broken up before it can be sluiced away; but in general the water could be made to do the whole of the work at a far less cost than by manual labour. There is now about 9,000ft. of wrought-iron pipes used on the field, of from 7in. to 9in. diameter. This size of pipe on many of the fields where hydraulic-sluicing is carried on would be considered far too small to work the ground; and so they would here if a good supply of water could be obtained, but in general the quantity that each claimholder uses is about three Hogburn sluice-heads, which is equal to one and one-fifth Government heads, and therefore they are sufficiently large to carry all the water they use.

In *Hogburn* there are still a few parties working in what is called the Main Gully. The Extended Company, who have a water-race of their own from Deep Creek, which gives them a supply of about three and a-half Government sluice-heads, are working the ground by a hydraulic-elevator, the depth being from 8ft. to 10ft. They use about 1,000ft. of iron pipes, which are from 7in. to 9in. in diameter, and keep three men employed in the claim. M. Young and party of three men have also a claim in this gully; they have the water from the Mosquito Water-race, and use canvas-hose for hydraulicking. The depth of the ground is about 8ft., but there is very little fall, and consequently only a very limited quantity of material can be sluiced away. Messrs. Barrett and Pullen have also a claim in this gully, but have very little fall to work it; the ground is about 6ft. in depth, and they use only three Hogburn sluice-heads of water.

In *Roche's Gully* Messrs. Guffie and Inder have taken up a claim, and are working it with a hydraulic-elevator. They purchased the hydraulic plant belonging to a company which worked for years in the bed of the main gully, near the township, but had to go into liquidation. As Messrs. Guffie and Inder were shareholders in this company, and became responsible for some of the debts, they had to purchase the plant to save themselves. They have shifted it up into Roche's Gully, and commenced working directly on the upper side of the main street, using about three and three-fifths sluice-heads of water, and from the returns that this claim has been giving since sluicing operations have commenced, it is likely to pay the proprietors about £100 per month, clear of all expenses. There are 2,000ft. of wrought-iron pipes, 9in. in diameter, in connection with this plant, and two men are employed in the claim.

In *Enterprise Gully* there are about five parties of Europeans, and several Chinamen at work, each party using about three Hogburn heads of water, with the exception of A. Brown and another, who have leased the Surprise Water-race, and get, when water is available, about two Government sluice-heads, the quantity from this water-race being variable according to the supply in the Eweburn. If there be two sluice-heads in the Eweburn that quantity is supplied from the Mount Ida water-race; but as the supply gets less the quantity turned into this water-race is regulated accordingly. There is, however, a dam in connection with this water-race which always guarantees a fair supply being got. A. Brown has about 1,000ft. of pipes, 9in. in diameter, in connection with his claim, and Messrs. Bysord and Reed, who are in the same gully, use about 300ft. of 7in. wrought-iron pipes.

In *Coalpit Gully* there are two parties at work, both of which use iron-piping, and one of them —S. Hewitt and party of three men—have about 700ft. of 7in. pipes, and use six sluice-heads of water when it is available; the other party of two men has about 250ft of pipes, the ground here in places being 40ft., and varying to only 8ft. in depth.

In *Home Gully* there are six parties of Chinese at work, the ground being from 4ft. to 8ft. in depth. Four of these parties use 1,200ft. of wrought-iron pipes, 7in. in diameter, and the other two use canvas-hose in connection with the working of their claims. A good deal of gold has been obtained from this gully since the extension of the water-race, but the upper portion of it is now pretty well worked out. There is some private or leasehold property in the lower portion of the gully and its watershed, and in some instances arrangements have to be made with the owners to work a portion of the ground. Two parties of miners are working in Wet Gully, and also there are two or three claims being worked in Robertson's Gully, where the ground averages from 4ft. to 7ft. in depth.

In *Spec Gully* there is a considerable area of auriferous ground to work. Indeed there is very little done in this gully yet, it being at the extreme end of the water-race. There is very little water to be had at this point. There are only about four claims being worked. The ground here in places is a considerable depth, requiring a good head of water to sluice it away. All the claims that are being worked in this gully is said to give payable returns. There is also a large extent of auriferous gravel-drifts on the terraces and sides of the gullies between Spec Gully and the Kyeburn, and a few parties are working in this locality, but the difficulty to contend with everywhere here is the limited supply of water.

The following is a list of the principal claims being worked in the vicinity of Naseby:—

Name of Party or Company.	Depth of Ground.	Length of Iron Pipes used.	Diameter of Pipes.	Number of Men employed.	Sluice-heads of Water used.	Locality.
	Feet.	Feet.	Inches.			
Guffie and Inder ...	8 to 10	2,000	9	2	$3\frac{3}{5}$	Roche's Gully.
Extended Company ...	8 to 10	1,000	7 to 9	3	$3\frac{3}{5}$	Main Gully.
Newman and party ...	40	1,500	7	4	...	Enterprise Gully.
S. Hewett and party ...	40	700	7	3	6	Coal-pit Gully.
White and Hinds ...	8	250	7	2	...	,,
M. Young and party ...	8	...	...	3	...	Main Gully.
Burrett and Pullen ...	6	...	...	2	3*	,,
C. Rumble and party ...	25	...	...	2	3	Enterprise Gully.
Gu Li	25	...	...	2	3	,,
Ah Cuck	25	...	...	2	3	,,
A. Buchanan	6	...	...	2	3	,,
J. Wheeler	5 to 6	...	..	1	3	,,
A. Brown	10 to 12	1,000	9	2	25*	,,
R. Moon	6	...	...	2	3	Wet Gully.
Si Yung	4	300	7	2	3	,,
Ah Ping	4	300	7	2	3	Home Gully.
Ah Lick	6	...	...	2	3	,,
Sue Ming	4	...	...	1	3	,,
Sae Hun	3	270	7	2	3	,,
Ah Toy	8	300	7	2	3	,,
Len Mon	6	300	7	1	3	,,
Ah Yott	6	...	...	2	3	Robertson's Gully.
Hang Toy	7	...	...	2	3	,,
Sheiles Brothers ...	10 to 12	...	...	2	3	Spec Gully.
G. Walker	8	...	...	2	3	,,
Lon Lip	6	...	...	...	2	,,
W. Hundrickson ...	6	270	7	1	3	,,
Bysord and Reed ...	8	300	7	2	...	Enterprise Gully.

* Hogburn heads.

Kyeburn.

At Kyeburn some of the miners are doing very well; the claims of Moses Brown and that of Thomas Forgie are said to give very good returns for working; these parties have water-races of their own, and get a fairly constant supply. The Kyeburn diggings may be said to be a good field for a few miners; although there is plenty of auriferous ground in the locality which will pay fair wages for working with a constant supply of water, only a limited number of miners can be employed owing to a large supply not being available. Mining operations and the number of miners employed may be said to be entirely limited to the available supply of water on the field. The days have gone by when ground can be made to pay for working by using a cradle, and only washing a foot or a few inches, as the case may be, of the wash-drift lying directly on the rock-bottom. There is a little gold in all the ground, but a large quantity has to be operated on to enable the miners to earn a fair wage.

Bannockburn.

There are still a good few claims being worked in this locality, the principal ones being on the side of Pipeclay Gully, and between Pipeclay and the Kawarau River, all of which pay fair

wages for working with a good supply of water, but the quantity of water available on this field is very limited; this, together with the ground being poor, necessitates the claims being worked continuously throughout the year, except when the ground is frozen in the middle of winter, to give fair returns. All the ground in the vicinity of Pipeclay Gully is being worked out by means of the main tailings-channel, which was constructed several years ago with subsidy from the Government; had this channel not been constructed the ground could not have been worked, as there is not sufficient water on this field to use the hydraulic-elevating system.

Another tailings-channel has been constructed higher up the valley of the Kawarau than the outlet of the Pipeclay channel, into which the claims in the locality are being worked. There is still a large area of ground in this valley containing a little gold, which no doubt will yet be worked, but to do this profitably a larger supply of water is required, and to get this to command the ground would be a very expensive undertaking, as all the available streams from which water can be easily brought on to the ground is already taken up.

Cardrona.

There are a considerable number of miners employed on this field, some of whom are doing very well. As year by year passes by one sees less canvas-hose used for hydraulic sluicing and more iron pipes, although in some instances on this field even yet the full head of water is not used on the nozzles, notwithstanding that it is required for breaking up the material. At the time of my visit to this field there was a good supply of water, and all the claims were being worked. Although none of the owners told me the actual quantity of gold they were obtaining, they all had good hopes that the washing-up this season would in general be very satisfactory. Robertson Brothers' claim, that was formerly very rich, is now held by Craig and party, and the best of the ground is worked out. Mr. Craig informed me that they are tracing the run of gold, which is going up the range, and the higher up they go the particles of gold are getting larger, thus giving an indication that it came down from a higher level. If this should prove to be the case, there is some hope that payable ledges will be found higher up the range. During last year about 2,000oz. of gold were obtained from Cardrona, and about seventy miners were employed on the field, which would give the average earnings of the miners about £110 a man per annum.

Hydraulic Sluicing Company.—A number of the miners and residents in the locality have taken up some of the old worked ground near the upper township, and have formed themselves into a syndicate or company, consisting of thirteen persons, to work the ground on the hydraulic-elevating system. This ground was only partially worked in the early days, and, as it is about 40ft. in depth, and had all to be driven out, in some instances the water became too heavy to contend with. The syndicate purchased the hydraulic plant formerly belonging to Messrs. Scoles and Company, at Arrowtown, who had it at work in the bed of the Arrow River, about two miles above the township; but, as the ground there had been very carefully worked in the early days, the venture proved a failure, and subsequently the plant was sold to the present proprietors.

At the time of my visit, in January last, the company had constructed a water-race from the Cardrona Creek, along the side of the range to opposite the place where the ground is taken up, being at its terminating point about 360ft. higher than the level of their claim. The line of pipes—7in. and 9in. in diameter—was laid down, and a commencement made to sink the first paddock with the hydraulic elevator, the latter being only about 9in. in diameter, the elevating nozzle being 2½in. in diameter, which would be capable of discharging about five sluice-heads of water, under a head of 360ft., if a sufficiently large main was used, but with the main being only 7in. in diameter five sluice-heads of water would not come through it, and therefore the nozzle is out of proportion to the size of the main. They complained to me at the time that the pipe was not large enough to bring water for the breaking-down nozzle, and stated they intended to cut another water-race at a lower level to use for the sluicing-nozzle. The paddock was sunk to a depth of about 15ft., and they then expected to get the bottom at about 32ft. The ground is very stony, and consequently the whole of the stones had to be lifted out of the first paddock. This was done by trucks on an inclined tramway, the winding being done by a water-wheel. There appeared to be a little gold through the material in sinking, as sometimes fair prospects were got in a tin-dishful of stuff; but until the first paddock is bottomed and a fair trial afterwards made, it will not be known whether the venture will be payable or not.

With regard to this plant, it will prospect the ground and prove the quantity of gold it contains to the cubic yard of material. This will be reliable information for the company to form an opinion as to the best method of carrying on future operations. In any case they will find that the plant is far too small to work this character of ground economically, and instead of cutting a fresh water-race at a lower level, they will find it more advantageous to increase the carrying capacity of their present water-race, lay down a main supply-pipe of about 15in. in diameter with larger pipes on the upper end, and take the water for sluicing and breaking-down purposes from the same main which supplies the water for the elevating-nozzle, and also have the elevating-pipe either 14in. or 15in. in diameter. They will find such a plant will make their venture a highly-remunerative one if the ground will average 4gr. of gold to the cubic yard; but with their present plant the ground would have to be very rich to pay for working. A good deal of the top stuff can be sluiced off in the ordinary manner; and when this can be done it ought not to be put through the elevator, Even if only 4ft. of top-stripping can be sluiced off it is far more economical to use the water for this purpose than to use it for lifting the same material in the elevating-pipe. It is very gratifying, however, to see this system of working introduced on this field, as it will probably be the means of other parties taking up ground lower down the flat, and adopting a similar way of working it.

Since writing the above, information has recently come to hand that the syndicate have bottomed their paddock and got about 15oz. of gold. This may be a little disappointing to the shareholders, but they must recollect that the amount of work done is very little, and that with a

proper hydraulic plant the venture is likely to become a good investment. The amount of capital expended up to the present time is about £1,500.

Criffel.

This field still continues to yield a fair quantity of gold for the number of miners employed, and taking into consideration the limited period for which mining can be carried on, which does not exceed six months in the year, the ground may be said to be tolerably rich. Halliday and party, the original prospectors, have done very well, not only by working the ground, but also in supplying water from their water-races to the other claimholders. All the workings are now carried on by hydraulic sluicing, and Halliday and party may be said to hold the whole of the available water-rights of any consequence there is on the field. Some two years ago they purchased Craig and party's water-race in addition to the one they constructed themselves to work their first claim, but neither of these water-races have been properly laid out, that is, they are not constructed on a uniform gradient, some places being very level while in other portions of the race there is a great fall; the consequence of this is that the races carry very little water even when the same is available. During the past year there has been about twenty-three miners employed on the field, and it is said that they have obtained about 1,200oz. of gold for the few months they have been able to work, which would be equal to about £180 per man.

Arrowtown.

There are still a few miners working in the bed of the Arrow River and its tributaries, making small wages. On the terraces there is always a little gold to be obtained when water can be got to work the ground. Traces of an ancient river-bed can be seen here and there on the terraces, three or four hundred feet above the present river-bed, which shows that a long period must have elapsed since this deposit was made. Thousands of years have rolled by since the first river deposits were made in this locality to admit of the gorge of the river between Macetown and Arrowtown being cut down some hundreds of feet in solid schist rock. Wherever a river deposit or a concentration of the drift has taken place by flowing streams, gold is almost certain to be obtained; but this occurs in many instances too high for water to be lifted from the beds of the present streams to work the ground. The country in this locality is also of a very rugged and broken character, that the construction of water-races becomes of an extremely costly nature; unless the ditch is cut well into the solid rock, and tunnels driven through the spurs, it becomes a great expense to keep them in repair, as has been the case with Messrs. Moody and Davis's water-race from Skipper's Creek to Londonderry Terrace. Judging from the appearance of the gravel-wash terraces on the Shotover side of the Arrow River, there is a large extent of ground which would pay for working if a good supply of water could be brought on to them from near the head of the Arrow River, an undertaking which would cost a considerable amount of money, but will no doubt be done some day.

Davis and Moody's Claim.—This is the largest undertaking in connection with working the auriferous-drifts there is in the district. A tunnel has been constructed in the solid rock on the left side of the river going from Arrowtown to Macetown, for a distance of about 950ft. The tunnel is 10ft. wide and 7ft. high, being paved in the bottom with stones so as to act as a sluice for saving gold and to take the whole of the water in the river at the same time. At the head of this tunnel a shaft was commenced in the solid rock to connect the tunnel with the surface of the bed of the river, and from this shaft a channel was to be cut to admit of the material being washed through the tunnel. A slip, which has blocked up the gorge of the river at this point, has raised the bed about 70ft. above the level of the tunnel; therefore the shaft was expected to have gone down 70ft. through solid rock. Instead of having solid rock all the way down, it was found that the action of the water had cut away the rock and left it overhanging at this point, consequently a portion of the shaft went through shingle, and at the time of my visit to the district it was not within 20ft. of the bottom. It was intended to have the shaft divided in two partitions, and to have gates, each 4ft. wide, so as to regulate the quantity of water and material passing into the tunnel; that is, in ordinary weather the whole of the water would pass through the tunnel, and during floods the gates would be shut down to such an extent as only to admit of a certain quantity of water to pass through, and the rest would bank up and go down the present course of the river over the falls. Mr. Miller, the manager and engineer, being away in Melbourne at the time of my visit, the gentleman in charge could give me little or no information as to when the work was likely to be completed. It has always been considered by those acquainted with mining in this river, that a heavy deposit of gold will be obtained between the head of this tunnel and Soho Creek, and several attempts have been made to try and sink paddocks and shafts in the bed of the river at this place, but none ever succeeded in getting down near the bottom on account of the heavy influx of water. It is to be hoped that the work will be successfully completed, and that the proprietors will be richly recompensed for all their outlay and their perseverance in combatting with the many unforeseen difficulties attending the bringing of their venture to a successful issue.

Crown Terrace.—Gold was discovered in land held by John William Baker as an agricultural lease, and some good claims have been secured. As soon as the holder of the lease knew of gold being discovered he wanted to exact certain royalties which the miners were not entitled to pay; and consequently a meeting was held and a memorial drawn up and forwarded to the Lake County Council on the 17th of October last, praying that the whole of the land in sections 9 and 10, Block X., Shotover District, might be resumed and the lease determined. After making the necessary inquiries respecting the land, the Hon. Minister of Mines gave Mr. Baker notice in January last that his agricultural lease would be determined, as the land was required for mining, and on the 16th of February the land was thrown open. Some of those who have claims on this terrace are doing very well; amongst those may be mentioned Messrs. Jenkins and party, who at the time of

my visit to this district were said to be making from £10 to £20 per week; but, be that as it may, Mr. Jenkins, although not giving the actual returns from his claim, stated that the claim was a very good one. His party's claim is in shallow ground, on the lower side of the road leading up from Arrowtown; but as the claims extend backward into the terrace some of the ground will be very deep and more difficult to work, requiring to be either driven from shafts or adits. The number of men that it will give remunerative employment to fully justifies the determination of this leasehold, which had only about two-and-a-half years to run, and it being held under the Mining Act of 1886, the holder has no claim to be entitled to purchase.

Shotover.

There are very large areas of auriferous drifts in the valley of the Shotover and on the side of the terraces. Some of these drifts show that the bed of the Shotover River has been at a much higher elevation than it is at the present time. Old river-channels can be seen fully 700ft. above the present bed of the river. In the valley itself the auriferous drifts are in some instances over 250ft. in depth, as is the case in Davis Brothers' claim, which continues to give handsome returns for working. Indeed, there is scarcely any drift-terrace in the valley of the Shotover but would pay well for working if there was a good supply of water; but it is such a rugged and broken country that the construction of water-races capable of conveying a large supply would be an extremely costly undertaking. The supply of water is also very limited except it were taken from the Shotover River, and the length of a water-race from this source would be so costly as to prohibit any private party undertaking its construction. No doubt the time will come when strong companies will undertake large works of this character; but before such will be done large areas of ground will have to be secured to them to justify the expenditure. There are very few places in the vicinity of the Shotover, Arrow, Kawarau, and Clutha Rivers, wherever there are alluvial drifts, but would pay for working with a good supply of water.

Davis and Moody's Claim.—Sluicing was commenced on the 12th October last, and carried on for twenty-seven days, when the principal gentlemen from Melbourne who are connected with this claim came over to see their property; and in order to give them some idea of the value of the ground, a washing-up took place, and they were well satisfied with the result. During the twenty-seven days sluicing operations were carried on, the foreman of the works informed me that he ran away a block of ground, the measurement of which was as follows: 20yds. by 60yds. by 26yds., which is equal to 31,200 cubic yards of material, or 1,155⅓ cubic yards a day. If the working had been carried on continuously, this would be equal on an average of about 48 cubic yards per hour. There is every facility for running away a large quantity of wash-drift in this claim, as they have opened out near the side of the river at a considerable distance above its bed. The greatest difficulty will be the saving of the gold with the short line of sluices they adopt.

The water-race is cut along the siding of the steep range on the Shotover side of Skipper's Creek; portions of it are continually slipping down and giving a great deal of trouble; a considerable length of piping has already been used, instead of allowing the water to flow in the ditch; and the gentleman in charge of the work informed me that he expects to have an additional 14 chains of pipes yet to lay down. At the time of my visit, Mr. Miller, the manager, was absent in Melbourne, so that the gentleman left in charge did not like to give me any information as to the value of the ground, or what it would be likely to yield in gold per cubic yard; but he assured me it was highly payable. The utmost carrying capacity of the water-race, owing to the ground gradually slipping and altering the level of the ditch, is said to be only ten sluice-heads, whereas if an uniform level could have been maintained as laid out, on a gradient of 1 in 660, its carrying capacity should have been about thirteen sluice-heads, that is allowing that the level of the water does not come within 3in. of the top of the lower side of the ditch, its dimensions being 2ft. 6in. wide in the bottom, 3ft. 6in. on the top, and 3ft. deep.

At the time of my previous visit Mr. Miller contemplated extending the water-race on to Londonderry Terrace; but nothing has yet been done towards this. Indeed the whole of the water the race can convey is required on one face, so that until the ground is worked on Burke's Terrace, where the present sluicing operations are being carried on, it will be of little use to extend the water-race at the present time. The Melbourne syndicate, to which this property belongs, is so well satisfied with the results of this claim that they have taken up another one at Moke Creek, and intend constructing a water-race to lift the water out of Dead-horse Creek, and to ultimately extend the race to Moonlight Creek. The gentleman in charge of the works informed me that the ground in this locality is similar to that they are at present working.

R. Johnstone's Claim.—The returns from this claim have been very good this season, as he has had a plentiful supply of water. The ground here must be rich to pay good wages with the hydraulic-plant Mr. Johnstone uses. A good portion of his water is allowed to flow over the face, and the balance is taken in a canvas-hose, to which is attached the breaking-down nozzle. As portion of Mr. Johnstone's claim is very deep ground, it will take a longer period than he is likely to live to work it out at the same rate that the workings have been progressing the last twelve years.

Davis Brothers' Claim.—This claim still continues to give handsome returns for working. They have a good hydraulic plant, and a plentiful supply of water in anything like an ordinary season. It is, however, possible that in course of time the tailings may become troublesome, as the quantity continually being sluiced into the river will in time raise its bed, and, as there is a very deep gut through this claim, it will no doubt necessitate their tail-race being carried on a very low gradient.

Aspenal's Claim.—There being a fair supply of water this season, sluicing operations have been pretty steadily carried on, and the result has been a good yield of gold. This claim is said to yield about 2oz. of gold an hour when six sluice-heads of water is available.

SOUTHLAND DISTRICT.

Round Hill.

There is still a large area of unworked auriferous ground in this locality, but the scarcity of water, together with very little fall, limits the quantity of ground that can be worked and the number of men that can be continuously employed. In former years there were about three hundred Chinese employed on this field, but now there are only about one hundred and sixty, and about sixty Europeans. Several of the claims belonging to the Chinese are said to be paying from £6 to £10 a man per week, while other claims are not paying wages; but taking all things into consideration the ground must be tolerably rich for men to make wages with the mode of working. A sluice-head of water here is termed a Round-hill head—that is, the quantity which will pass over a notch in a board 10in. wide by 1in. deep; and about four of these heads are used to work the ground, which is in some cases from 50ft. to 60ft. in depth. This small quantity of water, together with the extremely little fall there is to carry away the tailings, can do but very little work.

Some years ago Dr. Young, of Invercargill, and some other gentlemen, took up a claim in the Ourawera Valley, and erected a steam-engine and elevators to lift the material. A shaft was sunk, into which it was intended to sluice the old tailings and sludge and to lift the whole of the sluiced material and water by elevators, but very little work was done before the scheme was abandoned. Another party erected a steam-engine higher up the valley to work the ground on a similar principle as that proposed to be adopted by Dr. Young's company, but this venture also proved a failure. It has been, however, believed that there is a large quantity of gold in the Ourawera Valley, but the depth of sludge and tailings on the surface has hitherto, until recently, prevented any one from working the ground advantageously.

Round Hill Syndicate Company.—In 1883 application was made to the Government for a subsidy to construct a sludge-channel up this valley. Plans were sent in showing that the length of the channel was 3 miles 67 chains, and that the fall in this distance was 55·7ft., or about 2·1in. to the chain. Another survey was made in 1885 by Mr. David W. Wetherly, Assistant Engineer of the Public Works Department, Invercargill, with the view of constructing a sludge-channel. The survey in this instance was carried for a distance of 2 miles 79 chains, and the terminal point was 44·5ft., about high-water mark, or close on 2¼in. to the chain; but considering there was about 15ft. tailings and sludge on the surface of the ground at the upper end of this surveyed line, there was not sufficient fall to make a sludge-channel of any great value. Again, in 1889, application for a sludge-channel was made by M. G. Evans; and Mr. L. O. Beal, Mining Engineer, Dunedin, on examing the locality, recommended a double channel with tramway on each side, so that a Priestman grab could be mounted on a trolly and made to lift the tailings and sludge into the channel. Mr. Evans went to London and floated a company to work the ground, with a capital of £50,000, of which amount £19,800 was given the promoters in paid-up shares, thus leaving a working-capital of £30,200, of which £15,000 is paid up; but shares to the value of £10,000 are held in reserve for future issue, so that there is only £20,200 actually available at the present time. This is now known by the name of the Round Hill Syndicate Company.

The Syndicate Company has purchased the most of the water-rights in the district, and had at the time of my visit about ten sluice-heads of water. They utilised from six to seven sluice-heads in working the ground, and the balance of water is sold at the rate of 15s. for a Round-hill sluice-head per week—namely, 10in. by 1in., with no pressure-board. A survey has been completed of a water-race from the Pourakino Creek which will be 34 miles in length, and it is stated that after this race is constructed there will always be a supply of at least twenty sluice-heads. The company has also commenced to construct the sludge-channel from the ocean-beach near Wakapatu. Short piles have been driven for a certain distance 13ft. apart to allow sufficient room to construct boxes for sludge-channel in between the rows of piles.

In regard to the company's present operations, they have opened out a large paddock at the edge of the valley with a hydraulic elevator; the ground is from 20ft. to 30ft. in depth, and they are elevating the material about 40ft. The water is supplied to the elevator by a line of wrought-iron pipes 13in. in diameter, having cast-iron flanges every 20ft., and the length of the line is about one mile, having a head or pressure at the elevator-jet of about 337ft. According to a pressure-gauge that was fixed on the main-supply pipe, about 40ft. above the level of the nozzle of the elevator, the gauge showed a pressure of about 128lb. to the square inch; but when the elevating and sluicing nozzle was at work the pressure stood at 100lb.; the elevating nozzle being 2½in. in diameter, and the sluicing nozzle 1¾in. in diameter, which would deliver about six and a half sluice-heads of water. Taking the pressure shown on the gauge 40ft. above the bottom of the paddock, and the pressure due to 40ft. head, which is 17·2lb. per square inch, this shows the total hydrostatic head when sluicing is carried on is only equal to 272ft. 6in., whereas the actual hydraulic head is 337ft. according to the pressure shown on the gauge when the water is shut off the nozzles, the loss in the head being in this case 64ft. 6in. which is absorbed in friction by six and a half sluice-heads of water passing through the pipe, thus proving conclusively that the main-supply pipe is too small to admit of the water being utilized to its fullest extent.

Their washing appliances consist of a short length of sluice-boxes, 3ft. 6in. in width, fitted with angle-iron ripples. At the end of the sluice-box there is a perforated iron plate, 16ft. long, having holes ⅛in. in diameter, with ½in. centres. The fine material that goes through the holes of this plate falls on to a board in the shape of a saddle-back, which leads the material into tables covered with matting on each side of the main sluice. There are five tables at each side, 3ft. wide and 12ft. long set at right angles to the sluice, and the water and the material is led from these tables into a waste-sluice to convey it away clear of the workings. This waste-sluice is constructed on a grade of 1⅛in. to 12ft., being equal to $6\frac{3}{16}$in. to the chain; but they find that this is too little fall in order to keep the sluice clear. They are constructing a second elevator, and giving the flume for carrying away the tailings and sludge, 1½in. to 12ft., or 7½in. to the chain. From the experience the

manager, Mr. Evans, has already had in working the tailings and sludge, he is satisfied that the natural fall of the valley—namely, about 2¼in. to the chain, will not be sufficient to use a flume to convey the tailings to the ocean-beach at Wakapatu; and therefore the original scheme of laying down a flume up the bed of the Ourawera Valley is not likely to be carried out.

The company commenced operations with the hydraulic elevator on the 4th November last, and up to the 16th January they got 160oz. of gold, representing a value of about £640. This must be considered very satisfactory, seeing that they have been working nothing but old ground. The number of men employed altogether by the company is twenty-six, of which number eight are employed at the elevator, and the rest constructing works for the future development of their claim.

In reference to the future prospects of this company, there is plenty of ground in this locality which will give good returns by working it on the hydraulic-elevating principle for the next fifty years with the supply of water that can be brought on to the ground, and it is in the construction of a water-supply the company should devote their attention, and not expend money in laying down a large flume to carry away the tailings, which will be found to be a failure on account of the natural fall. The construction of their water-race to the Pourakino Creek is a work that no time should be lost in putting in hand; and, instead of constructing a large flume for a sludge-channel, it would be more advantageous to construct a drainage tail-race of sufficient dimensions to carry off the water used in working the ground; by this means, as soon as one paddock was taken out, the elevated material from the next one could be deposited in the worked-out ground. The cost, however, of such a tail-race would be very considerable, and it is a question whether it would not be better and more economical, considering the interest on the first outlay, to lift the water with a jet-pump, instead of constructing a drainage tail-race. The fall allowed for such a tail-race would, in any case, have to be very little. The success of this company depends on the quantity of water they are able to bring on to the ground. If they can depend on twenty sluice-heads of water continuously the property is likely to be a very valuable one, inasmuch as the quantity of payable auriferous ground in this locality is very large. With careful management, and a systematic method of working, it should be as valuable a mining property as there is in the colony.

Since my visit to this company's claim they have the new elevator at work, which acts better than the first one erected, inasmuch as the tail-boxes have more fall. The material is lifted by one of the elevators 53ft., and by the other 44ft., the total head of water being 337ft., and the diameter of the jet or nozzle at the elevator is 2¼in. This is a greater height lifted than at any of the hydraulic elevators otherwise in use in proportion to the head of water, but it is doubtful if a large quantity of material can be lifted to the height mentioned. The company have also erected one of Crompton's dynamos for lighting purposes, so that they can work at night. They use two lamps, each arc of 3,000-candle power. The motive power for driving the dynamo is supplied by a Pelton wheel, 3ft. in diameter, and only a ¾in. nozzle is said to be used, which would be capable of discharging about 27 cubic feet of water per minute, allowing that the hydrostatic head was equal to that hydraulic one, which is not likely. The theoretical horse-power employed would be about seventeen, or, deducting an allowance for friction, about eleven horse-power may be used in generating the electricity.

Coal Island.

On Coal Island about twelve men were employed in February last, working the beds of gullies and streams wherever they can get sufficient water to sluice with. Gold has been found on the mainland close to Preservation Inlet, and some of the miners there are doing fairly well, and about fifty-four men are employed. The whole of the workings are confined to the beds of creeks and streams, where the gold has, to a certain extent, been concentrated from the light-drift material. So far, no workings have been done on terraces. In some instances the creeks are diverted for certain distances from their original beds, and wing-dams placed therein to allow their beds to be worked; but no one has as yet commenced to carry on hydraulic workings. Some men are also working in some of the creeks between this and the Waiau River, but no one seems to know much about this part of the country.

The finding of gold on the mainland, and between Preservation Inlet and Waiau, will no doubt lead to this portion of the country—which has hitherto been *terra incognita*—being well prospected. There are between sixty and seventy miles of country without a road or track, and had it not been for the portion of the track which has lately been surveyed and cleared of bush, men would not have prospected the country in this direction so much as has been done during last year. It may be said to have been the means of gold being found at Price's Inlet, Boat Harbour, and in other creeks along the coast.

DREDGING.

Dredging operations have been more successful last year; improvements are yearly being made in the washing and separating appliances, by which a larger percentage of the gold is saved. There is ample room for improvement yet in that respect; but it is only a question of time when appliances will be introduced to make this branch of the gold industry a large and remunerative one. If only ordinary care is taken to prospect the ground, by bores or small cylinders, with dredging-buckets, on the same principle as Waipori Flat was tested, before commencing to put dredges on the ground, dredging ventures could almost be certain of being brought to a successful issue. The most of the dredging companies who have failed to make the ground pay have not used sufficient precaution, and the failures are entirely due to either negligence or mismanagement. The ground was either not prospected before the dredge was put on, or those in charge of the dredging operations had not sufficient knowledge of gold-saving to

make the venture successful. In some instances men were placed in charge of these operations who had never been employed on the goldfields previously, their only recommendation being that they were either good mechanics, capable of repairing any portion of the dredging machinery, or men who had been accustomed to have charge of dredging operations in deepening harbours. The result has been that as far as the lifting capacities of these dredges were concerned it may be said they were fairly successful; but the gold-saving appliance—by men not acquainted with it—was of secondary importance, and consequently many failures have taken place; yet the time will come when many of the ocean-beaches, and other places where dredging operations have proved failures, will be again taken up and made remunerative for working.

West Coast.

Greymouth.

Taylor's Dredging Company.—This is a company that was formed about twelve months ago to purchase the claim and dredging-plant belonging to Mr. Joseph Taylor, who has been working the claim successfully for these last three years. When Mr. Taylor first commenced working the ground he lifted the material with a Priestman grab, which emptied the material into a hopper, and from there the wash-drift was partially sluiced in boxes, when the stone and coarse shingle was separated from the sand, the latter material being washed on tables. After working by this method for some time, a cataract-pump, similar to the one used on the Saltwater dredge—which was highly spoken of as being the class of dredging machinery employed in deepening New York harbour—was obtained. However, it proved an entire failure; it would not lift stones above 3in. in diameter, and had to be abandoned as a dredging-machine capable of dealing with the class of material found on the sea-beaches. However, it is now fixed as a stationary pump for draining the paddock and lifting water for washing purposes, which it is admirably adapted for. Since the formation of the present company a set of stationary elevators have been fixed, worked by a steam-engine; but the supply of water for washing purposes was not sufficient, unless in wet weather, to keep the stationary dredge at work, and consequently this appliance is now abandoned for a time, and the Priestman grab again employed, but under different conditions than formerly.

The width of the lead or run of gold that is being worked is about 25ft. The steam-engine and grab is fixed on a trolly with wheels, and placed on rails. The jib of the derrick, to which the grab is attached, has a radius of about 30ft. The upper material overlying the auriferous black-sand layer is about 23ft. deep; there may be a few colours of gold here and there in it, but nothing to justify any one washing it for the value of the gold it contains; therefore, this material is stripped off with the grab and deposited in the worked-out paddock. A large wooden box-drain is carried along from the pump-well to the face of the ground to be stripped, and as each paddock is taken out another box is added on, so that the cataract-pump always keeps the ground drained during the time it is being stripped, and wash-drift lifted entirely dry. When the stripping is completed, the wash-drift, which is about 2ft. in thickness, is then lifted with the grab and deposited on a level place made for it on the bank, and afterwards lifted and washed on tables in the ordinary manner.

With regard to the quantity of material lifted, Mr. Taylor states that a paddock 45ft. long, 25ft. wide, and 27ft. deep, is taken out every week, and that eight men are employed. This is equal to 15yd. by $9 \times 8\frac{1}{3} = 1{,}125$ cubic yards of material lifted every week. Out of this quantity there would be about 83 cubic yards of auriferous drift that is washed on the tables—that is, supposing the auriferous layer is 2ft. in thickness. The quantity of gold obtained varies considerably. Taking the total quantity of material shifted, including stripping and wash-drift, the value of the ground, Mr. Taylor states, ranges from about 1s. to 2s. per cubic yard, but there are some places where the value comes even below 1s. per cubic yard. Taking the average, one month with another, at 1s. 3d. per cubic yard, it would give an average return of £70 6s. per week; or, say the wages and other expenses are about £40 per week, it would leave about £30 per week profit on the workings. If this can be depended on, the venture ought to be a payable one, as this means a profit of £1,500 per annum, which is equal to 10 per cent. on a capital of £15,000. Taking the value of the actual wash-drift treated on the tables as £70 6s., it means that it gives an average yield of about 4dwt. $2\frac{3}{4}$gr. of gold per cubic yard. Mr. Taylor states that in some instances the actual material washed has yielded from 1oz. to 2oz. of gold per cubic yard. The nominal capital of this company is £20,000, but only £7,000 is actually paid up.

Parker's Dredge.—This dredge is constructed on a somewhat different principle from any other at work in the colony in regard to the separation of the stones and shingle from the fine sand, and although the mechanical appliances are not perfected to any great extent, the idea is one which if properly carried into effect will solve the question of separation. The hull, on which the dredging machinery is erected, is considerably larger than most of the other pontoons used for this purpose; its length is 65ft., with 30ft. of beam, and a depth of 9ft. Most of the other pontoons are only about 18ft. beam, and the result is that the slightest thing makes them oscillate, and this action is injurious to the gold-saving tables, as these should be as steady as possible.

The dredge is what is known as a centre-bucket dredge, the capacity of the buckets being $3\frac{3}{4}$ cubic feet each, but in ordinary dredging they lift on an average 2 cubic feet, and as the speed of the buckets is twelve per minute, the quantity of material lifted is therefore about 53 cubic yards, or 80 tons per hour. The difficulty in washing so large a quantity of material on the limited area of tables which can be erected on the hull of a pontoon is to a great extent minimized here by the use of a travelling-table, which is 7ft. 6in. long and 4ft. wide, having the discharging end 9in. higher than the receiving end. This table is made of bars or plates 6in. wide, which are perforated with $\frac{3}{8}$in. holes. The plates are all hinged together, so as to form a flat surface when conveying the material, and being hinged it travels round pulley-wheels at each end, and forms a complete chain-belt. This table is driven off the vertical shaft on which the pinion is placed to drive the crown

wheel on the tumbler-shaft, and the speed of the table is about equal to the speed of the vertical shaft.

The dredged material is lifted to a height of 24ft. above water-level and dumped on the hopper, which shoots all the material on to this travelling-table; a portion of the water from the centrifugal pump comes in to the hopper and then on to the travelling-table, washing the dredged material, and carrying all the fine sand through the perforations in the belt, while the coarse stuff, shingle and stones, are carried away by the belt or table, and when it passes over the end pulley the coarse material is shot into an inclined chute, into which a stream of water from the pump is brought to convey the waste material away clear of the stern of the dredge, while the fine material falls on an inverted ∧ slide placed directly under the travelling-belt, which causes about an equal quantity to fall into a longitudinal chute on each side, and thence from this chute the material and water is distributed on to the gold-saving tables. The stone and gravel chute is made in semicircular form of iron plates, and carried on light trestle-work placed on a floating platform at the stern of the dredge. This platform is supported by a number of casks and barrels, lashed together, and by this means the waste material is deposited about 120ft. beyond the stern of the dredge. With regard to this floating platform it is of a primitive construction, and does not give full satisfaction; as, for instance, when a block takes place in the stone chute, the extra weight of material at this particular place sinks the platform and consequently the chute, and therefore it becomes more difficult to clear. The effect of the chute being supported on a flimsy floating platform, is that it cannot be kept at a uniform grade, but wherever the most weight is in the chute it buckles in places, producing the same effect that a heavy load does in passing over a bridge with very light beams.

The washing-tables are similar to those constructed by Mr. S. Brown, of Wellington, on the dredge in the Saltwater Creek at Paroa. There are six tables on each side on stern end of the tumbler-shaft, each 14ft. long by 4ft. wide, and five tables on each side of the bow end of the tumbler-shaft 11ft. long. Although the latter is constructed they are not used; it is found difficult to get the firm material equally distributed so as to utilise the tables on the forward part of the hull. The area of the tables used is 672 square feet. The material is very evenly distributed, and there being nothing but fine stuff passing over them they ought to save a fair percentage of the gold.

The whole of the machinery is driven by a compound steam-engine having cylinders of 11in. and 22in. in diameter respectively, and the minimum pressure of steam entering the high-pressure cylinder has to be 68lb. to the square inch, the stroke of the engine being 22in., and the engine-shaft travelling ninety revolutions per minute. The water is supplied for washing purposes by a centrifugal pump, which was said to be discharging 2,000 gallons per minute.

With regard to this dredging-plant there is a considerable improvement in the washing appliance over any hitherto adopted in dredging; and although it is somewhat crude as regards the mechanism, Captain Parker has given the right idea to separate the material, and no doubt many of the dredges in the future will be provided with a similar system of separating the sand from the coarse shingle and stones; but Captain Parker's travelling-table is not long enough to carry away the material over the stern of the dredge unless a chute is used of a considerable length, and this seems the most objectionable part of his appliance. The travelling-belt or table should be long enough to convey the wash material over the stern of the dredge with a short chute at the end on a steep incline, which would require no water to be used to carry any coarse material away clear of the dredge. This dredge is working at the head of the Saltwater Lagoon, on the north beach, Greymouth; it had only been at work for a few days prior to my visit, and it was not then known whether the ground would prove remunerative for working or not.

Hokitika.

Kanieri Dredge.—This dredge is working in the Hokitika River, opposite the Kanieri Township. Some rich claims were worked on the bank of the river in the early days, and the gold was traced and worked as far into the river as could be done with the pumping appliances then used—namely, Californian pumps. It is thought that the same lead found behind the Kanieri Township goes across the river to Woodstock; but be that as it may, there is a rich auriferous gravel deposit in the bed of the river which is now taken up as a dredging-claim by the Kanieri Dredging Company. The wash-drift contains a large amount of boulders, and is cemented together to a great extent, so that at the time of my visit they were blasting the wash-drift in order to loosen the ground, so that the dredge could lift it. Previous to adopting this system they tried to make the buckets sink a hole in the drift, but they merely revolved, skidding off the hard cement, and coming up almost empty. In some of the wash-drift that came up in the buckets coarse specks of gold could be seen, and if the difficulty of breaking it up can be got over the company ought to have a valuable property. Instead of having all buckets, there requires a certain number of skeleton-buckets with hooked steel prongs placed on the ladder to loosen the material; but it then becomes a question whether the engine is of sufficient power and the other portions of the machinery strong enough to admit of this being done. Latterly the dredge has been getting fair returns.

The dredge is what is known as a centre-bucket dredge, the hull being 90ft. long, and 18ft. of beam, having a depth of 4ft. The tumbler-shaft is 19ft. above water-level, and the bucket-ladder can dredge to a depth of 25ft. below the water. The buckets are placed 3ft. apart, and have each a capacity of 3 cubic feet, and travel at the rate of from ten to twelve buckets a minute. The water is supplied for washing purposes by a centrifugal pump of 3ft. 9in. in diameter, having a discharge-pipe of 15in. in diameter, which is driven at a speed of 200 revolutions per minute. There are two compound steam-engines used for driving the machinery, both of which have cylinders of 7in. and 14in. in diameter respectively, the engine working the dredging appliance having a 14in. stroke, making 120 revolutions per minute, which is equal to a piston speed of 280ft. per minute; while the engine for driving the pump has a 12in. stroke, making 200 revolutions per minute, being a piston speed of 400ft. per minute. The minimum pressure of steam in both instances entering the

high-pressure cylinders to keep the dredging and pumps at their proper speed must not be less than 80lbs. to the square inch, the steam being in both engines cut off at half-stroke. Having this data, it enabled me to calculate the actual theoretical horse-power employed in this dredge, taking the low-pressure engines to develop the same power as the high-pressure ones, but in reality they would give a higher result. The terminal pressure of steam in the high-pressure cylinders being 40lbs. per square inch, the mean pressure would be 67·7lbs per square inch, which would make the high-pressure cylinder of the dredging-engine develop 22·2-horse power theoretically, and the one for working the centrifugal pump 31·5-horse power theoretically. This means that it requires 44 theoretical horse-power to work the dredge, and 63 theoretical horse-power to drive the centrifugal pump.

The washing appliances consist of one longitudinal sluice-box, 2ft. wide, fitted with Jones's patent cast-iron riffles. Near the end of the sluice there is a grizzly 5ft. long placed in the box, and all the coarse material passing over the grizzly falls over the stern of the dredge, and the firm material and water going through the grizzly passes on to return-tables, which are covered with cocoanut-matting. The whole of the machinery and appliances on the dredge are of good workmanship and substantially constructed. The only question appeared to me to be whether the engine and gearing for working the dredge was powerful enough to be able to break up the cemented wash-drift, and there will also be soon very large boulders amongst the auriferous drift, which will be a great obstacle in the way of carrying on dredging operations.

The whole of the machinery was completed and dredging operations commenced in November last, and from this up to the middle of April last about 282oz. of gold, representing a value of £1,106, was obtained. They have had many difficulties to contend with in dealing with large boulders in the river-wash, and also in the cemented character of the wash-drift, but the ground proves to have sufficient gold to pay for working.

Otago District.

Waipori.

Waipori Dredging Company.—This company have two dredges working the Waipori Flat, and their operations have been attended with success. Last year 358,000 tons of material were treated, which yielded 965oz. of gold, representing a value of about £3,860. This shows the value of the material was about 2s. 6d. per ton.

Jutland Company.—This company are also carrying on dredging operations at Waipori. Last year they treated 170,000 tons of material for 503oz. of gold, valued at about £2,012, which gives the average value of the wash-drift operated on at about 2s. 8d. per ton. This shows that very poor ground can be made to pay for working by dredging.

Clutha Valley.

There are a number of dredges of various kinds employed in lifting and washing the auriferous ground from the bed of the Clutha River, and most of them have been successful in their operations last year. The old current-wheel dredges are all getting altered to be worked by steam, as these dredges can only be worked in a place where there is a rapid flow of water; they cannot be used in any place where there is still water, or in eddies. The Golden Rim Company have now erected a new steam dredge to work a claim in the Clutha River, at the upper end of the Island Block, where there is every prospect of their getting payable results. The Miller's Flat Company have just about managed to pay expenses last year; the great depth of tailings in the river for some time past has retarded them getting down on the good wash-drift. The Ettrick Company have been at work in the Clutha River, opposite Ettrick, since September last, but owing to the machinery not being suitable for the work, they have not been so far as successful as they might have been, their returns averaging about 12oz. of gold, or £48 per week.

Dunedin Company.—This has been one of the most successful dredging companies on the Clutha River last year. It is said that between the 1st August and 5th October last year, in fifty-three days the yield of gold was 1,035oz., representing a value of £4,140, out of which £3,600 was paid in dividends, being equal to 8s. per share. This company have recently purchased a small dredge, which had been working on some of the beaches on the river unsuccessfully, and have removed it opposite to Coal Creek, where it will be employed in prospecting the river-bed. During a portion of last year this company suspended operations for the purpose of having alterations made in their dredge, so that they could work the river-bed to a greater depth. These alterations have been made, and dredging operations resumed. The hull and pontoons have been altered, and the ladder lengthened, so that dredging can be carried down to a depth, it is said, of 39ft. under water-level.

A dredge has been working on Upper Clutha River, above the Lowburn Punt, for a considerable time, and giving fair returns to the shareholders. At the Cardrona a number of claims were also taken up to work with dredges; but no steps being taken to place machinery on the ground, all the claims have been cancelled.

Wakatipu.

Dredging-machines, applied to gold-working in this district as well as in other places, have not been so successful in their operations as many people anticipated; but at the same time it has been demonstrated by their use that large quantities of material can be lifted from below water-level at a small expenditure, if it can be afterwards treated successfully, so that a large percentage of the gold contained in the material is recovered. The latter has been the chief cause of failures in dredging ventures. The principle hitherto acted on has been, "Rush the material through, even if gold is lost; the quantity operated on will make up any differences of such loss." This might hold good if the character of the gold was coarse and heavy; but generally in rivers most of the particles of gold being ground up into fine dust and minute scales it requires a very careful system to be adopted to save a fair percentage of it. If the wash-drift is rushed through in large quantities,

without a corresponding washing-table surface, it means that it is lifted in the dredging-buckets, rushed through the sluice-box, and deposited again in the bed of the river, ready to be operated on a second time. This is really what has taken place in regard to some of the dredging operations in the Shotover River. One of the dredges belonging to the Sue Hoy Company have dredged the same ground twice over, and the returns from the second operation were as good as from the first. This in itself is perfectly convincing that the failure attributed to these dredges is due to the loss of gold-saving appliances, and not to the actual dredging operations.

In introducing any new system of working, or adopting any entirely new process at first, although it is seen that the general principle involved is correct, yet in very few instances are all the details fully worked out. It is only after considerable experiments have been made on a large scale that the defects can be seen; and the principal defects in dredging-machines at the present day is their gold-saving appliances. In connection with this is a suitable and economical appliance to separate the fine sand from the coarse shingle and stones, for unless this is done it is impossible to save a fair percentage of the fine gold in either the sluice-boxes or tables; and this applies wherever the gold is in fine dust or in thin minute scaly particles. The film of material operated on ought to be so thin that every grain of sand or gold should roll on the matting or blankets, and not be carried forward with a large body of water; for, although gold has a high specefic gravity, it does not follow that it will sink and remain at the bottom of other materials having a less density. On many occasions gold has been seen actually floating on the surface of the water. The quantity of water required to do the work depends on the pitch or gradient on which the tables are set, and has to be sufficient to keep the surface of the matting or blankets clear of sand. If sand accumulates on the surface of the matting the tables are no longer of any use for gold-saving. In the ordinary dredging-machines it is a difficult matter to so arrange a constant discharge from the buckets. Sometimes they come up full and at other times not so; therefore the discharge is somewhat irregular. This affects the quantity of water required for washing purposes. There may be quite sufficient at times, while at other times there will not be enough to carry the sand away so as to leave the surface of the riffles or matting clear; but it is always better to err on the side of having plenty of water than not to have sufficient, as in the one case sand will accumulate on the bottom of the box or table and insure a loss of gold, but in the other case if once the gold got down on the matting the water will seldom lift it again.

Although dredging has now been carried on for the last ten years, those interested in it are only beginning to see that something else than lifting a large quantity of material is required to make the dredges deal with the auriferous drifts successfully. Their present defects will, no doubt, in course of time be remedied, and they will eventually be the machines in the future for working the beds of streams and ground of a shallow depth, containing a large quantity of water that cannot be overcome, unless with very heavy and costly pumping machinery. Dredges for working auriferous ground of this description are by far the best machines that have yet been introduced; and, strange although it may appear, it was only when their use was strongly advocated and brought prominently before the public by men who had no experience of gold-working, namely, by Mr. Brooke Smith and Mr. Gibson—the former advocating the Ball dredge and the latter the Welman dredge—that they began to come into general use. Both the dredges that were first constructed on the principles advocated were failures, but since then the improvements made in the Welman dredge have made it a useful machine for certain descriptions of ground; still the bucket-dredge for working the beds of rivers, where there are many stones amongst the wash-drift, is still considered the most suitable. This description of dredge was in work for years before either Mr. Brooke Smith or Mr. Gibson thought of introducing theirs into the colony; the only difference now being that, instead of the bucket-ladder being on each side of the dredge, as is the case of the one constructed by Kincaid and McQueen and now being used by the Dunedin Company on the Clutha River, the recent dredges are constructed with the bucket-ladder in the centre; still, the centre-bucket dredge, although being superior to the side-bucket dredges, and better for lifting stony wash-drift, is not so suitable as the Welman dredge for lifting the gold from a rocky bottom. A combination-dredge, embracing both principles, would answer better than either of those dredges now in use. The most of the gold will be found lying on the bed-rock and in the crevices where neither of the dredges would ever get; still the Welman dredge will always take more gold off the bottom where the rock is hard than ever can be done by the bucket-dredge.

Sue Hoy Company.—This company has four centre-bucket dredges, three of which are on the Big Beach on the Shotover River, and one is at work at Arthur's Point. Only two of the dredges on the Big Beach are being worked; the first one constructed was found to be too small to dredge deep enough. Several experiments have been made by this company with appliances to separate the coarse gravel, shingle, and stones from the sand. At the time of my visit to the district Mr. Gore, of Dunedin, was constructing a shaking-table on one of the dredges to effect this object. The revolving-screens that they were fitted with at first were not found to work satisfactorily—the revolving motion always caused more sand to be deposited on one side than on the other, consequently on one side the tables worked clear, while on the other the tables were generally filled up with sand, and their use for gold-saving destroyed. However, the returns of gold from these dredges during the last year have been regular, and satisfactory results obtained.

Enterprise Company.—This company was formed during the last year, and took over the plant and property of the Horse-shoe Bend Company, who were unsuccessful in carrying on dredging operations, and was wound up. The present company are working the same ground, and although the returns of gold are not large, they are managing to clear expenses.

Kawarau Company.—This company have entered into an arrangement with the proprietors of the Golden Link Claim to work their ground, the latter getting the use of the dredge belonging to the Kawarau Company on condition that they receive, or be allowed to retain, 15oz. of gold per week to pay all working expenses and wear and tear, and whatever gold is obtained over and above 15oz. per week is to be equally divided between the two companies. They had just commenced

dredging operations at the time of my visit, but no returns at that time had been got. The Golden Link Claim is situated at the junction of the Shotover and Kawarau Rivers.

Frankton Beach Company.—This company have not been successful in carrying on dredging operations. They have recently purchased the claim belonging to the Golden Bar Company, and removed their dredge to it, but their capital being exhausted they had not, at the time of my visit, commenced active operations.

Sand-hills Company.—This company have been successful in their dredging operations last year, notwithstanding the difficulties they had to contend with in time of floods and stranding of their dredge. This is the only dredge in the colony which is worked by electricity, which is generated about one and a-half miles from the place where dredging operations are carried on. These returns show that they are working payable ground, being from 12oz. to 30oz. of gold per week.

SOUTHLAND DISTRICT.

Waipapa Company.—This company suspended operations for a considerable time pending the arrival of a large Welman pump from England, similar to that used on the Six-mile and Lake Brunton Companies' dredges. It is stated that when this company first commenced dredging operations in February, 1889, they only got about 60oz. of gold for six months' work, but for the year ending September, 1890, they got about 1,000oz. of gold. This pump has now arrived, and dredging operations have been resumed.

Lake Brunton Company.—This company is dredging near the ocean-beach, south of the Waipapa Company, and opposite Lake Brunton; the depth of the ground where the auriferous wash is deposited is only about 8ft. Underlying this wash is a layer of peat. The best portion of drifts lies close to the bottom, and in some places it is very stony. It is said that stones 60lb. in weight are thrown on the washing-tables. One would hardly credit, with the experience that has been gained in working dredges for lifting auriferous drifts, that such a thing should take place as heavy stones and material passing over gold-saving tables. Wherever this takes place there is a large portion of the gold lost. It is also said that this company are getting fair returns from the ground.

Other two dredges have been erected during last year—one by the Otara Company and one by the Bushy Point Company. These dredges have Gwynne's centrifugal pumps instead of Welman's. The runner is 3ft. in diameter and only about 2in. wide, which will cause these dredges to be a failure, inasmuch as they are not capable of lifting large stones.

Six-mile Dredging Company.—This company has been carrying on dredging operations very successfully last year. A description of their dredge, which is one of the Welman pattern, fitted with a pump-runner 3ft. 6in. in diameter, with a 13in. delivery, was given in my last report. This company was formed in October, 1889, with a capital of £12,000, of which £2,250 was given in scrip to the promoters, and £7,421 has been paid in calls. The ground that this company are working is about five miles further north on the ocean beach from Waipapa Point, and from the returns they have been getting last year it should be a valuable mining property.

LOCKS AT THE OUTLETS OF THE OTAGO LAKES.

A good deal of correspondence has taken place with reference to the construction of locks near the outlets from Lakes Hawea, Wanaka, and Wakatipu, for the purpose of damming up the water in these lakes for certain periods during the winter months, so as to allow the miners to work the beds of the Clutha and Kawarau Rivers for gold. In regard to the construction of the locks referred to it was first necessary to ascertain whether it was practicable to dam up the water in these lakes without damaging property along their shores, and also to see whether good foundations and abutments could be got for the construction of works of this character.

On my visit to the district in January last I examined the outlets from each of these lakes, and measured the width and depth of the rivers, and ascertained the velocity of the water in each. The depths of water in many instances were difficult to get accurately, on account of the high velocity of the stream; but measurements were taken at different places in the river so as to check the others; at the same time they cannot be taken as being thoroughly accurate, but merely a close approximation in ascertaining the volume of discharge; it has, however, to be borne in mind that the quantity of water coming out of each of these lakes was considerably greater at the time of my visit than during the winter months. Possibly the volume of water in the rivers would not be more during the months of June, July, and August than one-half of the quantity flowing at the season of the year when it was measured. There are sometimes floods in the winter as well as during the summer months; but in general they are not so high, as the flooded state of the rivers during the spring and summer months is due to the melting of the snow on the mountains.

In considering the question of constructing locks near the outlets to any of these lakes, the widths of the openings into each of the rivers would have to be considerably increased in order to provide for the outlet of the flood-water. Not only will the area of the present water-way have to be increased, but a certain width of the locks will be taken up in divisions and piers. To take a case for example: say a river is 300ft. in width, having an average depth of 5ft., and a velocity of 7ft. per second, the volume of discharge would in this case be 10,500 cubic feet per second. If each of the gates are taken as 5ft. wide, this would require sixty gates to have an equal area of water-way; but the friction of the water in passing through these small openings would be increased by about 25 per cent. There would have to be seventy-five gates of 5ft. wide to have an equal carrying capacity to the original outlet; therefore it may be said that locks, including piers and divisions between the gates, would have to be about twice the width of the present outlets, irrespective of the distance that they would have to be carried into the banks on each side to get sufficient abutments. The gates in the locks would have to be of such a description as to be easily worked, either

by manual labour or by hydraulic appliances. The latter would be preferable, as the force required to lift ordinary draw-gates would be considerable. Assuming the gates to be 5ft. wide, and depth of water 18ft., the pressure on the face of each gate would be 22·6 tons; however, centre vertical-hinged balance-gates would be much more easily worked than draw-gates, and equally as cheaply constructed; but this is a question that need only be taken into consideration when the construction of the locks are determined on. The present question at issue is, "Is the scheme practicable?"

Several moveable weirs have been constructed in rivers in different parts of the world on designs somewhat similar to that required for the locks in question—as, for instance, the draw-door weir on the Thames River at Teddington, in the rivers in Northern India, on the Seine below Paris, and elsewhere; the question, therefore, of the feasibility of constructing locks at the outlets of the lakes is one that can be answered in the affirmative. The work can be done, and the lakes are of sufficient area to admit of their outlets being closed up for short periods without doing any damage to property alongside their shores; but such works would entail the expenditure of a very large sum of money.

Hawea Lake.

The Hawea Lake comprises an area of forty-eight square miles. At the outlet there is a good site, with rock-foundations and abutments at each side, for the construction of a lock. The water could be raised 10ft. above the level at the time of my visit. At the place where a lock could be constructed the width of the river is 100ft., having an average depth of 5ft., and a velocity of 6·4ft. per second, which gives a discharge of 3,200 cubic feet of water per second. In checking this discharge measurements and soundings were taken at the bridge, about 20 chains below the outlet of the lake, the width of the water in the river at this point being 84ft., having varying depths, which were taken at certain distances along the bridge. The volume of water by measurement at this point was 3,216 cubic feet per second; therefore 3,200 sluice-heads may be taken as a close approximation of the quantity discharged at the time of my visit. This discharge would, if dammed up, raise the surface of the Hawea Lake 2·6in. in the twenty-four hours, and it would take about forty-six days to raise the surface of the water 10ft.

The width of the lock from abutment to abutment would be about 300ft., and the width in water-way in the gates would require to be about 125ft. Assuming each gate to be 5ft. wide, there would be twenty-five gates, each 5ft. by 15ft., which have a pressure against them when the water was up to the full height equal to about 18·8 tons. Taking the whole width of the structure between the outside piers as 200ft., it would have to be capable of resisting a pressure of about 728 tons.

Wanaka Lake.

The Wanaka Lake comprises an area of seventy-five square miles. There is no natural site with rock-foundations and abutments for the construction of a lock at the outlet of this lake. The banks on each side are apparently comprised of shingle, but it is possible that rock might be found on each side on excavation. The bed of the outlet is sand and shingle, having a great depth of water, especially on the Pembroke side of the Clutha River. The width of the outlet near the head of the river is 330ft., but possibly the best site for the construction of a lock would be about a mile down the river, towards Albert Town, where it is said that there is a rock bar across the bed of the river; however, in either case a considerable excavation would have to be made in order to provide for sufficient width of water-way, which would have to be, inclusive of piers and divisions, about 660ft. Until a site was selected, and tests made as to the nature of the ground, it would be difficult to tell what the total width of the structure would be in order to get good abutments. If it had to be constructed at the outlet it would require piling and concrete foundations across the bed of the river. It was difficult to measure the volume of water at the outlet with any degree of accuracy with the time at my disposal; but I measured the width and depth of the river at Albert Town punt, where it has a regular depth all the way across, and ascertained the velocity of the current by a float. The width of the river at this point was 265ft. 6in., having an average depth of 8ft. 6in., and flowing at a velocity of 200ft. in thirty-three seconds, which is equal to 6·06ft. per second. This gives the volume of discharge as about 13,676 sluice-heads; deducting from this the discharge from the Hawea Lake—namely, 3,200, it leaves the discharge from the Wanaka Lake as 10,476 sluice-heads, or the same number of cubic feet per second. The surface of the water in this lake could be raised 6ft. above the level at the time of my visit without doing any damage to property. Taking the volume of discharge as 10,476 sluice-heads, if this was dammed up it would raise the surface of the water in the lake 5·15in. in every twenty-four hours; it would therefore take nearly fourteen days to raise the surface of the lake 6ft.

There are other elements to be taken into consideration in connection with both this lake and Lake Wakatipu, and that is the force of the wind, which has a great deal to do with raising the surface of the water in the lake; and from information received from Mr. R. McDougall, a very old resident at Pembroke, the surface of the water in the lake was on one occasion fully 10ft. above its level at the time of my visit, and if such were to occur, and locks placed at the outlets, no doubt the parties having houses and property on the flat would attempt to lay claims for compensation; at all events, it proves that in the event of locks being constructed a larger water-way would have to be provided for than the natural opening. The whole structure would have to be substantially constructed so as to insure its durability. The pressure which it would be subjected to, supposing the lake stood at 6ft. higher level, would be about 2,282 tons.

Wakatipu Lake.

The Wakatipu Lake comprises an area of 114 square miles. There is a good site for the construction of a lock at the outlet of this lake into the Kawarau River, having rock-foundations across the bed of the river, also rock-abutments at each side. The width of the outlet at the

Kawarau Falls, at the time of my visit, was 385ft., but in this width there is a small island in the centre. If a lock were constructed at this point the falls could be lowered. The difference of level of the water in the river and the lake at the time of my visit was about 4ft. Mr. Robertson, at the flour-mills, stated that when the river is low there is a difference in level of about 7ft. 6in. In measuring the discharge of water at the Kawarau Falls, the whole of the measurements were only taken as approximate; they gave the discharge as 13,475 cubic feet per second. In the same afternoon I measured the width, depth, and velocity of the water at the Victoria Bridge. The width of the river at this point was 143ft., having an average mean depth of 12ft. 6in., and the velocity of the water was 8ft. per second, which is equal to 14,300 sluice heads or cubic feet per second. The difference in these two measurements—namely, 825 cubic feet per second, is partly accounted for by the inflow of the Shotover and Arrow Rivers between the outlet of Lake Wakatipu and the Victoria Bridge. The discharge out of Lake Wakatipu may be set down as 14,000 sluice-heads. It would raise the surface of water in the lake at the rate of 4·57in. in twenty-four hours. The level of the surface of the water in the lake at the time of my visit could not be raised more than 3ft. 6in. without damaging property in Queenstown, especially if a high wind was blowing down the lake. The falls at the outlet into the Kawarau River could, however, be easily lowered 2ft. in the event of locks being constructed, which would provide for the surface of the water in the lake being raised 5ft. 6in. above the level it was at the time of my visit, and this would be equal to a storage of the discharge for a period of about fourteen days.

If a lock was constructed at the Kawarau Falls the present outlet would have to be considerably widened to allow for passage being blocked up by the divisions between the different gates in the lock, and also for an additional water-way in the gates to provide for the extra friction of the water flowing through small openings. The water in this lake rises very rapidly during the melting of the snow on the mountains. During my stay in Queenstown, about Christmas, 1866, the water covered the low streets, and was about 1ft. deep in Eichardt's Hotel, and the flood in 1878 is said to have been higher than any previous one; in constructing a lock, therefore, ample provision will have to be made to carry off the flood-water. It has been suggested by some that the proper place for a lock is in a narrow gorge below the junction of the Arrow River. The great objection to this is that there is a considerable fall between the surface of the water in the lake and the surface of the river at this point, and if a lock were constructed at this place it would flood a considerable portion of low land before raising the surface of the water in the lake; and in order to provide for sufficient water-way in time of flood, the gorge would require to be considerably widened at the place where the lock was constructed, and there would be more difficulty in constructing foundations in a narrow gorge than there would be at the Kawarau Falls; also the increased pressure of water on the gates would be a consideration, as extra power would be required to work them.

The discharges from the three lakes were as follows:—

Hawea	... 3,200 sluice-heads, or	3,200	cubic feet per second.
Wanaka... ...	... 10,476 "	10,476	"
Wakatipu ...	... 14,000 "	14,000	"
Total ...	... 27,676	27,676	

Although these measurements were made hurriedly, they may be taken as a near approximation of the mean annual discharge, and coincide very closely with the measurements taken by Mr. Balfour, as mentioned in his report to the Provincial Council on the discharge of the Clutha River in 1864, wherein he states that his measurements where taken when the water in the river was low, and even then he makes the discharge 1,690,400 cubic feet per minute, or 28,173 sluice heads. Taking my measurements of 27,676 sluice-heads as the discharge from the lakes, say that other tributaries, such as the Shotover, Arrow, Nevis, Lindis, Manuherikia, Teviot, Pomahaka, Tuapeka, and Waitahuna Rivers contributed 2,224 sluice-heads, it would make the discharge at the season of the year my measurements were made at about 30,000 cubic feet per second, or 1,800,000 cubic feet per minute. To compare these measurements with the rainfall over the area of the catchment-water basin, it will be found that the river, at the time my measurements were taken, was a little higher than its ordinary mean water-level.

It is difficult to ascertain the exact rainfall on the mountains forming the watershed of the lakes which empty into the Clutha River; it is well known that it is far greater than in Central Otago. The rainfall on the West Coast, on the opposite side of the watersheds of these lakes, is about 120in. per annum. The annual rainfall about Queenstown varies from 33in. to 45in., making a mean average of 37·5in. If this rainfall be taken over one-half of the drainage area, and the average of 82·5in. be taken for the annual rainfall on the mountains over the other half, it will give a mean rainfall over the whole area of 60in. per annum. The whole of the watersheds of the lakes and tributaries of the Clutha River comprise an area of 8,406 square miles, and allowing that 25 per cent. of the rainfall is lost in evaporation and absorption, it would leave 75 per cent. of the water to be discharged into the ocean by the Clutha River. On this basis, therefore, the total rainfall per annum would amount to 1,171,729,152,000 cubic feet, of which 292,932,288 cubic feet is lost in evaporation and absorption, and 878,796,864,000 cubic feet is discharged annually by the river, which is equal to a mean discharge of 1,671,987 cubic feet per minute of 27,866 sluice-heads. The maximum discharge is always during the melting of the snow on the mountains, and in heavy rains during the summer months, and the minimum discharge during frosty weather in the winter months; therefore, at the season of the year when the discharge is about at its minimum, the water could be dammed up for a longer period than is calculated for.

It has been inferred by a good many that the volume of discharge of water by the Clutha is about the seventh of any river in the world. The statement cannot be borne out, and it may be

interesting to give a comparison of the length and drainage areas of the principal rivers in the world, with their approximate mean discharge.

River.	Drainage-basin in Square Miles.	Length in Miles.	Mean Discharge in Cubic Feet per Second.	River.	Drainage-basin in Square Miles.	Length in Miles.	Mean Discharge in Cubic Feet per Second.
Europe—				*Asia (continued)*—			
Volga ...	527,000	2,400	384,000	Amu-Daria ...	193,000	900	423,000
Danube ...	306,000	1,795	207,000	Irawady	220,000	1,800	350,000
Don	176,000	995	125,000	*Africa*—			
Petchora ...	114,400	900	72,000	Congo	1,300,000	2,883	432,700
Dneiper ...	195,000	750	136,000	Nile	1,085,000	4,020	118,900
Rhone ...	37,000	645	25,000	Niger	900,000	2,300	107,010
Rhine ...	75,000	600	51,750	Zambezi	500,000	1,400	59,450
Elbe	55,000	550	37,000	Orange	418,000	1,000	57,000
Tagus ...	33,000	540	20,000	Limpopi	216,000	990	34,500
Loire... ...	44,500	530	25,000	Cubango	300,000	950	35,670
Dneister ...	27,300	500	19,500	Senegal	170,000	900	26,000
Po	34,600	450	20,000	Shari	300,000	810	35,000
Oder... ...	45,200	445	26,000	Gambia	30,000	650	3,750
Guadiana ...	25,000	400	17,500	*America*—			
Asia—				Mississippi-Missouri	1,250,000	4,194	675,000
Yenisei ...	1,180,000	2,950	416,000	Amazon	2,275,000	3,545	1,300,000
Obi-Irtish ...	1,400,000	2,800	590,000	La Plata	1,242,000	3,063	830,000
Lena... ...	1,000,000	2,600	379,000	Mackenzie ...	590,000	2,868	...
Amur ...	807,000	2,920	372,000	Tocantus	285,000	1,500	195,000
Yang-tze-Kiang	722,000	3,158	349,600	Rio Grande del Norte	245,000	1,400	...
Hoang-Ho ...	387,000	2,600	242,300	San Francisco ...	187,000	1,300	...
Brahmaputra ...	370,000	2,000	350,000	St. Lawrence ...	410,000	2,000	203,000
Indus ...	370,000	1,980	312,000	Orinoco	400,000	1,200	172,000
Ganges ...	432,500	1,600	203,485	Columbia	298,000	1,020	...
Tigris-Euphrates	259,000	1,496	76,000	Colorado	257,000	1,000	...
Mehong ...	216,000	1,250	138,000	*New Zealand*—			
Sir-Daria ...	237,920	1,000	151,000	Clutha-Kawarau ...	8,406	210	27,866

It will be seen from the above table that the Clutha may only be rated amongst the lesser rivers; still, for the area of its drainage-basin, it discharges as much, if not more, than any river in the world. It discharges over 3 cubic feet per second for every square mile of its drainage-basin.

In reference to the benefits to be derived by the construction of the locks, they no doubt would enable a large number of miners to get a little gold during the time the locks were shut down, and possibly in a very dry winter these locks might be closed for twenty-four days; but then it would take a considerable time to draw off the water to its original level before the gates could be again closed. The quantity of tailings and gravel now in the bed of the river would prevent much gold being obtained by manual labour, as every time the gates were opened the bed of the river would be all levelled, so that no trace of a paddock formerly taken out would be left. The only portion of the river that could be worked to advantage would be on the sides and in the crevices of the rock. The scheme is purely one of policy, and becomes a question of pounds, shillings, and pence, as to whether the benefits to be derived would justify the expenditure. If the Government undertook works of this character the only direct benefit would go to the counties for additional goldfields revenue, and whatever collateral advantages might be derived would be in the shape of indirect revenue through the Customs.

Before an estimate could be given of the cost of constructing locks, surveys would have to be made, and plans prepared; but one thing is certain—that no works of a temporary character could possibly be constructed at either of the outlets from these lakes. The difficulty in getting down proper foundations, so as to insure the stability of the works, would in itself be a great item in the cost of construction, especially in the Clutha and Kawarau Rivers, where a very large allowance would have to be made for unforeseen contingencies. The volume of water is large; but the greatest trouble to contend with is the very high velocity of the current, with the possibility of floods during the time the works were in construction. Any estimate now given has to be taken as purely an approximate one, which may be set down as follows:—

Lock at Hawea Lake	£12,000
Lock at Wanaka Lake	70,000
Lock at Wakatipu Lake	45,000
Total	£127,000

The construction of these locks would also necessitate men being steadily employed at each, so as to lift and regulate the gates, and to attend to everything connected with them; and this expense

would have to be met during the spring and summer months when the lakes could not be closed up. Taking all the bearings of the scheme into consideration, the collateral advantages likely to be derived do not justify so large an expenditure.

SCHEELITE.

Recently there have been several inquiries from gentlemen in London and Liverpool as to the supply of scheelite. In a letter sent me by Mr. George G. Blackwell, 27, Irwell Chambers, West Liverpool, of the 1st of April last, he stated that a parcel of scheelite had been turned over by him, testing 40 per cent., at £13 per ton; and he says that probably £14 could be got. This mineral is found in several districts in Otago—namely, Wakatipu, Cromwell, Waipori, Waitahuna, and Macrae's; also in Marlborough, at Wakamarina; but owing to the uncertainty of finding a market for scheelite it has not received a great deal of attention. A company was formed a number of years ago, termed the Wakatipu Scheelite Company, which carried on operations at the Buckleburn head of Lake Wakatipu for a considerable time. In reference to this company Professor Ulrich, of the University, Dunedin, in reply to a letter from the Hon. the Minister of Mines as to the supply of this mineral, gives particulars, of which the following is an extract:—

"Bitter experience, however, has taught the Wakatipu Scheelite Company of this"—referring to the fluctuations in market price—"as I shall presently explain, after having made a few observations about the mode of occurrence and dressing of the scheelite. From all I have heard and seen the ore is tolerably abundant in the gold-mining districts of Otago . . . but only sporadical, so that it cannot be depended upon for making contracts for supplying definite quantities at certain dates. At one time it may occur in a pretty large pocket, traversed by thin quartz veins, but many feet may have to be driven or sunk before finding another pocket of the kind. Then, again, and this is the most common mode, it may appear in thin, broken veins, or in larger and smaller particles impregnated in the quartz throughout limited irregular areas of the reefs. Whilst the first occurrence can by spalling and simple hand-dressing be brought to a marketable percentage, which is limited to not less than from 50 to 55 per cent. of tungstic acid—that is, from about 62 to 69 per cent. of pure scheelite—this is not the case with the second one, which requires crushing and proper ore-dressing machinery. . . .

"The Wakatipu Scheelite Company, after working several large pockets of scheelite by hand-dressing, found the mineral lower down in the reef too finely impregnated to be saved by this method, and, as inquiry for it at good prices continued, the shareholders decided to erect proper ore-dressing machinery . . . which consisted of two stone-breakers, four double-acting jigging-machines, a series of classifiers, and a 25-horse-power turbine for motive power. Besides this, a water-race was purchased, and about three miles and a half of a dray-road constructed to get the ore sent to Glenochy for shipment. An expert ore-dresser, trained at the Mount Bischoff Tin-mine, Tasmania, was engaged, but up to the time of the commencement of machine-dressing the mine had produced about 18 tons of good ore, which was sold at prices ranging from £29 to £23 per ton; but as the expense for mining, dressing, carting, shipping to Kingston, railway freight to Port Chalmers, shipping to Hamburg, railway to Hanover, and agencies came to over £12 per ton, the profit was not so large as was expected. . . .

"When machine ore-dressing commenced there was still inquiry for the ore, and about 9 tons were sold at from £22 to £20 per ton; but then, all of a sudden, the Hanover firms did not require any more, and at that time there were no other purchasers. The company did not at first consider this in a serious light, trusting to an early revival of the market, and work was carried on for some time. . . . Two years passed by before there was any inquiry for scheelite again. Nearly ten tons of the ore, mostly produced since the collapse of the market, and which had been stored partly at Port Chalmers and partly in Hamburg, was sold at about £17 per ton. . . . This company spent close on £3,000 capital, besides all the money from sales of scheelite, and it would require now about from £500 to £600, if not more, to put the mine and machinery in working order again."

Professor Ulrich, being interested in the company he refers to, is in possession of all the facts of the case in reference to the demand for scheelite; and, no doubt, although there are several inquiries about this mineral at the present time, and a good price offered, the occurrence of scheelite deposits in New Zealand would not warrant any one entering into contracts to supply certain quantities within stated periods. As Professor Ulrich puts it, any company commencing to mine for this mineral would have first to go to a considerable expense in opening out a mine and erecting machines to crush and dress the ore, and after a short time would probably find that the use of this mineral is too limited to insure always a market for it at a fair price. If a market could be relied on there is no doubt but that a considerable quantity of ore could be sent from this colony.

MANGANESE.

There are large deposits of manganese in different portions of the colony. Rich samples have been got near the mouth of the Taieri River, in Otago, and there are large deposits inland in Canterbury; but the cost of transit to a port of shipment, together with the low value of manganese ores, which varies from £2 to £3 per ton, according to the percentage of manganese they contain, precludes any deposit being worked unless in close proximity to deep water where vessels can be loaded. During last year the Colonial Manganese Company, of Auckland, got 600 tons from Waiheke; Mr. Phillips, from Helena Bay, about 50 tons; Messrs. Cook and Harrison about 150 tons from Parua Bay; Mr. Smith shipped 100 tons from Mangapai, and Mr. Thompson got some 45 tons from the Island of Waiheke; making a total of 945 tons.

There is a good show of this ore at Hikurangi, but the expense of carting it prohibits the deposit being worked. It is stated that mining will be again resumed for this mineral in Kawau, from which 320 tons were shipped in 1890. The Helena Bay deposit is said to be very poor, but the deposits at Mangapai are large and payable for working.

DISCOVERY OF GRANITE ROCKS IN THE KING-COUNTRY.

An important discovery has recently been made by Mr. James Park, F.G.S., Director and Instructor of the Thames School of Mines, who visited the King-country for the purpose of examining a locality where granite rocks were thought to exist. Rumours have at various times reached the department that tin was found in this part of the North Island, and on several occasions Captain Jackson Barry stated to me that he had found it; but as there was no record of granite rocks being found in the North Island, the statement as to tin-ore being discovered seemed rather improbable. However, it is but fair to state that Mr. Park found granite rock *in situ* on the left bank of the Mangaone Stream, about twenty chains above its junction with the Turetea River, which is a tributary of the Waipa River, and junctions with it about four miles south of Alexandra. This was near the locality where Captain Jackson Barry stated he had found tin-ore. The discovery is therefore the more important, as it shows the probability of tin being found. Further explorations may show that granite and granitoid rocks extend over a large area in this portion of the country, which has hitherto been but little explored. The following is Mr. Park's report on the discovery:—

"Thames, 25th April, 1892.

"I have the honour to report that, in accordance with your instructions of the 15th March, I left the Thames on the 17th instant, and proceeded by steamer to Auckland. On the 18th I reached Otorohanga, and next day, accompanied by Mr. George King, of Otorohanga, and Mr. George Ormsby, of Alexandra, I visited and examined the locality where the granite rocks occur. On the 21st I returned to the Thames.

"The circumstances which led to the discovery of granite and granitoid rocks in this Island are briefly as follows: Mr. Charles King, some six months ago, while mustering his sheep in the Mangaone Valley accidentally found what was to him a new and peculiar rock, and one which he thought from its great weight and colour was likely to contain either gold or silver. Aided by Mr. Ormsby and Mr. Griffiths, of Alexandra, the latter an old alluvial miner, the locality was thoroughly prospected for gold, and one or two 'colours' are thought to have been found in the wash-dirt in the bed of the Mangaone Stream, and some fragments of granite, crushed and washed by Mr. Griffiths, were also believed to have yielded a speck or two of the precious metal.

"After this a number of pieces of granite and associated rocks were handed to Mr. G. T. Wilkinson, J.P., Government Native Agent at Otorohanga, who forwarded them to Mr. T. L. Murray, the manager of the Bank of New Zealand at the Thames, for assay. The result of these assays showed that gold and silver were not present in these rocks.

"Some time towards the end of February Mr. Max von Bernewitz, the assayer to the bank, showed me a number of these rocks, and I at once identified examples of true granite and granitic gneiss among them. Mr. Murray informed me that Mr. Wilkinson stated in his letter accompanying them that plenty more of the same kind could be got if necessary. I then placed myself in communication with Mr. Wilkinson, to whom I am greatly indebted for many specimens and much valuable assistance in making arrangements for facilitating and furthering the object of my visit to the King-country.

"The exact place where the granite is found is situated on the left bank of the Mangaone Stream, about a quarter of a mile above its junction with the Turitea River, which rises among the wooded Tapuaea hills, lying two miles east of the Hauturu Range, and falls into the Waipa River four miles south of Alexandra.

"From Otorohanga southward to the Upper Mokau Valley and westward to the sources of the Waitomo and Moakurarua Streams the country is occupied by long low undulating or flat-topped ridges and spurs, covered with deep rich soil, supporting a dense growth of fern and tutu. There is evidence in many places to show that this area was at one time covered with a great forest, the remains of which may be traced in the numerous small isolated clumps of bush which still exist on sheltered slopes and in deep valleys. These open fertile ridges are principally composed of soft green and yellowish-coloured sandstones, often interstratified with crumbling blue marly clays. Both the sandstones and the clays contain an abundance of marine shells and corals, and where there is an excess of calcareous matter, which is usually in their lower horizons, they pass into a hard semi-crystalline limestone, in many places of great purity and much value for building, agricultural, and mortar purposes. The rocks are of Cretaceo-tertiary age, and form an important and well-marked series of the coal measures of New Zealand. In this district, as at Raglan, Kawhia, Mokau, and Upper Wanganui, they are distinguished by the presence of valuable seams of superior brown coal, occurring generally at the base of the formation at or close to the point where it rests on the eroded floor or basement-rock of the country. It is, however, a noticeable circumstance that where the hard semi-crystalline limestone rests on or approaches the old rocky floor the coal is usually absent, or represented only by thin streaks of carbonaceous matter. This is also a characteristic feature of the coal measures around Whangarei and Kawakawa, and it would tend to show that the limestone and coal were, at least in part, the result of contemporaneous developments or growths, the former on a sea-bottom, the latter on low-lying swampy areas contiguous to the sea.

"Where coal exists in the Waipa and Mokau districts, the limestone does not attain its greatest development, but passes downwards into soft yellow or brown-coloured sandstones, often coarse-grained, gritty, or pebbly, with fireclay and coal seams at their base.

"From the sources of the Waipa the coal measures stretch almost uninterruptedly to Kawhia Harbour and the West Coast, but on the south slopes of Mount Pirongia and the Hauturu Range

they are much obscured by a heavy covering of trachyte tuffs and lavas, which occupy all the higher parts of this watershed, and descend in many places to the sea.

"In the month of January, 1885, I geologically examined the whole of the country lying between the Waipa and Pirongia, including the district around Hikurangi and the north end of the Hauturu Range, which was as far south as I reached on that occasion on account of the obstruction of the Natives, who at that time exhibited great jealousy of the excursions of Europeans in their country. I also examined the coal outcrops on the Moakurarua and Okoko Streams and found the coal measures resting hard on an old rocky floor of argillaceous sandstones and grey cherts at Okoko and Ngutunui.

"The formations represented in this district may now be tabulated as follow :—

"I. *Recent.*—(*a.*) Alluvial flats and river beds,
II. *Pleistocene.*—(*a.*) Pumice sands and gravels.
III. *Pliocene.*—(*a.*) Trachyte tuffs and lavas.
IV. *Cretaceo-tertiary.*—
(*a.*) Marly greensands and clays.
(*b.*) Calcareous sandstones passing into hard semi-crystalline limestone.
(*c.*) Yellow and brown sandstones with coal seams.
(*d.*) Sandstone and granite conglomerate.
V. *Old floor* or *Basement Rock.*

"The chief interest centres round the sandstone and granite conglomerate, and the probable nature of the rocky floor of the district.

"Proceeding up the Mangaone Stream from the point where it joins the Turitea River are first seen tough grey vesicular trachytes, and trachyte tuffs which crown the narrow ridge dividing the Mangaone and Moakurarua, presenting to both streams a long line of steep escarpment, varying from 12ft. to 80ft. in height. About 18 chains higher up the valley the trachytes are succeeded by the underlying calcareous sandstones which first appear in the bed of the stream, lying almost horizontal; but proceeding up the valley they are found tilted to the north-west at a low angle, and are seen to pass downwards into an impure limestone, which in its turn becomes first gritty then pebbly, and immediately passes into a coarse conglomerate, composed principally of hard, somewhat flaggy argillaceous green-coloured sandstones and granite. Where the limestone is pebbly the fragments of included rock are chiefly sandstone, but sub-angular pieces of granite are not uncommon.

"The granite element of the conglomerate reaches its greatest development a few chains past the outcrop of limestone in a rounded spur which terminates abruptly at the stream. Beyond this point the granite boulders become fewer, and are rapidly replaced by those of sandstone, soon disappearing altogether.

"The section for the next few chains, in following up the stream, is somewhat obscured by the trachytes, but at the falls a little distance above this the hard argillaceous sandstones contained in the conglomerate are well exposed *in situ*. Here they alternate with crumbling mudstones, and also exhibit a marked tendency to weather in rounded concretions or nodules formed of thin, easily-separated concentric layers, enclosing a hard central nucleus. At a point about 5 chains above the falls they possess a more flaggy character, and contain a thin, irregular streak of fine bituminous coal, and are themselves of a finely micaceous nature. They strike north-south (magnetic), and dip west at an angle of 45°. Higher up the valley the soft brown sandstones of the coal measures now wrap over the outcrop of the older sandstones, and close the section in this direction.

"The annexed sketch illustrates the position and relation of the rocks met with in the line of section just described, to which the following refer to :—

A. Mangaone Falls. B. King's Hutt. 1. Trachyte tuffs. 2. Trachyte lavas. 3. Impure limestone. 4. Pebbly limestone. 5. Sandstone and granite conglomerate. 6. Argillaceous sandstones.

"Returning to the conglomerate, a close examination showed that the fragments of sandstone and granite were generally well water-worn, rounded, or sub-angular, but large angular blocks, of granite sometimes over a foot in diameter, were found in the bed of the stream, and pointed to the close proximity of that rock *in situ*.

"A collection of rocks composing the conglomerate comprised, besides the sandstones, granites of all degrees of texture from very coarse-grained, like those of Mount Olympus, in Collingwood, down to the finest known varieties. The coarse, decomposing, grey granite seemed to predominate; but examples of gneissic granite, greisen, hornblende gneiss or syenite, and quartzite were also found. In the granitic gneiss the laminated structure of the constituent minerals was well exhibited, the mica being chiefly biotite. In the hornblende gneiss, which would be difficult to distinguish from the hornblendic rocks associated with the lower Silurian strata at the Baton and Graham Rivers, Pikikiruna Range, and Upper Aorere Valley, the hornblende is conspicuously developed, and of a dark green colour.

"No fossils were seen in the conglomerate, but in the pebbly beds immediately overlying marine forms, chiefly corals, were abundant. Judging from the character of the associated strata and their embedded life, it may be inferred that the materials forming the conglomerate accumulated on the shores of a sea bounded by a broken rocky coast-line, being transported by a Cretaceous torrent, which scoured its deep channels in the slopes of mountains composed of Silurian granites and crystalline rocks, and flanked by sandstones of Jurassic and Triassic age. Then followed a gradual but general subsidence of the land, thus permitting the coarse materials to be followed or succeeded by a series of finer deposits, and then limestones or calcareous sandstones.

"The argillaceous sandstones and mudstones appear to contain no fossils, and there is nothing to indicate their age with any degree of certainty, but the direction of their strike and their close

resemblance to certain fossiliferous sandstones at Kawhia of Jurassic and Triassic age would tend to show that they are probably not older than Secondary. Of the extent and probable distribution of the granitic rocks it is perhaps even more difficult to speak, as their outcrop is covered by younger formations. The numerous varieties of crystalline rocks found in the conglomerate would lead to the belief that a considerable area of these rocks must have been subject to sub-aerial erosion in order to supply the material. It is at any rate permissible to suppose that a floor of granite and granitoid rocks extends throughout the central portion of this Island, and this hypothesis would harmonise with and perhaps explain the highly acidic character of the volcanic outbursts which have devastated that area throughout later Tertiary times. The south-west dip of the argillaceous sandstones at the Ngutunui and westerly dip at the Mangaone Falls, near the outcrop of the granite conglomerate, would favour the extension of the granites to the eastward or inland side of Pirongia and the Hauturu Ranges rather than to the seaward side, since the dip would naturally be away from, not towards, the older rocks.

"Granites are often of an eruptive character, and in Scotland they have been found of Tertiary age penetrating Jurassic rocks (Geikie's Textbook, page 140), but none younger than Silurian have been shown to exist in New Zealand, and those in the Upper Waipa Valley are no doubt as ancient as the Lower Silurian granites and gneiss rocks of the Pikikiruna and Mount Arthur Ranges.

"Hitherto no granite or crystalline rock of any kind has been known to exist in the North Island, and this may be regarded as the most important geological discovery of the past thirty years. The discovery is not only unique and interesting from a geological and scientific point of view, but it also possesses an important bearing of an economic kind. Granite and allied rocks are well known as the constant associates of tin-ores, and although no tin has so far been found in the Waipa district, it is possible that a search of the broken unexplored country lying west of the Hauturu Range may disclose the presence of tin or other deposits of valuable ores."

MINING MACHINERY.

Lührig's Ore-dressing and Concentrating Plant.

Some two years ago Mr. J. Cosmo Newbery, Metallurgist to the Victorian Government, was sent to Europe at the instance of the Mines Department of Victoria, to inquire into and report on the best methods of treating metalliferous ores, and the system he has advocated since his return to the colonies is a plant designed and patented by C. Lührig, Mining and Ore-dressing Engineer, Dresden, Saxony. Since Mr. Newbery's visit to Germany this machinery has been patented in this colony, and the general adoption of the term "Lührig's Process" has given rise to much discontent and jealousy among other inventors, whose ideas are embodied in the combination of the plant and system Mr. Lührig has patented as his own; and it is a question yet that remains to be seen whether this system of concentration can be carried out more effectually and more economically than that which is done at the plant erected at the Sylvia Company's works at Tararu Creek, in the Thames District, which is certainly the best concentrating-plant yet in use in any of the Australasian Colonies.

During last year I communicated with Mr. Lührig with the view of having a full description of his plant, and received letters from him as well as the company in London which has purchased the patent rights in the colony, who referred me to Mr. J. Cosmo Newberry, of Victoria, who is agent for the colonies, for full information, which has not yet come to hand; but in a letter from the secretary of the company in London, dated the 29th April last, he states that an order for a perfect and complete plant has been given the Lührig Company for New Zealand, and that it will be shipped for New Zealand within two months from the date of his letter, and that pamphlets containing a full description of the process will be forwarded to me. These have not yet come to hand. Several descriptions of the process have appeared in several newspapers, and remarks as to the contentions raised by those who claim to have invented part of the process. On this subject the *Australian Mining Standard* says,—

"Such contentions, however, have nothing to do with Australians, whose only anxiety in the matter is as to adaptation of it for use in the colonies. Herr Lührig, at all events, has identified himself with it, having made from time to time all the necessary tests; and that he is a man of immense energy and capabilities is evident when it appears that, in spite of the hard struggle for existence which a working-man has to face in the Old World, and particularly, perhaps, in Germany, he has raised himself from the ranks to the position he now occupies. One Lührig plant is not necessarily the counterpart of another, for it is exactly in the rearrangement of machinery to suit every class of ore that Herr Lührig has achieved his successes. Thus, for instance, it was not at once apparent that the tailings taken to Germany by Mr. Newbery could be profitably dealt with. The first time the vanner was tried with them it failed entirely; but after due consideration of their composition, and subsequent alteration of inclination of table, speed, feed, and water, a most satisfactory result was obtained—namely, 80 to 90 per cent. of assay contents from 3dwt. stuff."

Again, in subsequent editions of the same paper, appear the following description of the new Lührig concentrating-plant erected at the Himmelfahrt Mine, near Freiberg, in Saxony, written by Oberbergrath O. Belhartz:—

"The new central concentrating plant, which has been in constant use since October, 1889, owes its origin to the necessity of combining the five old-fashioned washers which were formerly all separate at Himmelfahrt, and therefore doing away with unnecessary transport of ore, and also of introducing at the same time a continuous method of working, which would combine all the latest improvements as regards economy in working, cost of labour, transport, &c. The present site of the plant was not selected on account of its being in the neighbourhood of the River Mulde, but, firstly

owing to its convenient situation near the three main shafts of the mine; secondly, because a good connection was afforded by the main railway-line of Halsbrücke, Freiberg, and Mulden-Hütte, this line having been specially built in the interest of the Freiberg mines and smelting-works. The washer was built between the two main hauling-shafts (Abraham and David), thus at the time facilitating a good communication with the Thurmhof and Reiche Zeche (shafts). All the shafts are connected with the plant by a narrow-gauge railway. The chosen site is near the watershed of the Rivers Mulde and Münz, on the slope of the Mulde Valley.

"Steam alone may be used as the motive-power, whilst the water for washing purposes comes from the water-channel of the Himmelfahrt Mine, which is one of a network of channels which have been carried from one mine to the other; but, owing to this supply being very irregular, especially as the late summers have been very dry, and as no work is carried on at night, it has become necessary to construct a reservoir containing about 10,000 cubic metres—that is, 350,000 cubic feet, or 2,182,425 gallons. This reservoir, which is kept full by the above water-channel, supplies in its turn water for washing purposes and for the boilers. The dimensions of the reservoir are such that, should the water-supply be entirely cut off, it would take, if used for washing purposes, two and a half weeks to empty it, at the rate of 35 cubic feet per minute, or 21,000 cubic feet per day of ten hours.

"The maximum quantity to be worked was taken at 1,500 double centners, or 150,000 kilograms—equal to about 140 tons—consisting of milling- and stamping-ore. The above quantity was decided on, partly with a view to the possible increase in the supply of ore, and also to allow of the working of poorer classes of ore by means of a rational and cheap washing process; it was also arranged that ore of different silver-value could be worked separately in the same plant. The yearly average output of the Himmelfahrt Mine is 450,000 d.ctr., or about 44,300 tons of crude ore, of which four-fifths come from the veins of the so-called pyritic lead formation, and one-fifth from those cross-veins where brown and heavy spar occur, and where, especially on the crossings, native silver occurs, together with galena rich in silver. The latter is evidently a mechanical mixture, but at the same time chiefly a microscopical one. This one-fifth is for the most part worked separately by the dry process, hand-separation, and dry stamps, so that the four-fifths which passes through the washer may be estimated at not more than 360,000 d.ctr. per year, or 1,200 d.ctr. per day, equal to about 118 tons per day. From the above quantity a certain number of tons have also to be deducted, resulting from the rough hand-separation, shipping ore, and waste. The capacity of the plant therefore allows, if necessary, for the treatment of ores from the other fiscal mines. Particular stress is laid upon the fact that the plant is arranged on a double system, so as to allow for the separate working of ore from different veins or districts.

"The ore to be concentrated undergoes in the first place a rough hand-separation, and consists mainly of milling- and stamping-ore—that is, a more or less intimate combination of galena, iron, and arsenical pyrites, copper-pyrites (seldom), zinc-blende, gangue (gneiss), part containing quartz, part spathic gangue. The different minerals are in a partly fine but mostly in a coarse combination. In many of the ores galena predominates, but in most iron-pyrites occur as the most plentiful component next to the gangue. The value of the galena in silver generally varies between 0·15 to 0·17 per cent., and reaches 0·20 per cent. in some veins—that is, 49oz. to 55oz. 10dwt. 16gr. in the former, and 65oz. 6dwt. 16gr. in the latter. The small-grained galena is, as a rule, the richest in silver. Arsenical pyrites occur in some of the veins of the Himmelfahrt Mine, and it contains no silver. This mineral is separated as an ore of arsenic. Iron-pyrites do not contain any silver, and predominate in most of the veins. Copper-pyrites occur but seldom, and then, as a rule, in the form of small pockets in massive galena. It is shipped, together with the latter, as lead-copper, with 3 to 4 per cent. of copper. The zinc-blende is the well-known Freiberg black zinc-blende, containing up to 33 per cent. of iron, having a specific gravity nearly the same as the accompanying iron-pyrites. On this account, the separation, even with the best and most careful classifying of the grains, and the best-arranged jigging, becomes exceedingly difficult. The separation of the zinc-blende ores is therefore, begun in the mines, and is also carefully carried out on the surface by hand-separation, so that the accumulated blende ores may be worked as far as possible by themselves.

"*The Main Principles of the Plant.*

"The main principles, which have been carried out according to the nature of the ores to be treated, and to the cheapness of working, are as follows: First, the ore should be disintegrated step by step, and the different substances should be immediately collected after each disintegration, in order to prevent loss of metal and power, by doing away with unnecessary crushing. This principle was recommended by the author in his report to the Government in 1885. Secondly, the greater portion of the crushing and concentration should be done by the rolls and coarse jiggers, and as small a quantity as possible by the stamps, small jiggers, and slime apparatus, as the loss is always greater in the latter. Thirdly, the work should be continuous from the beginning to the end, as well in the coarse-grained ore as with the fine, so that all intermediate transport and accumulation of material may be avoided. By carrying out these principles, the saving of silver and lead is increased, and the hand-labour and the whole cost of treatment is greatly diminished. To obtain an automatic working of the process, as the slope of the hill could only be utilised for the lower part of the plant (the slime-works), the main building, consisting of rolls and jiggers, had to be built in several stories. It was also necessary to excavate nearly three-fourths of the ground, that is—19,375 square feet—for the main building, and one-fourth, that is—8,224 square feet—for the slime building. In the jigging work less stress has been laid upon the too exact carrying-out to decimals of the sizing of grains; but a more important matter is that the superficial area of the appliances be sufficient to effect a thorough separation. Much care is taken in the treatment of the fine grains (sand and pulp) before they are allowed to be worked on the slime-tables. As previously mentioned, to allow of the working of ores of different

grades at the same time, the plant consists of a double system throughout, each half working independently, the water-supply alone being common to both. Thirty-five and a half cubic feet of clear water per minute should be sufficient for the whole plant, including condensation, feeding of the boilers, and of the different washing apparatus—*i.e.*, in no case should the water used exceed that formerly used in the two old washers or the Thurmhof plant. Therefore, the water that has already been circulated through the washer must partly be repumped into the main reservoir already described. Owing to the carrying-out of the principle of crushing and sizing gradually, and at the same time avoiding too fine a pulverisation of the ore, only 7,266 square feet of settling-tanks were at first erected. It has, however, been found necessary to increase this space by one-third, to allow of the emptying of the tanks. Although the whole area is very limited, it has, so far, satisfied all requirements.

"*The Interior Arrangements of the Concentrating Plant, regarding Power and Transmission.*

"Taking into account that the plant should be arranged to work simultaneously yet separately ores which, although of the same mechanical composition, differ greatly in silver-value, it was arranged (notwithstanding the fact that in the Himmelfahrt Mine the amount of ore from the richer silver lodes is smaller) to divide the washer into two separate but symmetrical parts, each of which is capable of treating about 70 tons of crude ore (70,000kg. to 75,000kg.).

"It has thus become possible, in the event of there being a momentary falling-off in the supply of ore of either sort, to concentrate similar ores from other mines in the central plant, or to work the crude ones of any particular vein or lode separately, in order to ascertain accurately the percentage of valuable product in each. This division of the plant has not only not interfered with the supervision and control of the machinery and workmen, but has greatly facilitated it.

"*Principal Division for Roller- and Jigging-work.*—The crude ore composed of the roller- and stamping-ore, resulting from a rough hand-separation, and the natural amount of dust and smalls which cannot pass the hand-separation, is brought by means of a horse-tramway in trucks to the west side of the main building to the bottom of the hauling-tower. The trucks are here hoisted to the top level by means of a separate hoisting-engine. The floor to which the material is hoisted is 41ft. (12·50m.) above the level of the tramway and 62·8ft. (19·15m.) above the foundation of the principal building. The trucks, which carry a load of from 2,669lb. to 2,868lb., are run out on rails from the hoisting-cage on to a platform, and into a circular movable tipper, which can be run on rails over the four large hoppers, in which the ore is tipped according to its quality. Each hopper has a content of about six tons, or 85 cubic feet. Two men are required on this floor to attend to the lift. These two men run the trucks out into the tipper, and tip the ore into the various hoppers; they have also to mark the number of the truck delivered to the washer. Roller- and stamping-ore and smalls pass all together over a moving grating, through which the smalls fall, whilst the separated larger pieces are broken in the stone-breakers. It is necessary to supply the stone-breakers as regularly as possible. To accomplish this a very practical arrangement has been put in by C. Lührig. This consists of an iron sole-plate let in at the pointed bottom of the hoppers, and this moves slowly backwards and forwards with the ore resting upon it. By means of this forward motion, which is worked by machinery at the back of the hoppers, the ore is carried or forced on to the forward and backward moving sieves, a sort of shaking-sieve, with holes through which all under $1\frac{1}{5}$in. falls, whilst the larger pieces over $1\frac{1}{5}$in. fall slowly and regularly into the stone-breakers. This automatic feeding of the stone-breakers requires only two men to the four stone-breakers and shaking-sieves. The forward and backward motion of the automatic feeder can be stopped at will or set in motion by the workman by means of a lever. A perfectly automatic supply is not practical owing to the ore changing in composition, it containing at one time more smalls, at another more roller- and stamping-ore. The smalls which fall through the grating pass directly into a large double sieve-drum directly below.

"The stone-breakers are arranged in a row in front of the hoppers and gratings. There are two for each system, and each stone-breaker can crush 660lb. to 770lb. of ore over the size of 4in. to 5in. cubes per hour. The crushed ore from the stone-breakers falls into the same lead as that which fell through the grating, and passes with it into the sieve-drums. The drums are double, formed of sheet iron, with holes of $\frac{5}{8}$in., $\frac{1}{2}$in., $\frac{5}{16}$in., and $\frac{9}{32}$in.

"The separate grains of $\frac{5}{8}$in., $\frac{1}{2}$in., and $\frac{5}{16}$in.—16m., 12m., and 9m.—which come from the first large drums, are further worked on the large five-partitioned coarse-sand jiggers, being automatically carried directly on the jigs by means of leads. These jiggers (called Bergemaschinen) are arranged for the purpose of removing gangue, and besides, with the exception of collecting a few grains of galena, essentially produce concentrated lead milling-ore, mixed with arsenical or iron-pyrites, and stamping-ore with very little galena—that is, they give concentrated material for further treatment. The outflow from the drums falls upon the picking-bands, which move slowly upwards, being slightly inclined. From off these pure galena, blende, pyrites, and gangue are picked out, whilst the mixed ore is allowed to pass on. The picked ore and the gangue are thrown by boys into boxes, connected with leads, arranged on both sides of the picking-tables. These leads convey the separated ore and gangue to the lowest floor of the main building. The bands carry the remainder—that is, mixed ore, &c.—into the receivers of the first pair of large rolls, where the second crushing takes place. The ore that passes through the rolls is carried through leads direct below to the second pair of double sieve-drums, for above middle-sized grains. These drums have holes of $\frac{5}{16}$in., $\frac{9}{32}$in., $\frac{7}{32}$in., and $\frac{5}{32}$in. These drums also receive the grain from the first drums. Each of these different sized grains, with the exception of those under $\frac{5}{32}$in., pass direct through leads to different five-partitioned jiggers, there to be directly separated into their different mineral components. The outflow from the drums goes direct into the second pair of rollers, where the third crushing takes place. The third pair of sieve-drums, which receive the crushed middle grains from the rolls, and the grains under $\frac{5}{32}$in., are situated directly under the above pair of rolls, and are also

double cylindric. They have holes of $\frac{9}{32}$in., $\frac{3}{16}$in., and $\frac{5}{32}$in. These sized grains go direct through leads to jiggers on the lowest floor of the crushing part of the building. The outflow from the drums passes through the leads to the third pair of rolls (for fine grains), and here the fourth crushing takes place. The crushed grains from these rolls pass into the single cylindrical drums having holes. The outflow from these drums which is not sufficiently crushed fall into the pit, or hoppers, where the bucket-lifts raise it for the stamps. This is a small quantity. The grains which pass through the $\frac{5}{32}$in. holes of the drums go through leads into the drums in the slime-washer.

"This ends the step-by-step crushing, and next follows a description of the jigging-work, which is throughout continual, no intermediate transport occurring. On the second stage (from the top) there are six of the large cross-grained jiggers, treating grains from $\frac{5}{8}$in. to $\frac{9}{32}$in., supplied from the first pair of drums. Each machine is divided into five compartments—(*a*) in the first compartments concentrated mixed grains of galena; (*b*) in the middle compartments those with galena, &c. The first row of hydraulic jiggers, which are, like the remaining similar machines, fitted with eccentric movement work with a throw of from $2\frac{3}{8}$in. to $\frac{29}{32}$in., and with a varying stroke of 115 to 160 per minute. The second row of similar machines are situated on the third floor from the top, on the same level as the third crushers, and work with a throw of from $\frac{29}{32}$in. to $\frac{25}{32}$in. and a stroke of 165 per minute. The third row of jiggers (for middle grains) is upon the ground-floor of the crushing part of the building, and they have a throw of $\frac{25}{32}$in. to $\frac{23}{32}$in., and a stroke of from 165 to 200 per minute. Each one of these machines delivers rich lead in the first-sieve division; mixed ore (roller-ore) in the second division; rich pyritic ore (delivery-ore) in the third division; poor pyritic ore (delivery-ore) in the fourth division; zinc-blende ore (poor ore for stamps) in the fifth division; whilst clear saleable tailings flow out. In working arsenical ores, the product in the third division consists of zinc-blende delivery-ore. The products from all the second-sieve divisions are crushed again by the rollers, whilst the fourth and sixth divisions are sent to the stamps. The products and mixed products from the jiggers on the two upper floors fall through leads, through which water also runs to the lower stage, where they can be dropped into trucks to be conveyed to the store-room, or dry stamps, or be redelivered to the crushing machinery as required; only the products and mixed products from the jiggers on the lowest floor have to be emptied out with a shovel. The waste and overflow from all the jiggers on the three floors run into a common big lead, and through this to the hopper of the principal waste-bucket works, which stands outside the washer in a special wooden building. The bucket-works lift this mixed waste of all sizes to such a height that it can be separated into two sizes (for sale), and can be easily tipped into loading-hoppers (to facilitate loading into trucks) and carted away. With the foregoing arrangements it can be seen that only on the lowest floor of the crushing part of the building is there any hand-transport work to be done. The working, therefore, is nearly automatic, requiring only the extra hand-work in overlooking the amount of the ore delivered to the stone-breakers, the picking at the transport-bands, the delivery of the mixed middle products, and from the middle-grained jiggers on to the reserve machines.

"The number of hands required for the main building for both systems consist of—Two men at the foot of the hoisting-plant, two men at the top (including engine-driver), two men at the stone-breakers, eight to ten boys or women at the picking-bands, one man on the middle floor, four men (for shovel-work, transport, &c.) on the bottom floor, one overseer, one engine-driver for the driving machine, one stoker, one mechanic (for oiling machinery, &c.). The three sets of rollers have the same diameter, of 2ft. $3\frac{9}{16}$in., and the same width, of 1ft. $2\frac{3}{8}$in., and consist of removable cast-steel rings on a conical core.

"*Principal Division for Stamping, Fine Grain, and Slime-working.*—The fourth crushing (with the third pair of rollers for fine grains) is finally followed by the fifth—*i.e.*, stamping, by which means the real stamping-ore, that from the previouly mentioned process (that is, the resulting mixed overflow from the jiggers), is treated. This work is performed by two sets of American stampers, each with three boxes of five head of stamps, which are also situated on the lowest floor of the crushing part of the building. The overflow from the jiggers on the upper storeys falls through leads into the pit of the stamp-bucket elevators, on the bottom floor; this in turn is tipped into the supply-hoppers situated at the back of stamps. The poorer stuffs coming from the jiggers on the lowest floor are directly taken out and also thrown into the pit of the stamp-bucket elevators. Each stamp weighs 313lb. (142kg.), and is lifted 1ft. $\frac{7}{16}$in. (320 mm.) per stroke, and makes 53 falls per minute. Each fifteen stamps, or three sets of five stamps, have a separate iron battery-box. The two-stamp batteries are so arranged that the thirty stamps are in one row. Stamping is done through screens. These two batteries have been found sufficient to work through the required quantity, jigged waste only being required to be stamped, and 176lb. (80 kg.) being the greatest duty performed, as a rule, by one stamp. This quantity corresponds to $23\frac{1}{2}$ tons (or 24,000kg.) daily of crude stamping-ore to be worked, or 20 per cent. of the whole quantity supplied to the washer. The slimes that pass through the battery-screens are taken up by the collecting-channel which runs in front of the battery-boxes, and this is where the slime-separation commences. There are here erected two pairs (originally four pairs) of single drums, with holes of $\frac{1}{8}$in. and $\frac{3}{32}$in. These drums are situated in the principal division for small grains and slime-working, directly over the principal level of the plant. This part of the plant consists of—firstly, the above-mentioned drums, and the hydraulic fine-grain jiggers connected with them; secondly, the Spitzlutten and Spitzkasten system, for coarsely-powdered grains, and the jiggers connected with them; thirdly, The Spitzlutten Strongerinne, with the appertaining apparatus for the finest sand and slimes. It forms, taken altogether, an unbroken suite of appliances, whose duty is—first, to classify according to specific gravity; second, to concentrate the single kinds; and lastly, to obtain the metallic contents from the previously-prepared materials. The Spitzlutten systems for coarsely-powdered grains treat grains from $\frac{1}{32}$in. to $\frac{3}{32}$in., of which there are three sorts that come from each system, and flow direct into the five-partitioned round jigger, where they are separated into different components. All the overflow from these Spitzlutten passes with the other slimes into the reservoirs of

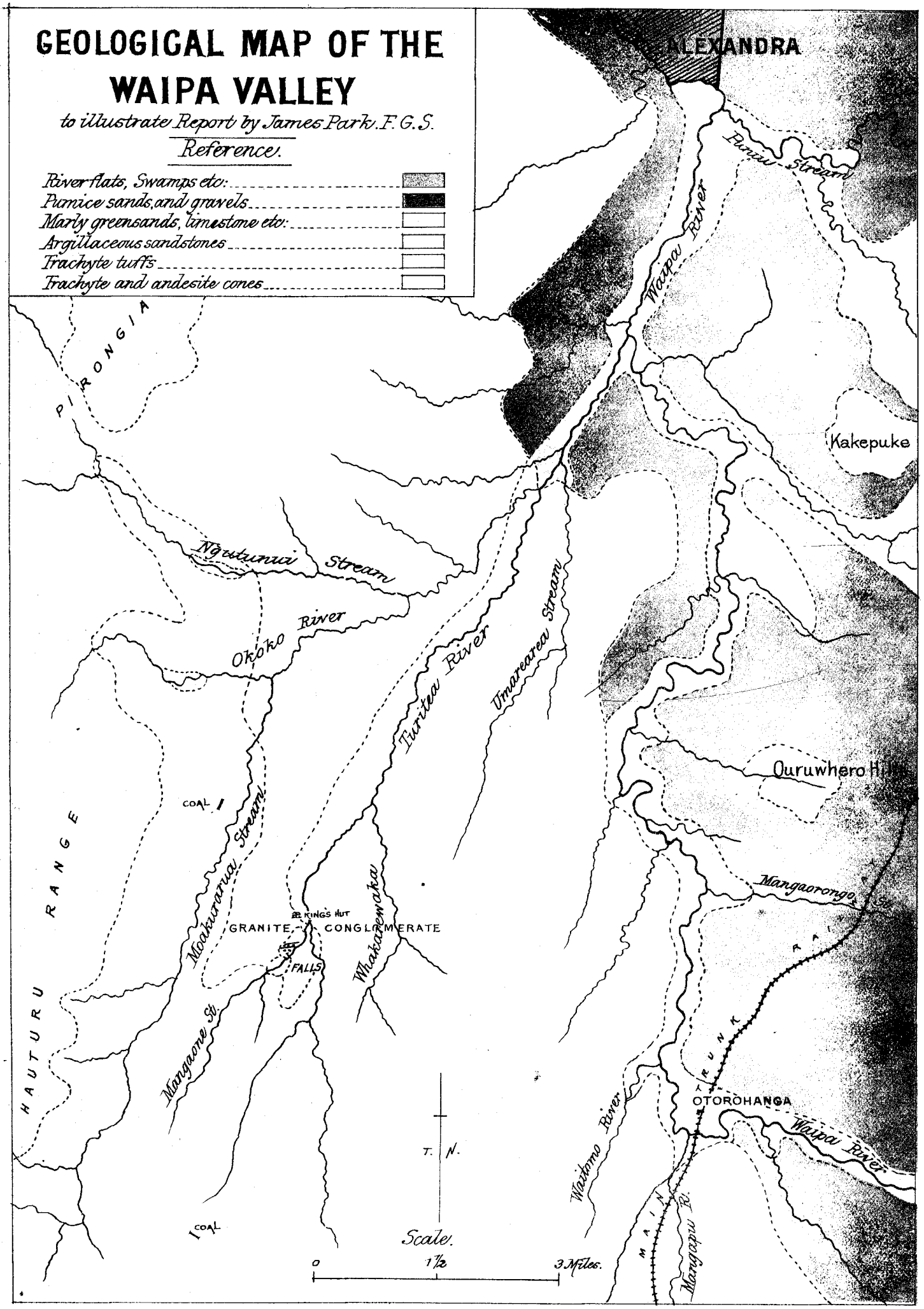
centrifugal pumps, which relift it the height of the Spitzlutten system for middle coarsely-powdered grains, sand, and slimes. This is the level where the slimes originally left the stamps, 12ft. 6in. above the principal level of the plant. Two range of pipes lead the slimes to the principal system. It may be also mentioned that all the piston-jiggers, situated on the bottom level, are also five-partitioned, fitted with eccentric motion, with a throw varying between $\frac{2}{3}\frac{5}{2}$in. and $\frac{1}{2}$in., and with 200 to 260 strokes per minute. Only the two first jiggers for separated grains give (besides the clear products) a small quantity of poor mixed waste to be stamped; the remainder consists of finished clean products. All these machines give—1. Rich lead-ore in the first division. 2. Mixed arsenical lead-ore in the second, when arsenical ore is worked; otherwise pyritic lead and ore. These products are reworked in both cases on the reserve machine. 3. Rich arsenical and iron-pyrites in the third and fourth divisions. 4. Iron-pyrites or zinc-blende in the fourth and fifth divisions, the latter when working stamp-tailings containing blende.

"*The Waste Tailings from the Fine-grained Jiggers.*—The waste grains, from $\frac{5}{3\,2}$in. to $\frac{1}{9\,6}$in., which come from all six machines belonging to one washing system, flow into the principal channel backward to an apparatus which is used for the purpose of leading them automatically to the reservoir of the bucket-elevators for the fine grains and coarse sand, which is situated next to the bucket-elevator for coarse-grained tailings. This apparatus was found to be not absolutely necessary for the plant.

"*The Final Working of Fine Grains and Slimes.*—The proper working of fine grains, sand, and slimes commences with entrance of the slimes into the principal Spitzlutten system. Here the separation of the grains takes place according to their specific gravity, as is also the case in the first system, and that is with more or less perfection, as the Spitzlutten gradually increase in size, whilst the velocity gradually decreases. The Spitzlutten system is divided into two parts: the principal portion for coarsely-powdered sands, and another portion for the finest sand and slimes. The principal portion gives coarse sand, middle grains, and fine sands and slimes in all siphon-pipes. To treat the coarsest sands from the first siphon-pipe there serve small series jigs, called element machines, on the same principle as the other jiggers. These jigs were erected later on, between the reserve machines in the row of principal jigs, and consist each of three single parts. These give direct: Lead shipping-ore, mixed shipping-ore, in the first part (the latter to be worked); pyritic shipping-ore in the second part; shipping-ore containing blende in the third part—the latter, naturally, only when stamp tailings containing blende are treated. The machines work with throws of $\frac{3}{1\,6}$in. and 220 strokes per minute. The second principal part of the first principal Spitzlutten system treats sands of middle and finer grains, which leave the apparatus through six separate siphon-jets. Instead of treating these products directly on the percussion-tables, they are first concentrated on a special apparatus for the purpose of separating any remaining coarse-sand tailings. This is done on the large circular pulsating jig. This jig is erected at the end of Spitzlutten, and at such a height that the concentrated ore which comes from it may flow through siphon-pipes directly on to the concentrating-tables. This jigger consists of six plunger-sieves, moving up and down about 200 to 220 times per minute, and working in a circular clutch, divided into compartments by radical partitions, each partition having a properly-sized mineral-bed. The fine sands from the pointed boxes, or Spitzlutten, are led on to the periphery of the round jig by means of pipes, and flow radially towards the middle. In this way the concentrates pass through the mineral-beds into the hutches below, and are led on to the percussion-tables through separate jets in a highly concentrated form. This machine serves both halves of the washer at once, each half having three sieve-compartments. The coarse barren rock is discharged through the pipe in the centre of the machine, and go to the slime-tanks. One of these patent pulsating jig-concentrators, about 7ft. in diameter, is sufficient to treat the whole of the fine sands of a well-arranged dressing-floor, having a capacity of about 120 tons of pyritic lead-ore per day of ten hours. To further treat the middle and finer sands prepared or concentrated on the above machine, the continuously-working percussion-tables are used, which are erected on both sides of the first principal Spitzlutten system. These machines are percussion-tables, with arrangements for altering the slope, but otherwise with a fixed wooden table, over which an endless rubber belt travels after Stein's principle, with improvements, which, with the previous concentration, greatly influence and improve the working of the tables. The rubber band of these tables travels forward 13ft. to 14ft. per minute, with a bump of $\frac{5}{8}$in. in amplitude, and about 140 percussions per minute. The incline of the table is adjustable, in order to regulate it to the class of concentrates to be treated. These tables produce pure galena, mixed galena to be worked on the reserve tables, pure iron-pyrites, blende, and poor waste. The separate portion of the principal Spitzlutten gives finest sand and slimes in six separate jets. To concentrate the former, a single-sieve percussion-jig is used; the other—that is, the very finest slimes—the double Spitzlutten are used. The finest sand and slimes from these apparatus, after concentration, are led through three separate jets to three separate percussion-tables erected in the two side-wings of the building. These tables are the same size, and similar to the other table. The products are also the same as those from the previously-mentioned tables. This ends the continuous working of the finest sand and slimes.

"*Personal.*—Besides the workmen employed in the crushing part of the plant, there are in two principal divisions below—two men to transport the products, two men for the reserve machines, two men to look after all the tables, two men for the reserve tables, four men for the transport of the products from the tables, three men for transporting the waste tailings, one carpenter, one overseer; so that fifty-one persons are employed inside and about the washer; two under-overseers and two overseers, of which one (the shift-boss) looks after the various cobbing-tables, and the carriage from the shaft to the washer, and the general loading arrangements.

"*The Arrangements for Clear and Purified Washing-water.*—35·3 cubic feet of clear water flow to the plant per minute, as already mentioned. This amount is next taken up by the condensation-pump of the driving-engine, and goes, after being heated to 23·5° C., to the pump-shaft of the big lifting-pump. The feeding-pump takes its supply from the condensation-pump, and forces it through


GEOLOGICAL MAP OF THE
WAIPA VALLEY
to illustrate Report by James Park, F.G.S.
Reference.
River flats, Swamps etc:
Pumice sands and gravels
Marly greensands, limestone etc:
Argillaceous sandstones
Trachyte tuffs
Trachyte and andesite cones
ALEXANDRA
Puniu Stream
Waipa River
PIRONGIA
Kakepuke
Ngatutumai Stream
Okoko River
Turitea River
Umaerewa Stream
Ouruwhero Hill
COAL
Mokauraua Stream
HAUTURU RANGE
Whakawaka
KINGS HUT
GRANITE
CONGLOMERATE
FALLS
Mangaorongo St.
Mangaone St.
MAIN TRUNK RAILWAY
OTOROHANGA
Waitomo River
Waipa River
Mangapiu R.
T. N.
Scale.
0
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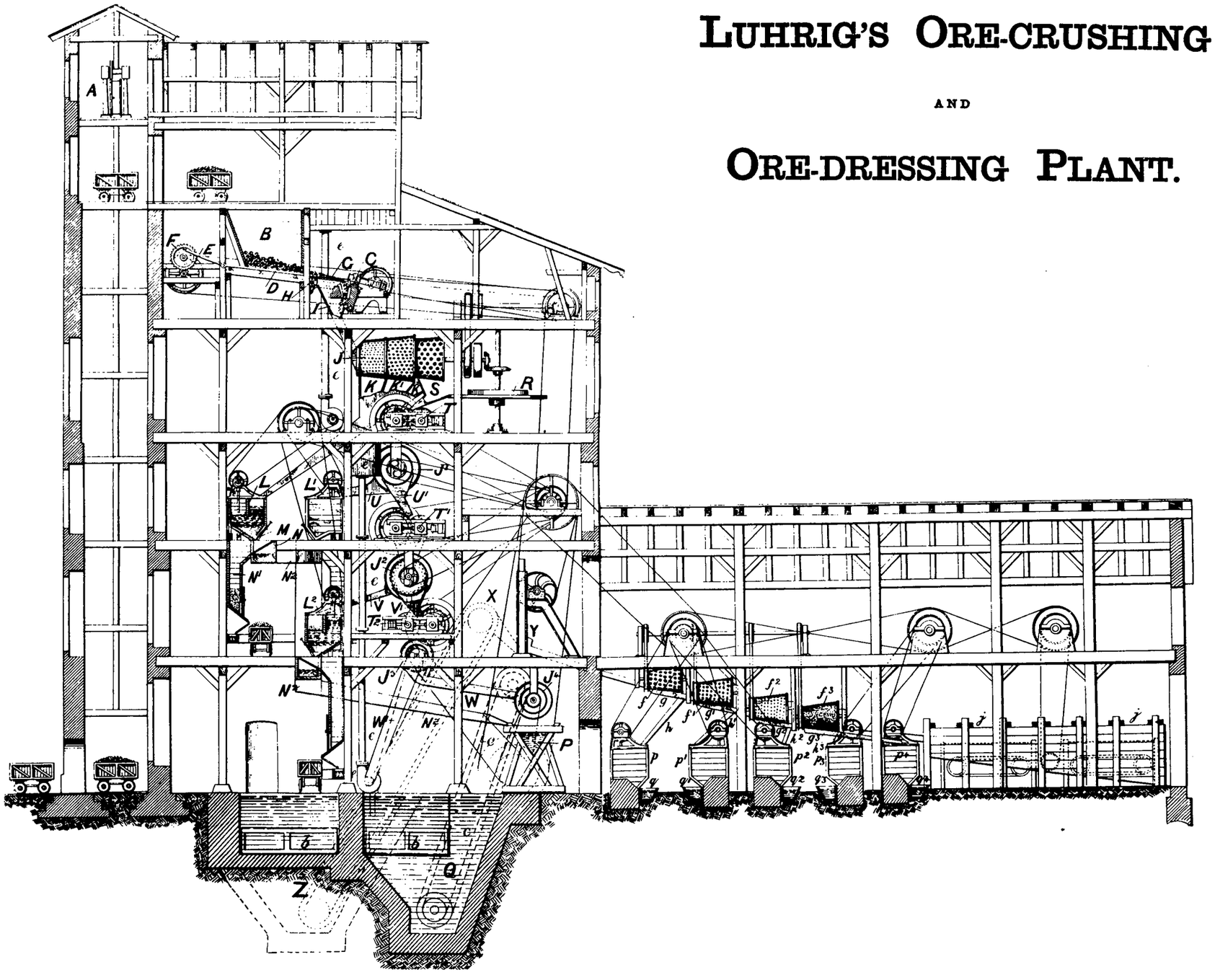
3 Miles.

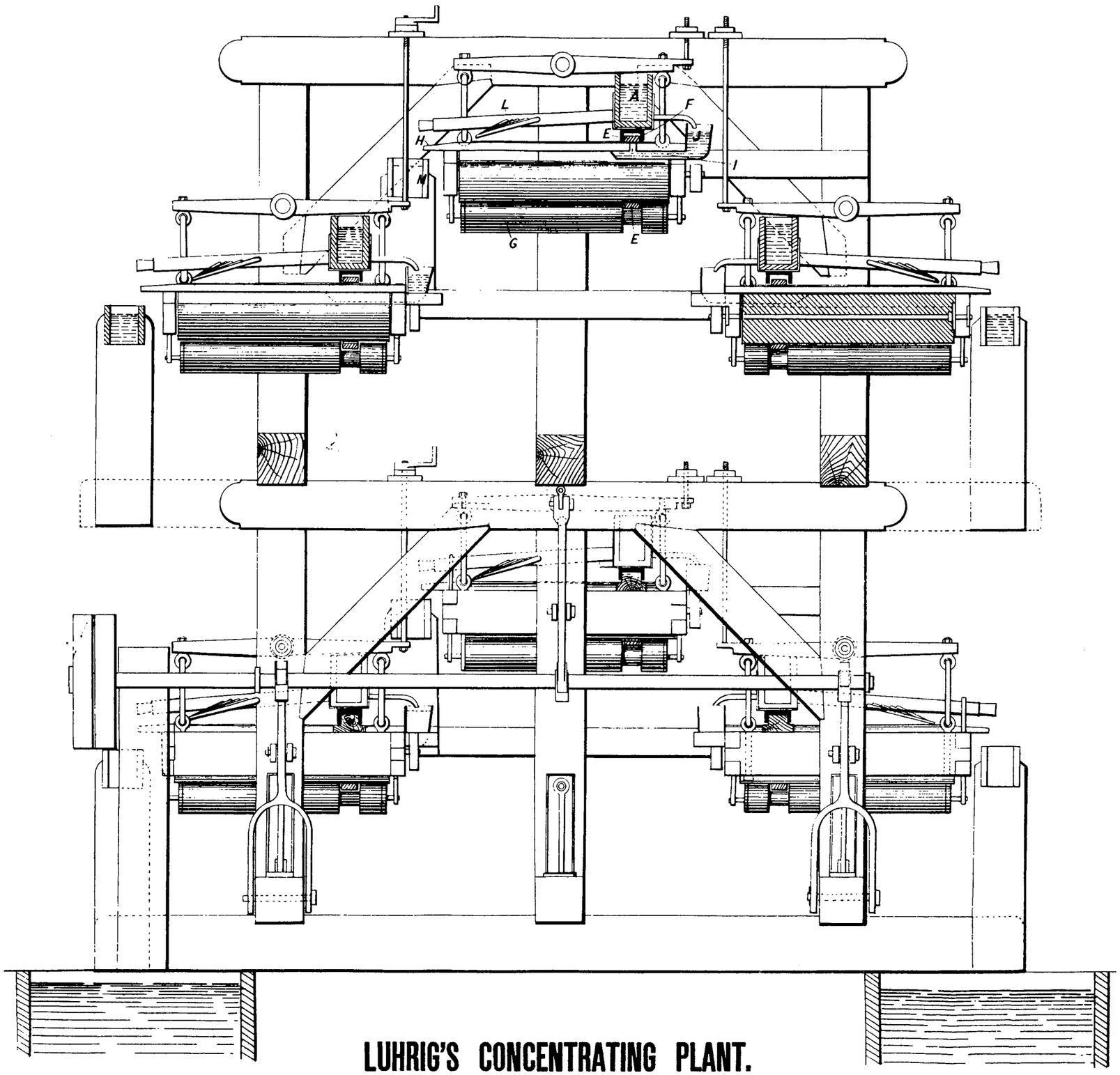


LUHRIG'S ORE-CRUSHING

AND

ORE-DRESSING PLANT.

FIG. 5.



LUHRIG'S CONCENTRATING PLANT.

LUHRIG'S CONCENTRATING PLANT.

FIG. 1.

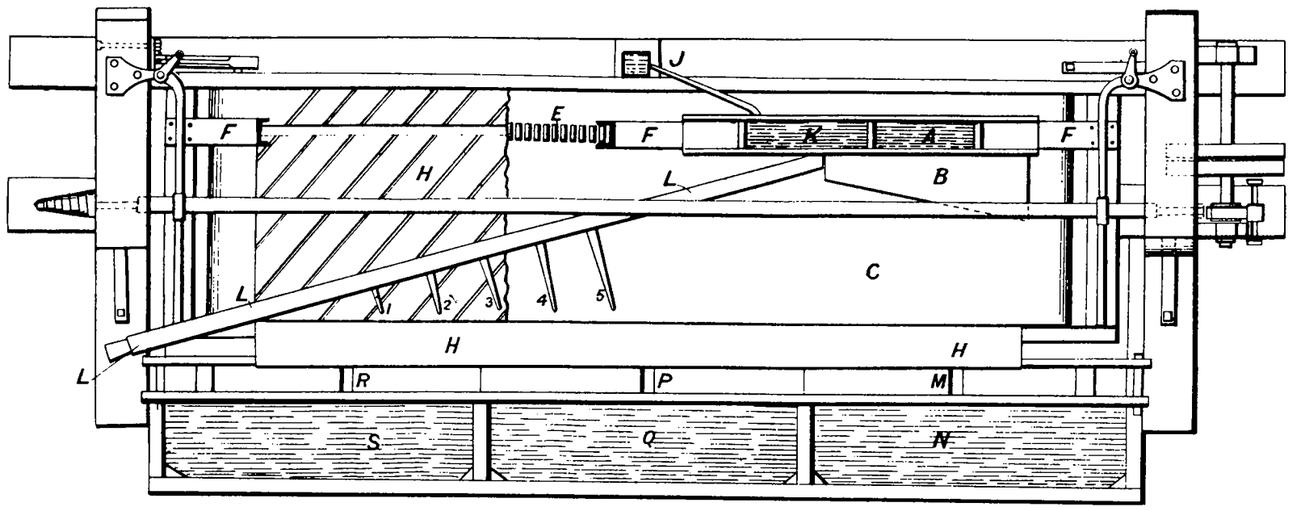


FIG. 3.

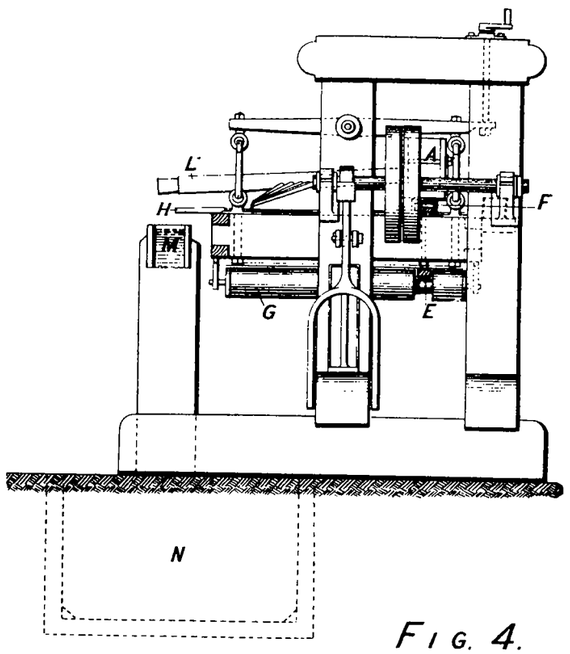


FIG. 2.

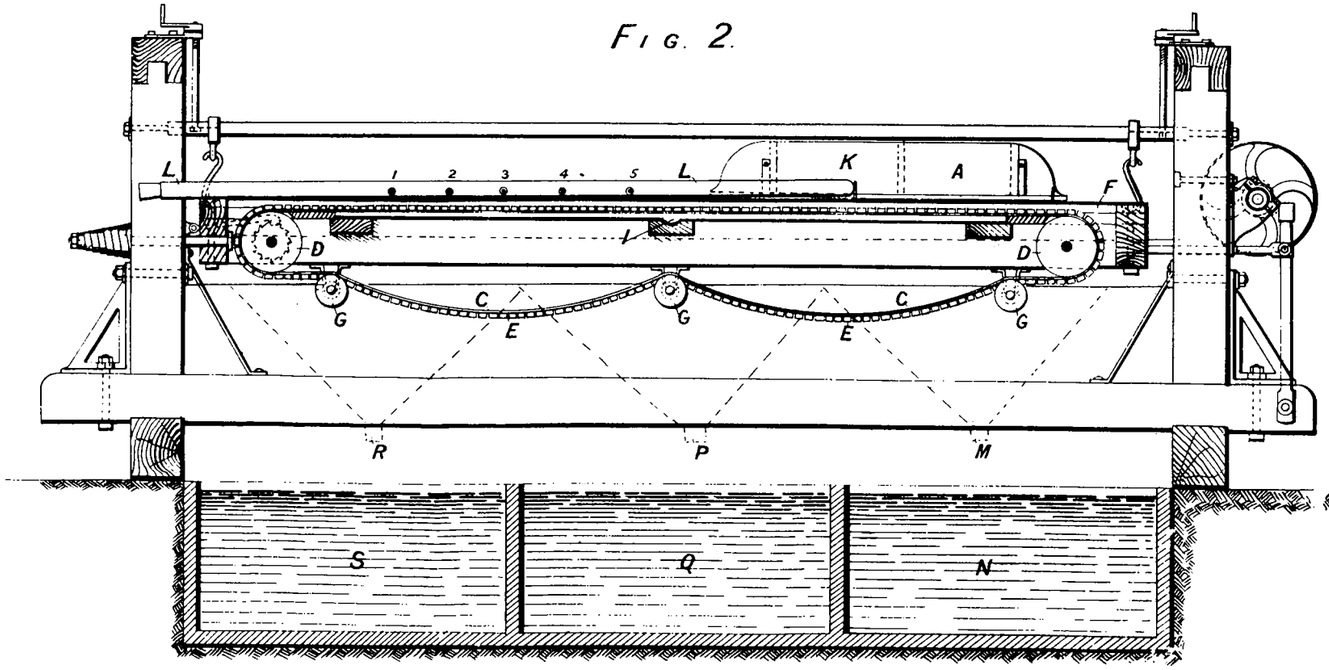
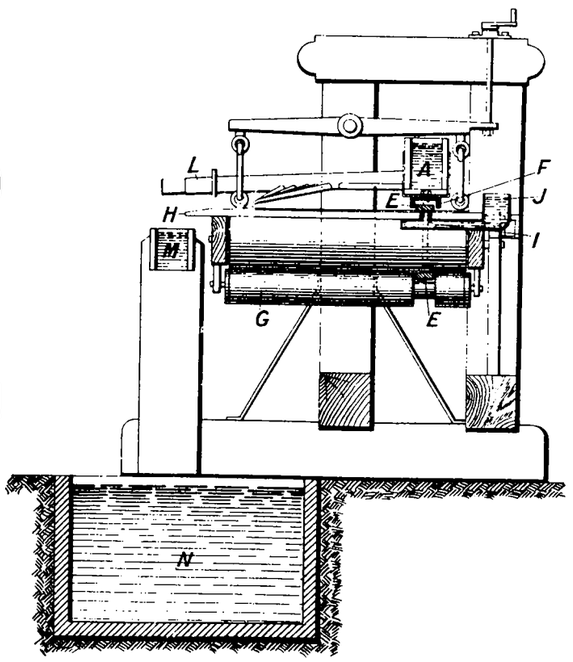


FIG. 4.



the feed-heater into the boilers. The big lift-pump raises the clear water to the height of the second stage (for middle-sized grainings) to the reservoir. From out of this a second pump lifts the necessary water to the upper and top storey. The necessary water for working the tables is taken from the principal reservoir below. The water, which is clarified in the settling-tanks—that is, water that has already been used—flows back into the shaft of the pump and is recirculated. Two hundred and nine gallons of water are discharged from the tanks per minute."

The following notes on the Lührig concentrating system, by W. C. Chapman, are taken from the Victorian Mining Report:—

"Notes on the Lührig Concentration System.

"The Lührig Company, in the first place, requires the following questions answered, and a sample of ore weighing not less than two tons sent for testing and examination:—

"*Questions.*

"1. How does ore occur at your mines?
"2. How much of your ore can you sell without previous treatment?
"3. Is the mineral impregnated finely, or is it in coarse crystals?
"4. Is the gold found in sulphides, and of what size are the crystals?
"5. Is the gold found as free gold in quartz, and is it visible with the naked eye?
"6. How many tons of gangue can you raise per 10 hours?
"7. What percentage of total output must go to the dressing-plant?
"8. Is the rock hard, clayey, or earthy?
"9. What are the costs of bringing one ton of the ore to the surface; and what percentage of the above-named minerals does an average sample contain?
"10. Have you a dressing plant at work?
"11. Of what is the plant composed?
"12. Have you stone-breakers, stamps, mills, and Frue vanners at work?
"13. Do you use amalgamation?
"14. What loss of gold in percentages, or how much gold, silver, &c., are you unable to win?
"15. How small do you crush your ore, with stone-breakers, stamps, &c.?
"16. What size, in inches, of ore do you feed into the breakers, stamps, &c.?
"17. How much water does your plant use per minute?
"18. What are your costs of working per ton of ore?
"19. Do you employ steam-power, and what horse-power?
"20. Or do you employ water-power, water-wheels, or turbines, and of what size are they?
"21. If you use water-power, how many cubic feet of water have you, and what fall in feet?
"22. What wages do you pay to labourers, smiths, mechanics, carpenters, and foremen, per day?
"23. What is the price of coal per ton delivered at the works?

"*General Remarks.*

"If your dressing plant consists of stone-breakers, stamps, Frue vanners, &c., and if you use the amalgamation process you are employing the most expensive and incomplete process in existence. With my patented system I win all the particles of the mineral, intergrown with quartz, which are not caught by the quicksilver. It is very expensive to crush these particles again, after having passed the quicksilver in stamps and mills. Slimes which generally go to waste, or are stored up in settling-pits, are collected by an automatic and continuous filter in my system, and the slimes are raised for further working up. Moreover, I allow only practically clear water to go to waste. The whole of the machinery and apparatus are delivered by me, constructed on the most approved principles, of very best workmanship, and at low rates. I undertake the complete erection of a dressing plant, and give full guarantees respecting the quantity and quality of the ores to be treated, also the loss and the cost of working, on condition that I receive an average sample of the ore—say, one or two tons, or any such quantity as may give a good average sample for testing purposes. The erection of a plant of 150 tons capacity per ten hours would take four months. A plant of 300 tons capacity uses 15 cubic feet of water per minute; a 600-ton plant 20 cubic feet a minute. The water is reused, and the slimes are extracted automatically and continuously. In Europe I have erected 153 plants for various kinds of ores, and I hereby invite likely clients to use the same.

"On returning this list of questions a plan of the site should accompany it. On this the position of the bins and site should be shown; also railway-siding and docks, if any. You should also inform me of the means of transport, distance of the nearest railway-station from the site, also the class of ground the plant is to be built upon.—C. Lührig, Mining and Ore-dressing Engineer, Dresden, Saxony.

"After fully testing the ore an estimate is given for the cost of a plant (f.o.b., Germany), and a list is given of the numbers of the different appliances, together with the price of each. In the event of a plant being ordered, an agreement is entered into between the Lührig Company and the mine-owners fixing the guarantees on the part of the Lührig Company and the royalty to be paid by the mine-owners. The Lührig appliances for ore-dressing are much the same as those used under any system—that is to say, stone-breakers, sizing-drums, rolls, jigs, stamps, elevators, pointed boxes, and slime-vanners; but the form and construction of these is more scientific and better than any other; and the system upon which it is planned, together with the vanners, is Lührig's own invention, and devised for giving the best results with the least amount of manual labour and of loss. The coal plants are to be seen all over Germany and France, and some are in operation in England. They are most successful. The ore-dressing plants are in use in many places in Germany, making ore pay that would yield no profit before. At Himmelfahrt, near Freiberg, they are concentrating

2 per cent. ore, and at Scharfenburgh, on the Elbe, ½ per cent. ore. At both places they are obtaining a profit from both zinc-blende and from iron-pyrites; and at the latter the tailings are mixed with cement, and made into drain-pipes. All by-products having a value, and wages only ranging from 1s. to 2s. per day, very poor ore can be handled profitably.

"In Spain the plant is working on an intimate mixture of siderlite, zinc-blende, and galena; in Algeria, on galena-ore; in Norway, on auriferous pyrites; elsewhere, on manganese-ore.

"At Laurium, Lührig is erecting a plant to cost £150,000 to deal with ore containing about 12 per cent. lead, 10 per cent. zinc, and from 8oz. to 12oz. of silver. This plant is in three divisions, one for oxidized ores, one for sulphide-ore, and one for old tailings.

"The Humboldt system and all others appear to be giving way to the Lührig system all over Europe. Quite lately, and since I left Europe, a French company has ordered a Lührig plant on a large scale for their mines in France; and the directors told Mr. Lempriere that they had satisfied themselves that the Humboldt plant was neither so efficient nor so economical. They had therefore decided to discard it in favour of the Lührig.

"A plant on the Lührig system is now being erected in Colorado, United States of America, and a large one is to be erected on some abandoned lead- and arsenic-mines in Wales.

"The Government of Saxony has introduced the system at several of the Fiscal Royal mines, and a report has been made by professional men for the Government. This report concludes with, 'All difficulty in economical separation of ores, and in dealing with slimes, has been overcome by Mr. C. Lührig, and the thanks of the community are due to him.' I may here remark that this is no new invention, but a system evolved from a thorough knowledge of all that is required in ore-dressing, and a long acquaintance with dressing plants and appliances in Saxony, the home of ore-dressing. The inventor has been gradually developing his system and appliances for twenty years.

"*The Plant.*

"One hundred and fifty plants, inclusive of local plants, had been erected up to December, 1889; many more have been built since. The plants are all made double—that is, one-half on one side of the building, and the other half on the opposite side; thus two classes of ore may be dressed simultaneously. The machinery is made under Lührig's own eyes, and erected by his engineers, who run it until some one is educated up to taking charge.

"The main features are good system; space round all the machines or appliances; saving labour wherever possible; losing but little water, merely the evaporation, and that which does not drain from the tailings; making an almost clean product in the principal minerals, and a middle product at each successive reduction in size, until the residue is reduced to slime, and at all stages working continuously; and finally, recovery of sludge, and filtering the water so that it may be used continuously. When arranging the plant, special attention is paid to grading, according to size; to gradual reduction for the jigging appliances; and to grading according to relative weights for the slimes.

"Too much importance cannot be attached to the fact that this system solves the important problem of how to construct a plant by which the reduction of the ore takes place gradually, thus avoiding unnecessary crushing of fine particles of clean ore, and only crushing fine such particles as cannot be brought up to a sufficiently high percentage of metal without such further reduction. Even with pyritous gold-ores it may be found better to adopt gradual reduction and concentration, so as to remove the whole of the pyrites before any amalgamation of the free gold is attempted.

"*Treatment through Lührig System.*

"After hand-picking, if such be necessary, the whole of the ore is fixed on a screen of about 1½in. mesh, the larger pieces passing over this to the rock-breaker. The troughs and tails from the screen and rock-breaker then pass to sizing-drums, which separate the finer stuff from that not yet sufficiently reduced by the rock-breakers. Material of about ¼in. and under ⅜in. is generally passed direct to jigs to get rid of worthless material only. The partially concentrated material is then passed through rolls and mills. The larger pieces or tails from the sizing-drum pass on to picking-tables, or continuous conveyors, where rich ore and worthless material is picked out by hand, the mixed ore passing through rolls and mills for further reduction. The ore from the mills passes into another set of sizing-drums, from which the finer sizes pass on to jigs direct, whilst the tails or larger sizes pass to finer rolls and mills for further reduction. In this way the reduction takes place gradually and automatically, the ore gravitates through the various mills and screens, and generally a fourth set of rolls, screens, and jigs is employed before the poorer mixed ore goes to the stamps for final reduction.

"The jigs in the Lührig system are generally built in four or five compartments, giving the following concentrated products: For instance, galena, arsenical pyrites, iron-pyrites, zinc-blende, and a middle product in which galena generally preponderates, or in which the gangue is very finely impregnated with ore. The middle product is passed through a set of rolls and again concentrated, or more frequently is stamped and concentrated.

"*Slimes through the Lührig System.*

"I wish to draw your special attention to this part of the system, because it is that which may be economically applied to the treatment of auriferous tailings and slimes, and be the method by which miners and labourers past active work underground may be provided with remunerative labour for many years to come, and the opening of a new and profitable industry on the goldfields of Victoria be provided. There is no occasion for me to dilate upon the advantages to be obtained from a satisfactory process for obtaining the bulk of the gold from tailings and slimes, or upon the quantity and value in the waste heaps on the goldfields. You probably know as much as, or even more than, I do upon this subject. The concentration of the sand and slimes commences with the

stamp-mill, and at this point the most important features of the Lührig system commence. The crushed material is allowed to flow through a system of sizing-drums of about $\frac{1}{32}$in. mesh. This is done in order to size off any particle of ore which may not have been stamped to sufficient fineness owing to bad workmanship or wear in the rolls and stamps; anything over $\frac{1}{16}$in. is then concentrated on continuous and automatic jigs. Concentration of the finer particles now takes place. They are firstly graded according to specific gravity in hydraulic graders, which are placed on a higher level than the concentrators and vanners to allow for gravitation. These hydraulic appliances have several sets of compartments, say four, and clean water is supplied to each compartment by a pipe, and the flow is regulated by taps, which are fitted with graduated discs. The following action then takes place: The material is fed into the first compartment, and the water carries on the lighter particles into the second set, the still lighter into the third set, and so on. Thus the fine minerals suspended in the water are graded according to their relative weights, and sink to the bottom in each compartment, their respective weights overcoming the upward stream of clean water. The grader is narrow at the inlet, and widens towards the outlet. This is done in order that the whole mass may gradually attain a very low velocity, thus insuring the overflow of only very light particles. The apparatus described gives products which consist of partially concentrated ore, and only the lightest material or tailings pass away with the waste water.

"*Products.*

"The products are: 1st, classified pulp, partially concentrated, containing a high percentage of mineral; 2nd, classified pulp containing a less percentage; 3rd, classified fine pulp or slimes; 4th, slimes containing a very low percentage of minerals.

"The product from the first is generally concentrated to a higher degree on continuous jigs constructed to treat fine ores, and the results obtained on the five-compartment jigs at Freiberg are generally as follow: First compartment, galena of 65 per cent. to 75 per cent., and a middle product of arsenical lead; second compartment, arsenical pyrites, with about 40 per cent. of arsenic; third compartment, arsenical pyrites, with from 20 per cent. to 25 per cent. of arsenic; fourth compartment, clean iron-pyrites; fifth compartment, zinc-blende and tailings. The middle products are again treated on concentrating machinery.

"The first product from the grader generally contains only about—

0·0208	Ag.
5·32	Pb.
2·7	As.
20·4	FeS.
10·9	Zn.

"The concentrates from the five jigs contain—

0·045	per cent.	Ag.
15·	,,	Pb.
4·	,,	As.
25·	,,	FeS.
14·	,,	Zn.

"This is now led into Lührig's compound vanner or percussion-table on which the minerals are concentrated and separated from one another.

"Tailings from the bottom vanner seldom contain more than—

0·005	per cent.	Ag.
0·0	,,	Pb.
0·25	,,	FeS.
0·5	,,	Zn.

"Lührig's patent compound vanner is a recent invention, and is employed in separating the various minerals after they have been concentrated and classified according to relative weight. The pulp from the various compartments of the grader is fed on to a band through a feeder, which is attached to a movable frame. The band is suspended on the frame, and whilst continually moving also receives an end-shake; this causes the several minerals contained in the pulp to separate according to their respective weights. The pulp flows over a distributer on to the continuous band, which is of rubber. The band is retained in position on the roller by strips of wood which travel along a groove. Free passage of water on the table enables the band to move without friction. The end-shake is imparted in the usual way. The lightest materials are washed off into a hopper; the first product is washed off by two jets of water into a second hopper, and the second product by jets into a third hopper. These vanners are used in the Lührig system compounded, the lower machine working up the products of the upper without manual labour.

"Thus, the materials fed on to the upper tables are firstly separated according to specific gravity, Class 1 going to the lower table on the right, Class 2 to that on the left, while Class 3 can go to the No. 4, and so on. In this manner a high degree of concentration is obtained without manual labour. In this compounded treatment of the pulp the only true solution of close and good concentration is to be found. And this close treatment, being automatic, has made Lührig's compound vanner the most successful ore-concentrator and separator in use.

"The products of the top vanners at Freiberg are—galena with 70 to 75 per cent. lead and arsenical lead-ore; pyrites, with 40 per cent. sulphur; and middle products which are worked up on the lower ones. One compound vanner will treat over 12 tons in ten hours, giving clean tailings. These machines are in sets of three and six, and are driven by tappets.

"The whole of the washwater used in Lührig's plant is run into a tank at the lower end of the plant, where it is filtered so as to use it again. The sludge or very fine tailings are collected by Lührig's sludge-recovering apparatus, and elevated by a perforated bucket elevator into hoppers;

and, if found by assay to contain an appreciable quantity of mineral, is raised to the stamps by a centrifugal pump, and subjected to further stamping, and thence to the graders and vanners as before. Loss is reduced to a minimum by this means, often to only 2 or 3 per cent., and the cost of working by reason of the whole system being practically automatic is often reduced by fully 80 per cent. The cost of working at the mines of the Fiscal Royal does not exceed 7d. per ton.

"Lead-ores from New South Wales can be concentrated by this system at a very low cost, varying with local circumstances, giving products containing 70 per cent. of lead, with 5 per cent. zinc, and 40 per cent. zinc and 5 per cent. lead. The plant referred to at Freiberg treats about 16 tons per hour. It requires 15 cubic feet of water per minute, of which 5ft. must be clean. The loss of water is about 1·50 cubic metres per hour, but this is no guide to what the loss would be in Australia, where it may be set down at about 22 gallons per ton of ore treated.

"C. Lührig, of Dresden, is the patentee, and has formed a company in London, called the 'Lührig Coal and Ore-dressing Appliances Limited, 32, Victoria, S.W., London.' This company has sold its coal rights to a big company in America, where there is a good opening, and where a large business will be done.

"*Abstract of Guarantee.*

"The Lührig Company guarantees under strict penalty: (1) Quantity plant will treat; (2) material and workmanship; (3) cost of treatment per ton; (4) percentage of enrichment of mineral contents; (5) maximum loss in tailings."

In order that the whole system may be thoroughly understood, complete specifications and plans, as lodged in the Patent Office, are herewith annexed. It will be seen that a portion of the machinery used—namely, rolls and screws—have been in use for many years, and the concentrating appliances are a modification of the Frue and Triumph vanners. Any new machine which is purported to save a large percentage of metalliferous ore at a low cost in necessarily greatly inquired after, but it must be remembered that the cost of labour is far more here than in Germany, and the cost of treatment will be increased proportionately. Seeing that one of these plants is to be erected in New Zealand, it will be well to wait to see the results of its work and the cost of working the same in the colonies, together with the terms and conditions under which this company will allow their process to be used. Until we know what royalty is proposed to be charged, the adoption of the system should be held in abeyance.

"Specification.—Ore-dressing Machinery.

"*Improvements in Apparatus for Dressing Ores.*

"We, Carl Lührig, of Dresden, Saxony, German Empire, engineer, and John Charles Cunninghame, of 127, St. Vincent Street, Glasgow, Scotland, iron- and coal-master, do hereby declare the nature of our invention for improvements in apparatus for dressing ores, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

"This invention relates to apparatus for treating ores, so as to separate and retain the portions containing valuable minerals, by the operation of a succession of machines, arranged so as to avoid as much as possible manipulation of the material dealt with. The arrangement which is adopted for this purpose is represented by the accompanying drawing, which is a vertical section of a building, with a set of the dressing-plant arranged according to this invention.

"The ore to be dressed is raised to the top of the building by means of an elevator or lift *A*. It is delivered into a hopper *B*, whence it passes to the stone-breaker, or it may be a set of stone-breakers, *C*. For feeding the ore from the hoppers *B* into the breakers *Ca* reciprocating-pusher *D* may be employed, this being moved to and fro by the connecting-rod *E* from a crank on a slowly revolving wheel *F*. As the ore passes towards the breakers, the smaller fragments escape downwards through sieves *G*, to which a jogging motion is imparted by the tappet *H*.

"The ore reduced by the breakers *C*, together with the smaller fragments from the sieves *G*, is conveyed by the shoot *I* into a revolving sizing-drum *J*, which separates the material according to sizes that passes into shoots *K*, K^1, K^2 respectively; thence they are led into three sets of washers *L*, by which they are concentrated in the usual manner. The concentrated material is at intervals passed from the washers by opening the valves *K* into drainers *N*. The water carrying the finest portions of the ore is led by a shoot N^2 in graders or funnel-shaped boxes *P*, by which these portions are graded according to their specific gravities and sizes.

"The larger fragments which pass through the drum *J* are delivered on a slowly revolving table *R*, where the attendants select the valuable pieces, which require no further dressing, and reject useless pieces. The rest, requiring further dressing, passes by a shoot *S* to a pair of crushing-rolls *T*, whence the fragments pass to a revolving sizing-drum J^1. From this the sized materal is passed by the shoots *U* into the washers L^1, to be concentrated, drained, and graded in the same manner as that dealt with by the washers *L*.

"Such of the material from the drum J^1 as requires reduction is led by the shoot U^1 to crushing-rolls T^1, and thence to the sizing-drum J^2, from which the sized material is led by the shoot *V* into sets of washers L^2, to be concentrated, drained, and graded as above. The material which passes through J^2 is passed by the shoot V^1 through another pair of crushing-rolls T^2 to a sizing-drum J^3, the finer material being led by the shoot *W* into the graders *P* and sizing-drum J^4, while the coarser fragments are fed by the shoot W^1 into the elevator *X* carrying them to the stamps *Y*. The sized material from J^4 is led into the grader *P*, the products of which are concentrated on washers *P*.

"The overflowing liquid from all the concentrators and graders is passed into the pit *Z*, where the heavier fragments and particles sink to the bottom, whence they may be raised by the elevator

X to the stamps Y, to be further pulverised. The finer and lighter particles flow with the water over a partition into a sludge-pit, in which the sludge-band b moves slowly in the direction of the flow of the water, scraping together the fine sludge and depositing it in the pit Q. The elevator c conveys the sludge to the grader P, or, if the sludge is of no value, it may be at once removed.

"The greater part of the water after settlement is raised by the rotary pump e to be used over again.

"The rollers T T^1 T^2 serve for crushing not only products from the sizing drums, but also such products from the washers L L^1 L^2 as require further treatment. The number of sets of rollers, drums, and washers may be varied according to the character of the material treated.

"The ore which has been crushed and pulverised in the stamps is separated into several sizes by means of the revolving-drums f, f^1, f^2, f^3 (communicating with one another by g, g^1, g^2, g^5), and led by spouts h, h^1, h^2, h^3 into washers p, p^1, p^2, p^3, whence from time to time the concentrated ore is removed, the water passing by the troughs q, q^1, q^2, q^3, q^4, to a channel leading into sludge-pit Q. The material that passes through the meshes of the drum f^3 is graded in a series of gragers j, which feed suitable percussion-tables or other known apparatus for concentrating slimes.

"Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

"The apparatus for dressing ore, placed in successive stories of a building with suitable elevators and shoots, so arranged that the ore raised to the upper story is dealt with as it descends, by crushing, stamping, grading, washing, and otherwise, as set forth, so as to separate the rich or metalliferous portions for subsequent treatment.

"Dated this 16th day of October, 1890.

"Carl Lührig.
"John Charles Cunninghame."

"Certified to be a true copy.—Whitaker and Russell, solicitors in New Zealand for the applicants."

"Specification.—Concentrating Machinery.

"*Improvements in Apparatus for Washing, Separating, and Concentrating Ores of different Specific Gravities.*

"We, Carl Lührig, of Dresden, Saxony, German Empire, Engineer, and John Charles Cunninghame, of 127, St. Vincent Street, Glasgow, Scotland, Iron and Coal Master, do hereby declare the nature of our invention for improvements in apparatus for washing, separating, and concentrating ores of different specific gravities, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

"This invention has for its object improvements in apparatus known as percussion-tables for treating ores and similar substances in a pulverised state, by which the ore is separated or classified according to specific gravity, and each class is caused to pass into a separate trough as it leaves the table.

"This invention also relates to an arrangement of several sets of the apparatus in such a manner that the pulverised ore washed from one table, or from one set of tables, in a partially separated or classified condition, can be passed over another table or another set of tables to be similarly operated upon for more complete separation or classification, and finally delivered into receptacles without requiring manual labour.

"The improvements are illustrated by the accompanying drawings. Figs. 1, 2, 3, and 4 represent respectively a plan, a side sectional elevation, an end sectional elevation, and an end elevation of a single percussion table. Fig. 5, sheet 2, is a part sectional end elevation showing an arrangement of several percussion-tables in combination.

"Referring first to Figs. 1, 2, 3, and 4, the liquid holding the minerals in suspension is supplied to the feeding-box A, which, according to this invention, instead of being stationary, as attached to the movable frame so as to move to and fro with it. From A the liquid passes over the distributing-table B on to the indiarubber band C. In order to cause the liquid to flow gradually on to C it is preferred to fix to the edge of B a strip of calico or other fabric, which rests loosely on, but in contact with C. To insure that the rubber band C shall retain its position upon the roller D, short strips of wood E are attached to its outer surface and placed in a row, so that as the band travels they pass along an inverted channel iron F, which is fixed above the table. The guide-rollers G under the table are recessed to allow passage of the strips E. The friction of the band C on the table may be reduced by making a number of diagonal cuts across the table H for the free passage of water supplied by a spout I and gutter J, so that there is a film of water interposed between band C and the table. Water flows on to the band C from the trough K by a pipe L extending diagonally across the table with a series of nozzles 1, 2, 3, 4, 5 for jets of water to remove adhesive matter from the rubber. The percussion action imparted in the usual way to the table separates the particles of mineral into several—usually three—different classes according to their respective gravities. The lightest collect on the band C, and are delivered by the hopper M into the receptical N, an intermediate product is delivered by P into Q, and the heavier by R into S.

"As shown by Fig. 5, six single tables are combined so as to constitute a compound machine, so arranged that the lower sets of the apparatus can be fed by gravity from the upper sets without requiring any manipulation of the material treated. Although six tables are shown in Fig. 5, obviously a greater or less number might be thus arranged.

"Assuming that there are only three—namely, the uppermost three as shown in Fig. 5, they may be worked as follows: The material fed to the uppermost table is separated into three classes, according to gravity as above described. The lightest may be allowed to flow to the table on the right, the intermediate quality to the table on the left, while the heaviest may be discharged as final products, or the products from each table may be discharged or treated in others of the table according to their character. The three tables are all connected to one motor, so as to work together.

"Having now partially described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is—

"1. In a percussion table, the herein-described means of guiding the travelling-band by strips of wood attached to its outer surface, and guided in a channel iron above.

"2. In a percussion table, attaching the feeding-boxes, jet-pipes, and distributing-table edged with fabric to the movable frame, substantially as described.

"3. The combination of three or more percussion tables arranged with communicating channels so as to constitute a compound machine for successive treatment of the material without requiring manipulation thereof, substantially as described.

"Dated this 16th day of October, 1890.

"Carl Lührig.
"John Charles Cunninghame."

"Certified to be a true copy—Whitaker and Russell, solicitors in New Zealand for the applicants."

Cyanogen Process for Extracting Gold and Silver.

This process has been used now in New Zealand for a considerable time with good success by the Cassell Company and also by the Sylvia. As will be seen by the results hereinbefore stated in connection with the treatment of the ore from the Sylvia Company's mine, it is certainly the most effective process yet introduced into this colony, and no doubt would be more generally used were it not for the prohibitive royalty the company exacts from those who erect one of their plants. But the question of extracting gold and silver by dissolving these metals in a cyanide solution is not confined altogether to the Cassell Company. Another patent right has been granted to W. D. Bohm for a different method of applying the cyanide solution, and, judging from an examination of his plans, Mr. Bohm's appliance is in some respects superior to the Cassell Company. It is stated by some mining men in the Thames that cyanide of potassium will not act effectually on some ores, especially on those containing a large percentage of iron and manganese, also on gold coated with oxides of these metals; but it has been clearly proved by the work already done by the Crown and Sylvia Companies at their works that there is nothing in this contention. The following interesting article appeared in the *Journal of the Chemical Society*, written by J. S. McArthur, the chief moving spirit in the Cassell Company:—

"*The Cyanide Process.—The McArthur-Forrest System of Gold Extraction.*"

"In order to understand the present systems of gold extraction, to properly appreciate the work already done, and to gauge the difficulties to be surmounted, it is necessary for us to look back and trace the connection between the known forms of gold as found in Nature and the methods used to separate it from its base environments.

"In the earliest ages gold would naturally only be found in nuggets and grains (our word carat is derived from a Persian word meaning a grain), which required no means of separation beyond picking up—happy age when gold had only to be picked up!

"From grains the ancient would come down to gold dust, and this was no doubt separated from the sand or earthy matter with which it was associated by the skilful use of air currents, which were caused to blow away the sand, leaving the precious metallic dust. This method is still practised in Arabia and the East. Wherever water was plentiful it was found that it did the required separation better and more economically than air, a method of separation which has been and still is in use everywhere all over the world. The prospector, digger, explorer, and even the tourist nowadays provides himself with a 'pan' in which to wash a sample of 'dirt' at the nearest stream. From the pan comes the 'cradle,' 'long tom,' and the innumerable mechanical arrangements for the separation of gold from earthy matters. Up to this point we have only mechanical means of separation which depend on the high specific gravity of gold compared with sand, clay, &c., but at this stage in the evolution of gold extraction we find the first move made towards a chemical method. When there was a lot of rich dirt in his pan, the digger found it very difficult to wash away the last of the sand without losing a large portion of the finely-divided gold, so he hit on the expedient of pouring in a little mercury, which formed a heavy massive though fluid alloy with the gold, making the separation of the last portions of the light granular sand a very easy matter. This plan is still in world-wide use alike by the solitary digger who lives in a lonely canyon, and by the well-organized company that "hydraulics" 1,000 tons of 'pay dirt' per day.

"Let us now look at the present state of the gold industry.

"Let us imagine a digger who has exhausted all the gravel and pay dirt in the canyon or gully; he travels up the gully looking to the right hand and to the left for traces of the precious metal; occasionally he finds a piece of gold-bearing rock, and is led on and on till he finds the source of these auriferous stones to be a reef. Now begins gold-mining proper. A shaft is sunk on the reef, or a tunnel driven into it, and great masses of rock are brought to the surface, and naturally the miner is led to imitate Nature by crushing this rock to a fine sand, and then he modifies the treatment formerly given to alluvial deposits, to adapt it to the new circumstances. The ore, immediately on being crushed to powder (which is generally done by huge gravitation stamps), is carried over an amalgamated copper plate by a stream of water. In passing over the amalgamated plate the gold is caught by the mercury, while the sand, now called tailings, is washed off. The gold is recovered by scraping the amalgam off the copper plate at stated intervals, generally once a month, when by distillation the mercury is recovered as well as the gold separated. If all the gold the ore contained existed in the heavy metallic form, the recovery by this method would be complete and the loss *nil;* but the tailings are frequently found to contain a little gold, and on close examination particles of pyrites and sulphides of the various base metals are found diffused through the mass.

When these metalliferous particles are separared from the mass of tailings, it is found that they principally contain the gold, so that it is now usual in practice to pass the tailings through some form of concentrating machinery, of which the well-known Frue vanner is a good example, whereby the pyrites and other sulphides are retained in virtue of their higher specific gravity and the sand washed away. The rich proportion now called 'concentrates' may contain up to 20oz. of gold per ton, though 4oz. or 5oz. is much nearer the average figure.

"If the concentrates are examined closely, even microscopically, no free gold can be distinguished, and if they be treated with mercury, they will yield to it little or none of their gold contents. Sometimes a considerable portion of gold may be got from them by a long-continued grinding in cast-iron pans in presence of mercury. This grinding seems to force the sulphur and base metals, as well as the gold, into combination with the mercury, so that the bullion got from the amalgam often contains over 95 per cent. of copper, lead, and other base metals, while there is a corresponding loss of mercury which is carried away partly as sulphide and partly in a 'floured state.' The flouring is caused by the small globules of mercury being coated with a film of sulphide of mercury, which prevents the particles coalescing. Thus there is a double loss—chemical, by the formation of sulphide of mercury, and mechanical by flouring. This loss is so well known that concentrates are only treated by this form of amalgamation in localities where Nature forbids any more elaborate process. Sometimes the amount of loss may be lessened by roasting the concentrates before amalgamation, but this is by no means a perfect remedy, as the roasting removes only volatile constituents of the concentrates, principally sulphur, while the base metals—lead, zinc, &c.—are left in the form of oxide to oxidise and waste their equivalent of mercury. Attempts have also been made to decrease the loss of mercury and increase the yield of gold by adding to the contents of the pan all sorts of chemicals to 'doctor' the 'sickened'—that is, floured mercury. These chemicals are generally mixtures of sulphate of iron, sulphate of copper, salt, lime, soda, &c. This kind of 'doctoring' may be effective in some cases, but it is seldom practised with intelligence. Where the percentage of concentrates is limited, and where there are a number of mines, it is common for some enterprising man to set up a smelting or chlorination work which is made large enough to deal with the concentrates of the district.

"I will not take time to describe the various processes of smelting, nor could it be done at any evening sederunt; but we may bear in mind that all smelting processes end in alloying the gold with lead, and cupelling in the usual way, with which we are all familiar. Because of the obvious impracticability of smelting, requiring well-built brick furnaces, coals, fluxes, &c., at the typical gold-mine high up on the mountain range, possibly near or beyond the timber-line, chlorination is much more commonly practised, and consequently merits a full description. In giving this description I will confine myself chiefly to the old standard Plattner process as I have seen it practised in California, where timber is abundant and cheap.

"The first and essential operation prior to chlorination proper is roasting. It is obvious that a mixture of sulphides and arsenides of iron, copper, lead, zinc, and metals generally will absorb an almost unlimited amount of chlorine, so that the small proportion of gold present would fare badly in a general scramble of the molecules for chlorine. That the metals may have the least opportunity to combine with chlorine, the sulphur is expelled, and their affinities satisfied as far as possible with oxygen by roasting. The roasting is generally done in a large reverberatory furnace, that has no very noteworthy feature in its construction. The concentrates are charged into the furnace at the cold end, heated very gradually, continually stirred and slowly worked forward into the hottest part, care being taken to admit air freely during the whole operation. Where chlorination is practised on the most extensive scale this roasting generally takes about twenty-four hours, and consumes from a minimum of half a cord to a cord of wood per ton roasted. (A cord of wood gives about as much heat as a ton of coal.) It is a common saying that the success of chlorination depends more on the furnace-man than on the chlorinator, and on looking into hard chemical facts we find that this is really the case, for if only $\frac{1}{2}$ per cent. of iron were left unoxidized it would absorb nearly 1 per cent. of chlorine, equal to about 3 per cent. of bleaching-powder, and all this before the gold gets a single molecule of chlorine. Towards the end of the roasting, and about fifteen or thirty minutes before the ore is discharged from the furnace, it is usual to stir in a small proportion of common salt. The object of this is to satisfy with chlorine, as far as possible, copper, zinc, and other metals whose oxides have a tendency to form chlorides when they get chloride presented to them in the free state. This chloridizing device is, however, only partially effective, as the chlorides formed are apt to be immediately decomposed under the influence of hot air, and in the case of lead the oxide of sulphate will not combine with chlorine in the furnace, but combines with it readily when offered moist and at the ordinary atmosphere temperature,

"The roasted and oxidized ore is now sprinkled with water to make it slightly moist, and is then charged into a wooden vat having a perforated false bottom. The chlorine, generated at an outside source, is led in between the true and false bottom, and gradually permeates upward through the mass of the porous ore. The small amount of water held by the ore then becomes a saturated solution of chlorine, which gradually acts on the gold, so that in the course of one or two days it may be washed out as the soluble chloride by a further amount of water. This weak solution of chloride of gold is run into a tank, a solution of ferrous sulphate added, precipitate of gold allowed to settle for forty-eight hours, if possible, and the supernatent solution allowed to flow off. When sufficient gold precipitate has accumulated, it is collected and run into bars. Besides the Plattner form of chlorination which I have described, there are others which vary from Plattner and among themselves in the manner of application of the chlorine—most of them using revolving barrels instead of open vats for the chlorination proper. The best known of these are: The Mear's process, where chlorine is used under its own gaseous pressure; the Newbery-Vautin, where air-pressure is used; the Pollok, recently described before this section of the society, where hydraulic-pressure is used; and the Thies, where the chlorination is done in a barrel without any pressure.

"Let us now return to the mine. The deeper we sink down into the reef we find that while the richness of the ore may remain constant, the proportion of free gold—that is, amalgamable gold, becomes smaller and smaller, while the proportion of gold-bearing sulphides becomes greater and greater till we come to the water level, where it often happens that the free gold leaves entirely and becomes wholly refractory—that is, non-amalgamable. The water level is generally regarded as the point where the atmospheric and weather influences cease, and that down to that point the rain-water has penetrated and gradually washed away the oxidisable base metals, leaving the inert gold in the crevices of the equally inert quartz, whereas the ore found below the water level, not having been subjected to oxidising influences, retains all its metals untouched and unchanged.

"An interesting problem now presents itself: An ore consisting of a complex mixture of silica and the various compounds of iron, copper, lead, zinc, antimony, arsenic, and sulphur (for convenience I will include all these compounds under the general term sulphides), and gold in the proportion of 10,000 parts of silica and sulphides to one part of gold, is very much richer than the average auriferous ore, and the question is, how can we best separate the one from the 10,000? Under favourable circumstances, the gold and the useful metals may be recovered by smelting, but these favourable circumstances, which are proximity of the gold-mine to coal, clay, limestone, and other fluxes, are quite exceptional, as auriferous reefs are generally found in primary formations. As before implied, chlorination is frequently inapplicable—no attempt is ever made to chlorinate gold-ore containing an appreciable qnantity oi lead—and where applicable is always troublesome and never cheap. When this question presented itself to Dr. Forrest and myself, we tried to find some solvent which, unlike chlorine and mercury, would have a stronger affinity for gold than for sulphides. Acting on this principle, we drew out a list of all probable or possible solvents fulfilling this condition. This list included cyanides, and we found that these salts solved the problem.

"Our experiments were conducted first on a small scale, and on ores of all kinds and from all mines in all parts of the world. The result of these small trials was so satisfactory that we gradually worked from less to more, and in no long time larger quantities were worked, and now the process is in, or on the eve of being put in, operation in all quarters of the globe. I have now much pleasure in describing the method of working most generally applicable. The ore is ground to about the fineness of sea-sand. If, instead of ore, we are working tailings from the amalgamation process, these are generally not reground, but treated as delivered. The finely-divided material is mixed with a solution of cyanide, say cyanide of potassium, containing on an average 0·4 per cent. of cyanogen as the cyanide of potassium or other alkali or alkaline earth. The ore and solution are stirred together for about six hours, more or less, this being the average time required to dissolve the gold; in practice the time required is determined by direct experiment. When the gold is known to be dissolved, the pulp is discharged into an ordinary filtering-tank, where the filtration may, if necessary, be assisted by suction, and where the ore is washed by water or by the waste cyanide solution from a previous operation. The ore, after treatment with cyanide solution, is unchanged to the eye, as almost nothing but the imperceptible proportion of gold present has been removed. The gold now being in solution, the next object is to get it precipitated, and here we encounter a serious difficulty. Gold and cyanogen have such a strong mutual affinity, that it is difficult to get any substance that will separate them. The gold cannot be precipitated by any ordinary method, such as the use of ferrous sulphate or oxalic acid; even sulphuretted hydrogen and sulphide of sodium will not precipitate gold from its cyanide solution, though they precipitate silver. On referring to books on electro-gilding, we got no assistance, as the invariable method given for the recovery of gold from cyanide solutions was, evaporate to dryness and fuse the residue. We had noticed, however, by experiment, that zinc precipitated gold very feebly, and tried this in the same way that copper is precipitated from its ordinary solutions by scrap iron, but scrap zinc had no effect; then granulated zinc was tried, with a most imperfect and disappointing result; then heating in presence of scrap and granulated zinc; but this had only the effect of forming urea, and assisting the precipitation very little indeed. Further, we tried zinc dust, but still there was no success; finally, we prepared some zinc in a form like sawdust, porous, and with a large surface of bright metal. On allowing the cyanide of gold solution to trickle through a mass of the zinc, we found that it trickled out gold free, and better still, we found that the action became more vigorous and pronounced after a portion of the gold had been precipitated on it, doubtless as gold and zinc formed together a more powerful electro-chemical precipitant than zinc by itself. An arrangement of a porous mass of zinc like a sponge formed a chemical filter, which at once precipitated and collected the precious metal; indeed, so like an ordinary water-purifying device was this zinc filter, that many non-technical visitors formed and held tenaciously to the idea that the gold was in suspension in the cyanide solution, and the zinc was used merely because of its durability.

"Improvements in detail were made in the direction of increasing the surface and decreasing the weight of the zinc, till now we have it in threads, 1lb. of which occupies about 2gal. measure. The zinc in this form is possessed of enormous chemical activity, of which the strongest and most direct evidence is the fact that it burns in the air like thin shavings of wood. When the gold has been deposited, it is necessary to separate it from the excess of zinc present. The filiform structure of the zinc, and the exceedingly fine powder, as which the gold is deposited, render this an easy matter. The filiform mass of zinc with gold powder adhering is vigorously shaken in water, when the gold falls off and the fibrous particles of the zinc may be collected in a sieve. The gold settles easily, is collected, and fused directly into bullion.

"Having now described the chief points in the process from the technical standpoint, let us look at the purely chemical aspect it presents. Reference has already been made to the fact that a cyanide solution acts on the gold in ores in preference to the sulphides of base metals with which it may be combined or associated. This selective action is the keystone of the whole process. It is known that metallic gold is dissolved by a cyanide. It is also known that sulphides of copper, zinc, and iron artifically prepared are readily acted on by a cyanide solution, but we found a very

different state of affairs in treating ores where these or similar compounds exist prepared by the hand of Nature herself. Nature seems to render the base-metallic compounds insoluble, while the gold combined with or contained in them is more easily acted on than the metal itself. This at once raises the question: How does gold exist in base refractory ores; is it combined or free? This question, I admit, I cannot answer satisfactorily to myself. Judging from theoretical considerations only, I think gold should exist almost invariably in the free state, for, if we assume that sulphides, pyrites, &c., were formed by deposition from aqueous solution, the gold would be deposited in the metallic state. This may be shown by dropping some powdered pyrites into a solution of chloride of gold, when gold will be precipitated as metal; on the other hand, let us assume that the pyritous formations carrying gold were formed by igneous agency; in this case the gold ought to be metallic too, because any sulphide of gold already existing would be decomposed by the high temperature, and of course sulphide of gold cannot be formed at a high temperature. It is true that sulphide of gold may combine with any alkaline sulphide and resist decomposition by heat, but such a combination as a matter of fact does not occur in Nature. Telluride of gold, and, I think, antimonide of gold are not decomposed by heat, but they occur in small quantities only and do not affect the general argument. In spite of these theoretical considerations, however, we have strong evidence to show that gold exists in several different states of combination or molecular structure.

"Let me give one case in illustration. A sample of tailings from the ordinary process of stamping and amalgamation was received, and I think it may safely be assumed that the mercury had extracted some gold from the ore which produced these tailings. We treated the finely-ground tailings by alkaline solution of bromine, which extracted a considerable portion of gold, and the bromine treatment was repeated time after time till it ceased to extract gold; then it was treated with a hot solution of ferric bromide, which yielded a further quantity of gold. This treatment was repeated time after time till it ceased to extract gold, and finally the residue of tailings were smelted and a still further quantity of gold produced. As this ore yielded its gold in stages to the four different processes of amalgamation, treatment with bromine, treatment with ferric bromide and smelting, we infer that the gold existed in four different states, mechanical or chemical. Notwithstanding the complex nature of these tailings, which consisted of all sorts of sulphides with the four-fold gold, the cyanide acted on it, almost perfectly extracting 93 per cent. of the precious metal, whilst the higher extraction by any of the bromination methods was about 40 to 50 per cent. The cyanogen seemed to have an affinity for gold, and a power of penetration so much stronger than mercury of bromine, that it broke through barriers impregnable to them and captured the gold.

"Elsner has stated metallic gold dissolves in cyanide of potassium only in presence of oxygen. Not having seen the original account of Elsner's researches, I am not in the position to criticize his experiments, but I never could find that the presence of oxygen was necessary either to dissolve gold by itself or from ores by cyanide. If a piece of gold be immersed in a cyanide solution so that air to act on it would have to penetrate 2in. or 3in. of the solution, the gold will dissolve in its usual slow and steady fashion. The equation shows that either oxygen must be absorbed or hydrogen evolved. I have seen no evidence of the former, and can adduce no proof for the latter, but I think the latter the more probable, because I cannot conceive oxygen penetrating even a film of cyanide solution without at once oxidizing the cyanide to cyanate, whereas in the other case, as suggested to me by my friend Mr. Ellis, the nascent hydrogen may be at once seized by the excess of cyanide present and ammoniacal compounds formed. However, we do not concern ourselves much with the reactions of pure gold, but as a matter of fact we cannot find that oxygen plays any part in the cyanide extraction of gold from ores. We have treated an ore with cyanide with free access of air, and then a parallel experiment was done with boiled water, the bottle filled to the stopper with solution and ore, and the stopper sealed. The extraction was the same in both cases.

"We have so far only considered ores which are refractory from chemical as well as mechanical causes, but ores are frequently found in which the gold is refractory from a purely mechanical cause, which is the extremely fine division of the gold. The cyanide process is quite as applicable to this class of ore as any other. These ores are generally spongy and absorbent, and this, we find, enables us to dispense with stirring the ore and cyanide solution together, the same end being accomplished by allowing this cyanide solution to percolate slowly through the mass—a clear saving in power.

"The advantages claimed for the cyanide process over smelting and chlorination are: As compared with smelting, it requires no furnaces and no coal, and no fluxes, and thus may be used successfully in remote situations where smelting is utterly impossible. As compared with chlorination, cyanide process involves no roasting, therefore no furnaces and no fuel. Moreover, by the cyanide process, ores containing lead, zinc, or earthy carbonates, which cannot be worked to profit by chlorination, may be easily and profitably treated as any other. For chlorination, about 7 per cent. of the weight of the ore to be treated often has to be carried to the ore in the form of bleaching powder, say, 1½ per cent., bisulphate of soda 2 per cent., and sulphate of iron 2½ per cent., with packing, say, of 1 per cent., whereas about 1 per cent. of the ore to be treated will cover the weight of the necessary cyanide, zinc, and packing. Thus, by chlorination, one ton of chemicals will treat only about fourteen tons, whereas by the cyanide method one ton will treat one hundred tons. Moreover, chlorination does not extract any silver, but by the cyanide method the most of the silver—invariably associated with gold in ore—is extracted along with the latter metal at the same operation. For the sake of simplicity, I have not named silver in the body of this paper, but the remarks made in reference to gold generally apply to the silver associated with it.

"From what I have seen of gold mines and gold-mining in the Sierra Nevada, in the Rocky Mountains, in the Southern States of America, in Nova Scotia, from the many kinds of ore I have seen from all parts of the world, and from what I know of the selective and energetic action of cyanides, I confidently predict that cyanide of potassium, hitherto used only to polish amalgamated

plates, will take a front rank as chief agent in gold extraction."—J. S. McArthur, in *Journal of the Society of Chemical Industry*.

Bohm's Cyanide Process.

Mr. Bohm is at present engaged in erecting a plant at the Waihi Company's works at Waihi. Cyanide of potassium is used in combination with sodium salt. Indeed, the solvent may be said to be the same as that used by the Cassell Company, but the application is entirely different with regard to the filtration process. Mr. Bohm proposes to use a vertical cast-iron cylinder, hung on trunnions in the centre, having a filter at both ends, so that when the material settles in too compact a mass for the solution to percolate through, the cylinder can be turned upside down. The solution is also forced upwards instead of being put on top of the ore in large vats as in the case of the Cassell process.

The same gentleman has also patented a hydraulic chlorination plant for gold-ores which is similar to the plant he uses in leaching. A description of both processes by Mr W. D. Bohm, M.R.I.F.C.S., together with plans showing the plant and arrangements, were handed me by that gentleman. The plans are annexed hereto to illustrate the following description:—

"*Cyanide Plant.*

"Fig. 1 represents a sectional elevation of plant, and fig. 3 a plan in which the vessel *A*, which is made in various sizes, capable of holding ten to twenty tons of concentrates, represents the leaching vat. The powdered ore is placed in this vessel, the cover *a* being removed by means of the screew tackle a^1, and run on one side along the beam a^2, and the solution of cyanide, or other solvent, is withdrawn from the tank B^1, in which it is prepared, and forced by the pump *C* through the pipe c^1 into the lower end of the vat. After passing through the ore the solution overflows, and is conducted by the pipe c^2 back into tank B^1; a constant circulation being maintained in this way until the precious metals are in solution.

"The suction-pipe c^1 of the pump *C* is then withdrawn from the tank B^1, and connected with a water supply, and sufficient water is forced through the ore-vessel to wash out the precious solution. The strongest portion of this solution is run into tank B^1, and the washings into tank B^2.

"Fig. 2 shows a section of the filter-vat with its removable covers *a*, and filters a^3, and supply- and overflow-pipes running into the plug b^1 of the hollow trunnion *b*, which is so arranged that on reversing the vessel by means of the worm and worm wheel b^3, the plug b^1 remains stationary, and a continuous upward flow of the solution still continues, but in the opposite direction in the ore vat, so that the filter which was uppermost, the working filter, is now undermost, and receives the solution on its opposite side, causing it to be washed free of slimes, while the filter taking its place offers a free and clear surface which will not tend to choke for some time. Once or twice reversing during one treatment is generally sufficient to insure the rapid working of one charge of difficult ore.

"Directly the solution begins to run into tank B^1 it is allowed to flow off through the pipe *d* into the precipitators *E*, and from thence into the tank F^1, from which it is returned to the tank B^1 by the pump *D*, through the pipes *e*, passing on its way through the filter *H*, which retains any portions of precipitated bullion which might be carried in suspension by the solution.

"While the washing of the ore is finished and the exhausted charge being tipped out and replaced by a fresh one, the solution in B^1 is tested and made up to round normal for re-use, an apparatus *K* being fitted up in the bullion-room for that purpose. The washings after passing through the precipitator are pumped back to B^2, and employed in the place of water for the subsequent charges.

"The bullion is washed off the metallic precipitant in the revolving screen *C* in water, and the product subsequently treated by heat in a reducing atmosphere, and washed and melted. Any waste or redundant solution or washings are run into the storage tank *I*, and are subsequently allowed to percolate through the poor-ore tank *J*, and its precipitator J^1, and thence run to waste.

"The poor ore or mullock is tipped into the vessel *J*, which is fitted with a permeable false bottom *L*, the flow of solution being regulated by the combined float and spreader *M*, so that no attention is required for this tank until the charge is finished, then, by opening the hinged end *N*, and turning down the removable block *O*, the tank can be discha;ged by allowing it to tip forward, the speed being controlled by the differential pullies *P*.

"The chief characteristics of this hydraulic-leaching plant are extreme rapidity and economy of working. Ores which are impermeable by the old percolation method may be treated with comparative ease, and very little power is required to effect this. No further handling of the ore is necessary after it has once been placed in the filter-vat, and the expense of power necessary for driving heavy mining apparatus is obviated.

"*Hydraulic Chlorination Plant.*

"Fig. 1 represents a portion of a plan of a 6-vat chlorination plant, and Fig. 2 a sectional elevation of a vat with its connections.

"The crushed roasted concentrates or other ore are mixed with a proper proportion of chloride of calcium, and charged into the vat *A*, its cover being removed, or the ore may be placed on top of the calcium chloride, a layer of ore being first put on the lower filter cloth at *b*, to preserve it. An acid solution is then forced through the mixture by the pump *D* through pipe *d*, until it overflows through *e* into the tub *B*; the resulting chlorine solution is then circulated by means of the pump until all the gold is in solution, the overflowing solution is filtered at *a* by a cloth stretched over concentric grooves with radial channels cut in wood, the height of the solution in the barrel *B* being maintained above the dipping end of pipe *e*. The vessel *E* contains the supply of acid, and is so arranged that a measured quantity can be drawn off. Pipe *F* connects with the acid-main, and pipe G with the water-main.

"As soon as the gold is dissolved the circulation is stopped, the pinchcock *h* closed, and the pinchcock *g* opened; fresh water being run into the vessel *B* from *G*, and forced through the ore-vat for the purpose of washing out the auriferous solution into the tank *C*, from whence it is allowed to flow directly through the precipitators H^1, H^2, and H^3, where a reaction takes place, resulting in the deposition of the gold in a metallic state, the precipitant—a complex sulphide—being recovered as to certain portions of its metallic constituents in the vessel *J*.

"In Fig. 4 the precipitator is shown in detail on an enlarged scale. It is so arranged that the vessels 1, 2, and 3, which have perforated bottoms and are filled with precipitant, may be so forced together by the screw *h* as to make good joints with the rubber-rings *i*, the solution rising through the vessels and overflowing at *j*. By means of the hinged pieces *k* attached to the movable top, the vessels 2 and 3 may be raised from off the vessel *l*, so that it may be removed when fully charged; after being refilled with precipitant it is placed topmost of the series. By this means the lowermost filter is always worked out, and very little washing of the recovered gold is necessary before melting. The ore-vessel is discharged by unbolting the bottom A^1, which may be opened or closed by means of the worm A^3 working in the worm wheel quadrant A^4.

"The most argillaceous ores or slimes may be easily treated by this method; large quantities may be dealt with at a time; very little handling of the ore is necessary, and no noxious fumes escape to injure the workmen. Great advantages are found to accrue from maintaining the chlorine in solution under pressure. By means of the new precipitant rapid and complete precipitation of the gold is obtained."

The following are the specifications on which Mr. Bohm holds his patent rights, which will show more clearly what he claims. The plans referred to in the specifications are not annexed, as the other plan referred to in the foregoing specification will be sufficient to give an idea of the principle on which the extraction of gold and silver is effected:—

"Specification.—Leaching Plant.

"*Improvements in and Apparatus for the Separation of Gold and Silver, or either of them, from Ores or Materials containing them.*

"I, William Dunsmore Bohm, of 5, Cumberland Villa, Chiswick, in the County of Middlesex, England, metallurgical chemist and engineer, do hereby declare the nature of my invention for 'Improvements in and Apparatus for the Separation of Gold and Silver, or either of them, from Ores or Materials containing them,' and in what manner the same is to be performed, to be particularly described in and by the following statement:—

"My invention has for its object to provide means, as hereinafter described, whereby gold and silver, or either of them, can be obtained very economically, conveniently, and efficiently from ores or materials containing them.

"In the process according to my invention, the ore or material to be treated (which need not be previously roasted, although it may be roasted if desired) is placed in a vat, and the leaching-solution is forced upwards through the ore or material (I will refer to it as ore), and through a filter at the upper part of the vat. In order to keep the filter of the leaching-vat clear without interrupting working to cleanse it, I, according to my present invention, provide a reversible vat with a filter at each end, the said vat being mounted so that it can be reversed to alternately reverse the positions of the filters as hereinafter more fully explained. In this reversible vat I may use any preferred leaching-solution, but I prefer one consisting of a solution in water of cyanide of potassium and carbonate of sodium or chloride of sodium, or both. Suitable proportions are one part of cyanide of potassium, containing 30 per cent. of cyanogen, to one-eighth of one part of carbonate or chloride of sodium (or both) to one hundred parts of water, but such proportions may vary with the value of the ore under treatment. The precipitating agent I prefer to employ for treating the solution after it leaves the vat is an alloy of zinc with an electro-positive metal, such as metallic sodium or potassium.

"I will particularly describe my invention with reference to the accompanying drawing, Figure 1 of which represents in plan an arrangement of apparatus suitable for use in carrying my said invention into effect. Figure 2 is an elevation partly in section of the same. Figure 3 shows two leaching-vats arranged side by side, one of the said vats being shown in section and of different proportions to the other vat; and Figure 4 is a longitudinal section of one of the trunnions of the leaching-vats drawn to an enlarged scale, showing passages for the ingress and egress of the liquor. I do not, however, limit myself to the precise form or details of apparatus shown, nor do I limit myself to the use of two vats, as one, two, or more may be used as desired, nor do I limit myself to the use of my improved apparatus with the particular chemical agents specified.

"When more than one leaching-vat is employed they may be all worked simultaneously if desired, or they may be worked alternately; so that, while one vat or several vats is or are being discharged and recharged with ore, the other vat or other vats may be in operation, whereby the process may be carried on continuously. I will describe my process with reference to one of the vats, it being understood that the like process is carried on with reference to the other vat or vats.

"Each vat AA^2 is provided at each of its opposite ends with a filter BB^2, which may consist of any suitable material, such as iron-wire netting, or of teak wood having grooves *a* in its inner face, and perforated with holes *b* situated in the grooves, and covered with filter-cloth b^2. These discs are secured by screws or other convenient means to the covers CC^2, there being spaces d^4d^5 between the disc and the covers, with which spaces the pipes ee^2 communicate. Through these pipes the leaching liquor passes to and from the vat. The outlets from these pipes into the said spaces are covered by perforated plates or roses ff^2, to cause the inflowing solution to spread evenly throughout the spaces d^4d^5. The said pipes ee^2 are fixed to the covers CC^2, so that they can be removed with the covers when detached for the purpose of charging the vats with the ore to be treated. The said covers may be secured to the body of the vat by bolts and nuts, secured in notches formed in flanges

provided on the covers CC^2 and the body A, so as to permit of the bolts being readily removed and replaced and the covers detached and fixed, rings of india-rubber or other suitable packing-rings g being interposed between the flanges to render the joints fluid-tight. The pipes ee^2 in the covers CC^2 communicate (when the covers are fixed in position on the body of the vat) by passages ii^2 in the flanges h with pipes kk^2 connected to one of the trunnions on which the vat turns. This trunnion, as shown in the enlarged section Figure 4, consists of two parts DD^2, the part D being fixed to the vat A and fitted to turn on the part D^2, which is held stationary by the bracket k^3, through which pass the pipes mm^2 entering the part D^2. The trunnions D, E, are mounted in bearings F carried on standards G, at a suitable height to admit of the vat being turned upon its trunnions. The part D of the trunnion shown in Figure 4 is provided with passages dd^1, with which the pipes kk^2 communicate, and in the part D^2 of the trunnion are passages d^2d^3 which communicate with the passages dd^1. Into the passages d^2d^3 are screwed pipes mm^2, which pass through a gland l fitted into the outer end of the part D. To the outer end of the pipe m^2 is secured a tube p^2 leading to the delivery end of a force-pump N or other device, by means of which the leaching liquor can be forced into the vat A. A pipe p is connected to the pipe m communicating with the vat containing the solution. The vat A being charged with the ore to be treated, leaching liquor is forced upward through the said vat by the pump N, the said liquor being conducted by the pipes p^2 and m^2 and passage d^3 in the part D^2 of the trunnion into the passage d^1, and by the pipe k connected to the part D of the trunnion, and to the pipe e fixed to the cover C of the vat. The liquor enters the space d^4 between the cover C and the filter B, and passes thence through the filter B and upward through the ore in the vat. It then passes through the upper filter B^2 into the space D^5 between the said filter and the cover C^2, and out therefrom by the pipe e^2 into the pipe p^2, by which it is conducted into the passage d in the part D of the trunnion, and passes thence by the passage d^2 and pipe m in the part D^2 of the trunnion into the pipe p, by which it can be conducted back to the vessel Q from which it was drawn.

"An upwardly-forced circulation of the leaching-solution through the ore contained in the vat A is thus effected, and this circulation may be maintained for any desired length of time. After a time the vat A may be turned on its trunnions upside down so as to reverse the passages; the passage d in the part D of the trunnion then communicating with the passage d^3 in the part D^2, and the passage d^1 in the part D communicating with the passage d^2 in the part D^2. The liquor passes through the ore in the same direction as before, but as the filter B^2 which is shown in the drawing uppermost is now lowermost, and the filter B which is shown lowermost is now uppermost, a clear, or comparatively clear, filter is presented at top, and the lower filter becomes clear of matter which may have clogged it.

"The turning or reversing of the vat A may be effected by a pulley on an extension of its trunnion, or by any other suitable means; for instance, as shown, by means of a worm-wheel E^3 fast on the trunion E of the vat, with which worm-wheel gears a worm H on a spindle carried in bearings I.

"The spindle of the worm H may be provided with a hand-wheel or a pulley, to which power is applied, by means of which the worm H may be rotated, and, through the wheel E^3, give a semi-rotation to the vat as required. For raising the lids or covers CC^2 when unfastened from the body A, I may use an overhead crane, or the like, attached to eyes in the cover by chains, so as to raise the cover from the body, and then the crane, together with the cover, may be run along rails from over the body A; or I may use a device like a ship's davits to swing between two vats. To insure the covers being properly placed in position, they may be provided with projections which enter sockets formed in or attached to the body A of the vat.

"The solution of cyanide of potassium and of sodium salt, or of cyanide of potassium alone, is first mixed in a vessel such as is shown at Q, and the pump draws it therefrom and passes it at greater atmospheric pressure into the ore-vat, through the inlet under the lowermost filter, and up through the ore in the vat, and maintains a circulation of the solution through the vat for any desired time, as hereinbefore explained.

"The circulation of the solution is continued until the precious metals are in solution, and then the pipe p, being connected to the precipitator R, the solution containing the said metals is forced from the vat A, and passed upwards through the precipitator R, which contains an alloy of zinc, with any suitable electro-positive metal (such as sodium or potassium), cut into shavings, or otherwise divided. A suitable alloy consists of zinc, with about $2\frac{1}{2}$ per cent. of sodium, and a trace of cadmium may be added to the alloy if desired. The precipitator shown consists of a vessel with an inlet at bottom and a filter R^2 at the upper part, above which is the outlet R^3. The said solution may be caused to circulate any desired number of times through the precipitator by connecting the suction-pipe of a pump to the outlet R^3, and the delivery of the said pump to the pipe p. The solution is passed away from the precipitator by the outlet pipe R^3 for regeneration and re-use if desirable, the precious metals having been taken up by the alloy, from which it may be obtained in any suitable or well-known way. After the solution has been drawn from the vat A, water may be passed (preferably upwards) through the ore in the vat to wash it of all remaining traces of chemicals and metal, and this water is passed through the precipitator to obtain the metal.

"The vat A^2 is worked in a similar manner to that hereinbefore described with reference to the vat A, a separate pump N^2 being preferably provided as shown, and may then be run away to any suitable place by the pipe R^3. The aforesaid operations are repeated with each charge of ore.

"To obtain the gold from the zinc-alloy the said zinc-alloy, which has become coated with gold, is introduced into the cylinder S, which has a periphery of wire-netting, or the like (fine enough to prevent the passage of the particles of zinc-alloy). The said cylinder S is revolved in water contained in the vessel T, until, by friction of the particles, the precious metals fall through the periphery of the cylinder S into the bottom of the vessel T, and from it they are collected and melted down.

"The precipitator R is preferably mounted on trunnions and bearings R^4, so that its contents (when the top is removed) can be readily tipped into the washer S, which has a cover S^2 which is opened for charging. Or I may heat the zinc and gold in a closed vessel until the zinc has passed off in the form of vapour, and so recover the precious metal.

"If, instead of using the agents hereinbefore mentioned for chlorinating, the vat should be lined with an acid-resisting material, or, with the exception of the covers, be built of wood, and chloride of lime having been mixed with the ore, and the mixture introduced into the vat, a solution is then prepared of chloride of sodium in water of a density of preferably 1,150 (water being reckoned at 1,000), and sulphuric or hydrochloric acid is added at intervals to decompose the chloride of lime and free chlorine, for the purpose of dissolving the gold, or the acid may be used without the salt.

"The solution will then be circulated through the mixture in the vat as hereinbefore described, until the gold is dissolved, when the solution, charged with gold, may be passed through the precipitator, which in this case may contain copper-sulphide, or the gold may be obtained in any usual or suitable way for obtaining it from such solution.

"Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is,—

"1. For the purpose described, the employment of a leaching-solution of, or containing, cyanide of potassium and carbonate of sodium, or chloride of sodium (or both), substantially as hereinbefore described.

"2. For the purpose described, the employment of a leaching solution of, or containing, cyanide of potassium, acid carbonate, or chloride of sodium (or both), as described, the liquid from the leaching-operation being passed through zinc alloyed with an electro-positive metal, such as sodium or potassium, as hereinbefore described.

"3. The obtainment of gold or silver, or both, from solutions thereof by passing the solution in contact with shavings or particles of an alloy of zinc with an electro-positive metal such as sodium or potassium.

"4. For the separation of gold or silver, or both, from ores or materials containing them, the mixture with the ore or materials of chloride of lime, and then forcing upwardly through the mixture an acid leaching-solution, whether containing chloride of sodium or not, substantially as hereinbefore described.

"5. In appartus for effecting the leaching by upward filtration of ores, or materials containing gold or silver, or both, a leaching-vat or vessel with a filter at each end, and capable of being reversed so that either filter can be brought uppermost, substantially as hereinbefore described.

"6. A leaching-vat having a filter at each end, and capable of being turned upon trunnions, or in bearings in which are the passage, for the solution, so that the inlets and outlets to and from the vat are reversed at the same time that the vat is reversed, substantially as hereinbefore described.

"7. A leaching-vat, constructed and arranged substantially as hereinbefore described, and shown in the accompanying drawing.

"8. For the purpose described, the arrangement and combination of parts as a whole, constituting the apparatus hereinbefore described, and illustrated in the accompanying drawing.

"Dated this 15th day of December, 1891.

"W. D. Bohm."

"I certify this to be a true copy.—W. D. Bohm."

"Specification.—Chlorination Plant.

"*Improvements in the Separation of Gold and Silver from Ores or Materials containing them.*

"I, William Dunsmore Bohm, of 51, The Avenue, Acton, in the County of Middlesex, England, Metallurgical Chemist and Engineer, do hereby declare the nature of my invention for 'Improvements in the separation of gold and silver from ores or materials containing them,' and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

"My invention has for its object to provide means whereby gold or silver or both are obtained from ores or materials containing them in a more ready, perfect, and efficient manner than hitherto, and my said invention has reference more particularly to a leaching-process such as that known as the 'Hungarian process.'

"According to the said Hungarian process the ground ores or materials after being roasted with chloride of sodium, and with added copper-pyrites or sulphide of copper (if copper be not present in sufficient quantity in the ore or material), are treated with a solution of chloride of sodium and chloride of copper in water, which is caused to percolate through the ore or material, the proportion of chloride of sodium being usually sufficient to make a solution of 1,150 density, reckoning water at 1,000, and the chloride of copper being added as a strong solution usually in about the proportion of not more than 1 per cent. of the chloride of sodium solution. The liquid is conducted into vessels in which the gold and silver are precipitated by means of a solution of oxide of calcium and sulphur with or without chloride of sodium. When precipitation has taken place the supernatant liquor is run off for re-use.

"According to my invention, in carrying out the process I add to the aforesaid leaching-solution hydrochloric acid or bromine, or both, as hereinafter described, before the solution is passed through the ore or material, and afterwards. I treat the solution after it comes from the leaching-vats with a precipitant. I filter the solution and separate the precipitate and the solution which passes through the filter. I bring up to its normal working strength by the addition of fresh quantities of the aforesaid components of the leaching solution, and again pass it through the leaching-vats, and so on. I preferably heat the solution before it is used in the leaching-vats. I find in most cases one part of bromine (added gradually to the solution as it circulates) to each

two thousand parts of the ore or material under treatment sufficient, but in dealing with some ores or materials which are very rich in finely divided gold it is advantageous to increase the quantity of bromine, for instance, to as much as one part of bromine to each one hundred parts of the ore or material under treatment. The acid should be added in such quantity as to make the solution just sufficiently acid to react on test-paper. The heating of the solution, if it is to be used in a heated condition for leaching, may be effected in any suitable way; for example, by passing the solution through a chamber surrounded by a hot-water jacket or having it in a coil, and the water supplied to this jacket or coil may be heated by the roasting-furnace, or by other suitable means. The solution is passed through the divided ore or material, preferably by means of a force-pump, and in an upward direction in a vat having a filter at the top. The liquid from the leaching-vat is then passed into a precipitating-vessel in which it is agitated with a precipitant, which I prefer to be sulphide of sodium, in quantity sufficient to throw down the greater part of the gold and silver from the solution, copper being left in solution. The quantity of sulphide of sodium should therefore be in accordance with the amount of precious metal in solution, and the quantity necessary can be ascertained by taking a sample of the solution with the precipitate in suspension, filtering and testing the filtrate with ammonia for the presence of copper. If the test shows that the copper of the leaching-solution has been thrown down, the quantity of precipitant must be lessened until the test indicates that the solution retains its normal amount of copper. The liquid is then by preference forced up through a filter for the purpose of collecting the precipitate, and the solution which passes from the filter is strengthened for re-use in the leaching-vats by the addition of hydrochloric acid and bromine, or either of them, and is again passed to the leaching-vats, being first (if the solution is to be used in a heated condition) passed through the heating-vessel. The precipitate may be pressed and treated for the obtainment of the precious metal or metals in the usual or any suitable way. The ore or material from the leaching-vessel may, after leaching, be washed with warm or cold water to remove the last traces of the solution, and such wash-water and solution removed by it may be run into an evaporator to be concentrated before being added to the solution for re-use. The ore may then be washed out from the vat over a plate or surface of zinc, or alloy of zinc, by acidulated water, so that hydrogen is evolved, and thence into contact with mercury, preferably in the form of an amalgamated copper-plate or surface which retains any gold and silver which may remain in the ore in the vat, and which would otherwise be lost.

"I do not limit myself to any one precise form of apparatus for carrying out my invention, but the apparatus described in the specification of my application for letters patent of even date herewith is well adapted for the purposes of my present invention.

"Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is,—

"1. In a process such as is hereinbefore named the use in the leaching-solution of hydrochloric acid or bromine, or both, substantially in the manner and for the purpose hereinbefore described, the leaching solution, after it has passed through the leaching-vat and filter being brought up to normal strength, and again passed to the leaching-vat for re-use in the manner described, whether the solution be heated or not.

"2. In a process such as is hereinbefore named, the use of hydrochloric acid or bromine, or both, for leaching substantially in the manner and for the purpose described, the solution, after it has passed through the leaching-vat and filter being brought up to normal strength, and again passed to the leaching-vat for re-use in the manner described, combined with the use of sulphide of sodium as a precipitant in the manner hereinbefore described.

"3. The treatment of gold- or silver-bearing ores or materials which have been leached by washing or passing the said ores or materials out of the leaching-vats over zinc, or an alloy of zinc, and then into contact with mercury, such as over an amalgamated copper-plate.

"4. The treatment of ores or materials for the obtainment of precious metals by subjecting the ores or materials to a succession of operations constituting the process as a whole substantially as hereinbefore described.

"Dated this 8th day of April, 1890. "W. D. Bohm."

"I certify this to be a true copy.—W. H. Quick, Solicitor, Wellington."

A Wonderful Water Indicator, by which Subterranean Water at any Depth can be Found with certainty.

The following is taken from the *Australian Mining Standard* of the 2nd July last, and if the instrument is capable of doing what is claimed for it, the invention may be termed one of the greatest in the age, and will save useless expenditure in boring for water where none exists:—

"No more vain searches for subterranean water. The secret of locating it with certainty has been discovered. The honour of this great discovery belongs to Messrs. Heerdegen and Schnee, of 48, Exchange Place, New York. The instrumentality is electricity. The construction of the apparatus is a secret, but ample demonstration as to the certainty of the method is afforded. The apparatus is constructed on strictly scientific principles, electricity being the detective medium. Subterranean flowing water can be discovered by this instrument at any depth, and exact width of stream, direction of flow, and approximate depth and quantity determined. The course of a subterranean stream can be followed for any distance, and the proper place to sink a well selected, thus enabling a person who has a well to sink to calculate the cost to a dollar before commencing, and every risk of failure is eliminated.

"This is the only invention hitherto known which insures certainty in all the particulars just stated. In fact it is one of the greatest inventions or discoveries of the age, and moreover one that is destined to be unique in its power and scope to confer increased benefits on the human race at

large. There are many arid districts in various parts of the earth where water could be found at various depths in certain spots, but until the period of the discovery in question, about five years ago, there was nothing to guide the anxious seeker for this prime necessity of life unless water appeared somewhere on the surface near the place of experiment, and much labour has been wasted in anxious hopes, often doomed to disappointment, of striking a spring at certain depths in some chosen spot. Many of these sterile districts could be changed into fertile plains if irrigated by the wells that might be sunk there or in the adjacent vicinity where no indications of water exist on the surface.

"In the far west there are large tracks of sage, brush, and alkali lands, for instance, which are comparatively worthless in their present condition, but could be made to produce excellent crops if watered from wells that might be sunk in those sections.

"There are many districts in which agriculture languishes, and where the soil affords but a poor subsistence, which could be transformed into productive fields by the system of discovering water, and consequent irrigation. In fact agriculture in almost every department can be made more remunerative by the certainty of water on the farm, or approximate enough to be obtained in case of need.

"Again, almost every industry, both mining and manufacturing, is more or less dependent on an abundant supply of water for its productiveness and success. In an especial degree this is true of placier-mining, which cannot be developed, and may already have had to be discontinued also in localities where gold was abundant in the gravel, on account of scarcity of water. This industry affords an example where it will pay to take the water even a long way from the point of location, and where gushing springs at great depth near the locality of the previous gravel are of inestimable value.

"There is a very large amount of money lost every year in boring and digging for water, without any satisfactory results; but this loss, though great, is but a drop in the bucket compared with the immense gain that would accrue in extra productiveness in all the great industries, if this method of discovering water were general and could be utilised in every section of the land. And there is no reason why it should not become universal. It can be placed within the reach of all who are in need of it. The beauty of it is that it pays expenses as it goes, and in most instances immediately creates large profits compared with the outlay of introducing and adopting it.

"The two gentlemen who are now the exclusive proprietors of the secret have already extended their experiments over a wide domain both in United States of America and Europe, and Mr. R. A. Hervey, of 144, Clarence Street, Sydney, is acting as sole agent for the patentees in Australasia. The inventors have got their Indicator now to the point of thorough practicality, far beyond the boundary of experiment. Profitable practical tests are the most convincing things in the world. A large number of such people bear testimony to the facts and remunerative results of this great discovery. The marvellous Water Indicator, however, speaks for itself, and seems to be infallible in its power to locate liquids in motion. So it may be said of this apparatus in a still more emphatic sense than has been stated of the photographic camera, that the instrument cannot lie.

"The best testimony to substantiate this has been obtained from a host of witnesses; but two are especially worthy of note, one in Moscow and the other in New York. The party in Moscow was Julius Baerlein, quite sceptical regarding the power of Mr. Heerdegen's discovery. They were a cotton firm, and had just begun to dig an artesian well. Mr. Heerdegen, after placing his Indicator on the spot, informed them that there was no water in that particular place at any depth, but they laughed him to scorn, and persisted to bore to the depth of 46ft. without any result. Mr. Heerdegen then pointed out a place on the same property where the instrument indicated water at a depth of 21ft., and where it distinguished two streams that joined at a certain point. There the sceptics, after some remonstrance, began to dig, and, when they reached the exact depth indicated, water gushed forth, and further investigation showed that the two streams joined exactly as foretold by the apparatus. The water was abundant and of excellent quality.

"The New York experiment was on the premises of the Huepfel Brewery, on St. Anne's Avenue, Morrisania. The Messrs. Huepfel had bored for an artesian well a few years ago to the depth of 1,300ft. without success. In December, 1889, Mr. Heerdegen went over the Huepfel premises with his Indicator and struck water, which he said would be found at a depth of between 30ft. and 40ft. Boring was begun, and at 25ft. a rock was struck of a few feet in thickness, which being penetrated to 31ft., water rose freely to within 10ft. of the surface, and, on a pump being introduced, the well yielded 60 gallons a minute for 120 hours, and has become a permanent source of abundant supply, and is now saving $4,000 a year, formerly paid for Croton. Tests and testimonials might be multiplied so as to fill several pages of this paper, but we have only space in a condensed form for a limited number of the most striking, though all are indubitably convincing, of the infallibility of the Indicator.

"Several prominent engineers were so much interested that they agreed to have the apparatus tested publicly. Messrs. Heerdegen and Schnee agreed to accept any terms proposed by the engineers to locate water, and went through a series of trials.

"One of the most interesting tests was conducted on the new Croton Aqueduct, under the auspices of some of the engineers of the works, and two scientific gentlemen of the editorial staff of the *Engineering News* and the *Engineering and Mining Journal*, who were conversant with the location and direction of the tunnels which the Heerdegen Indicator placed with unerring accuracy in every instance.

"The foregoing tests were followed by another test, which consisted in laying about 150ft. of ¾in. stream-hose on the second floor of the Raub Building, at the corner of Nassau and Fulton Streets, New York, Mr. Heerdegen being stationed upon the third floor before the hose was uncoiled. This hose was passed through various rooms, and a stream of water sent through it, and Mr. Heerdegen succeeded more than fairly well in locating and tracing its course on the floor above."

JORDAN'S CENTRIFUGAL GOLD-EXTRACTING PROCESS.

One of the newest, and certainly by far the most important, of recent innovations in reducing machinery is the centrifugal mill introduced by Rowland Jordan, Esq., C.E., and made by T. B. Jordan and Son, 15, George Street, Mansion House, London. The plant is especially designed for dealing with gold-ores, and consists of two distinct portions—the reducer and the amalgamator. The reducer is shown in Fig. 1, the amalgamator in Figs. 2 and 3, and the general arrangement of the whole in Fig. 4.

The following reports, made on trial-runs of machinery by the present author and other practical goldminers, are reproduced below, with permission. The author's report says,—

"The plant employed is remarkable for its simplicity, and but little description is necessary. The usual stonebreaker begins the process. This is followed by a revolving-pan, set at an angle, and carrying three massive balls of white iron, which work in a suitably-shaped bed, also of white iron, round the greatest circumference of the pan. The ore and water are fed automatically into the bed of the pan, and by the rotary motion of the latter are conveyed under the rapidly-revolving balls, whereby the comminution of the ore is effected. The inner half of the floor of the pan rises as a shallow dome surrounding the central shafts, and is fitted with movable frames carrying wire screens of any required mesh. The feeds of ore and water and the inclination of the screens are so adjusted that as the ore is reduced to a sufficient degree of fineness it is washed over the screens, and passed away into a launder for conveyance to the amalgamator.

"A comparison of this machine with the most approved form of stamp-battery reveals some highly important facts which may be summarised thus:—

"*Cost.*—A patent pan, equal in efficiency to a ten-stamp battery, is considerably less in first cost. To this saving must be added the greatly-reduced cost of transport to the mine, as the pan weighs less than half a battery. A third economy effected is in the erection—eminently simple and expeditious in the case of the pan, but a long and expensive operation with stamps. Generally, it may be stated that the total cost of the patent plant erected at the mines will not exceed one-half that of a stamp-battery.

"*Efficiency.*—The simple principle of the stamp-battery (that of a falling hammer), which proves such an attraction to its advocates, carries with it several disadvantages. Not the least is its intermittent action. The time during which actual work is being done bears but a small proportion to the time the battery is in motion. Each hammer must be lifted to a greater or less height, and, though the fall produces an effective blow, it is only at the moment of impact between stamp and ore that work is really done, and then the work is not of the most useful kind, as part of the blow always falls upon material which is already in a sufficiently-fine state, but has been unable to escape. The patent pan, on the other hand, has a continuous action on an evenly-distributed and constantly-changing layer of ore, and thus accomplishes a greater amount of work. In fact, it disposes of a rapid feed at an astonishing rate.

"Trials with various ores showed a power of reducing 20 to 25 tons per twenty-four hours to a size that would pass an eighty-mesh screen. Now, few ten-stamp batteries can do more than 15 to 20 tons, even when the mesh of the screens is as low as thirty. This is one of the great faults of the stamp-battery—fine grinding is impossible at anything like a reasonable rate and cost. The outlet for the stamped stuff is so limited and so ill-adapted that it takes almost as long to pass pulp through a battery as to crush coarse stuff and pass it through. With a patent pan this drawback is obviated. The screen-area is much greater in proportion, and the screens are set at a very low angle (almost horizontal). These features, combined with the wash produced by the rotation of the mill and inclination of the jet of feed-water, increase the facilities of outlet in a most remarkable degree. Another advantage, which in many cases would be of primary importance, is that the consumption of water is only about half the amount required by a battery. In a crushing of 'Edwin Bray' ore which I witnessed the water-feed was only a 1in. pipe—where a ten-stamp battery would have had a 3in.—and the ore, fed from a stone-breaker, was passed through an eighty-mesh screen at a surprising rate, not less than 20 tons per twenty-four hours. Such a result speaks for itself. Moreover, the power used to effect this is about half that needed with stamps, while the labour is virtually nil. With automatic feeds one man could watch a dozen pans, and the prodigal use of mercury, so common with stamp-batteries, is dispensed with.

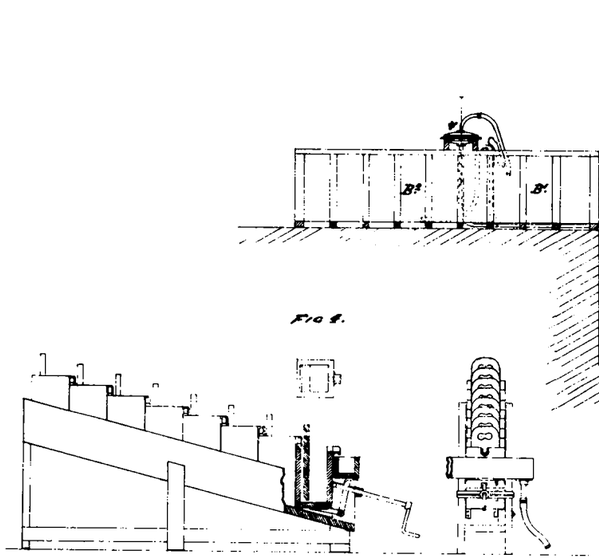
"*Wear and Repairs.*—Here, again, the patent pan has advantages over the stamp-battery. There are only two wearing-parts in the pan—*i.e.*, the balls and their bed. An examination of the latter, after six months' intermittent use, shows that the two surfaces wear in such a way as to maintain their proper relation to each other. When worn too thin, the bed can be removed and replaced by a new one with very little trouble. The screens are much less exposed to injury and wear, and are readily detached and renewed, any desired mesh being adopted. The frequent minor stoppages inherent to stamps, with their numerous working-parts, are quite avoided.

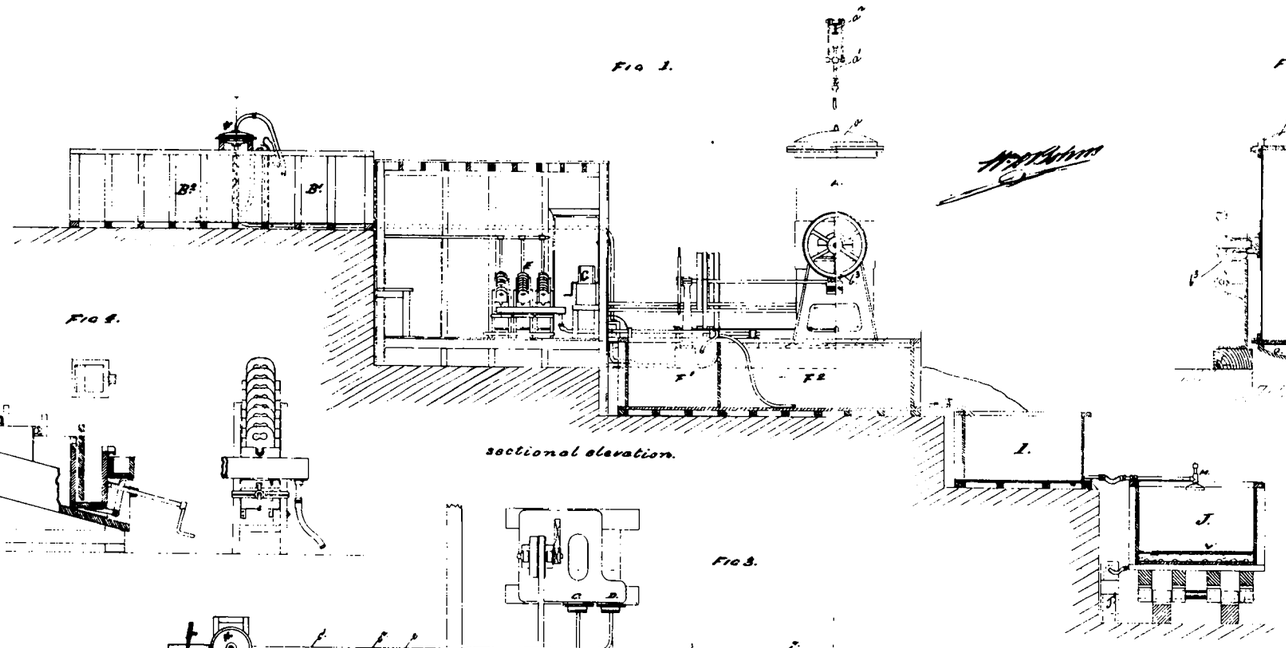
"The only other apparatus employed in the process is a novel form of amalgamator. The stream of pulp, without any addition of water, flows into the hopper of this amalgamator. This machine consists of a series of shallow dishes, attached one below another to a central revolving shaft, and enclosed in a fixed circular casing, which is kept under lock and key. Secured to the inner side of the casing, and alternating with the dishes, are slightly-inclined shelves, also amalgamated. The pulp fed into the amalgamator enters the first dish, in which it is revolved until impelled by the centrifugal motion over the edge of the dish. It then falls on one of the shelves, and is thus conveyed to the centre of the second dish, there to undergo similar treatment. This is repeated to the end of the series, where the tailings escape. The free gold and silver contained in the pulp are completely arrested by the amalgamated dishes and shelves.

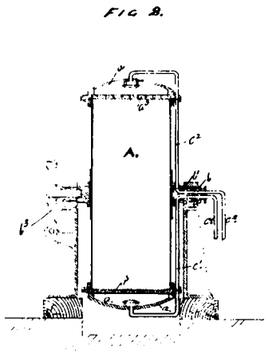
"The very high efficiency of this patent amalgamator is apparently due to several causes. In the first place the ore is reduced in the pan to such a degree of fineness that all precious metal not actually in chemical combination is set free. Then, the shape of the dishes and the manner and

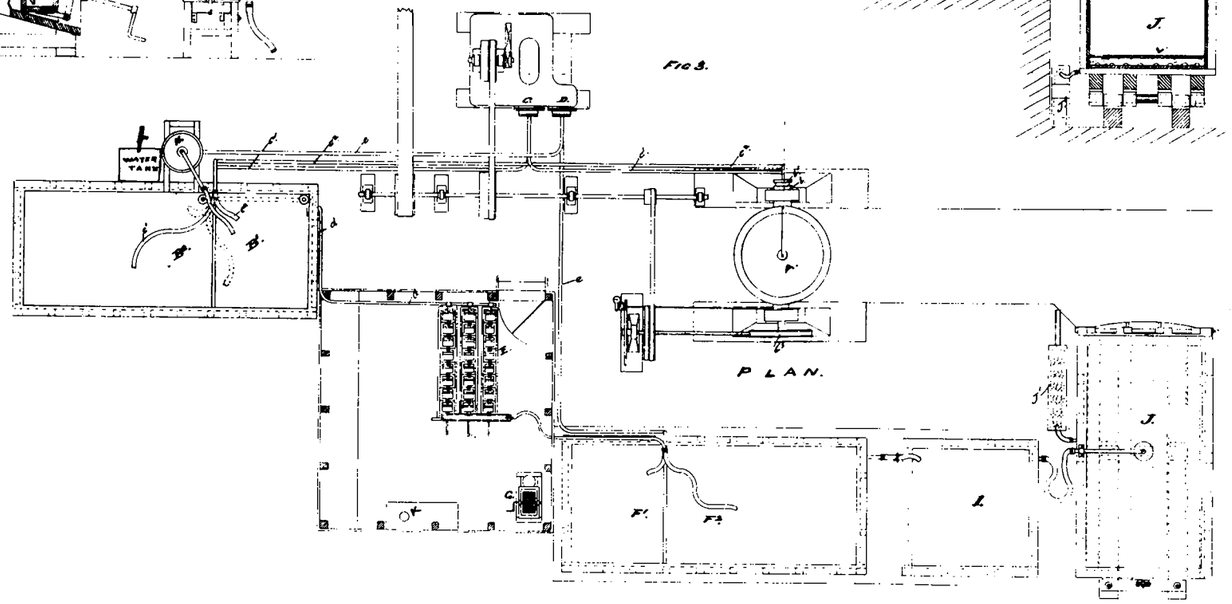
BOHM'S PATENT LEACHING AND CHLORINATION PLANT

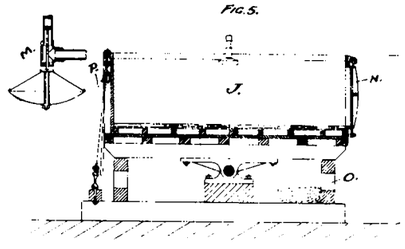
SCALE ¼ INCH TO A FOOT.

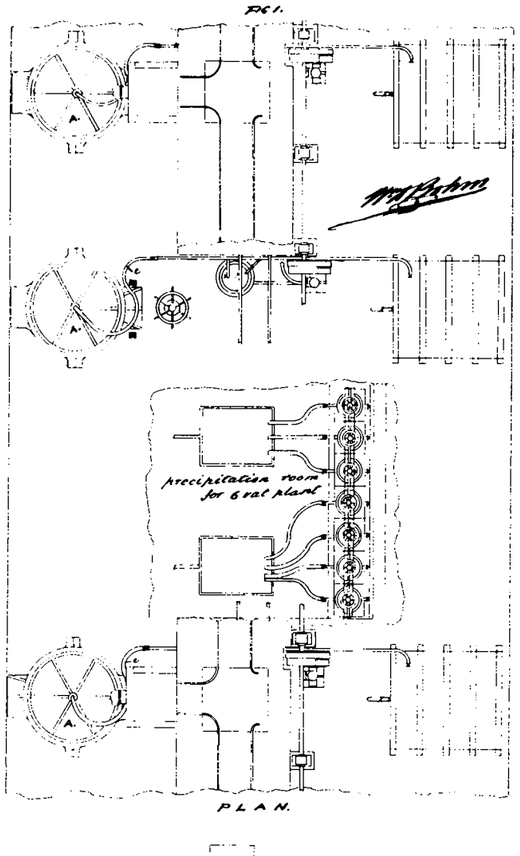


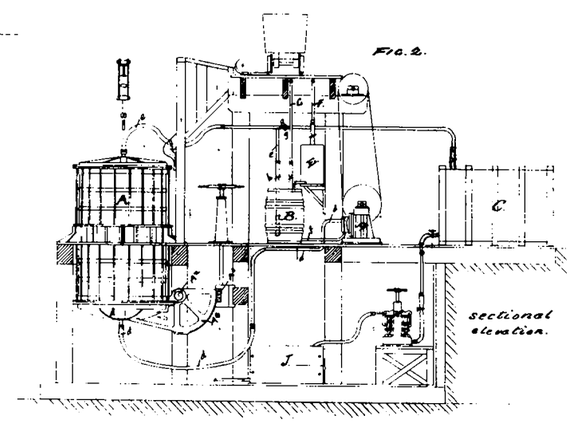


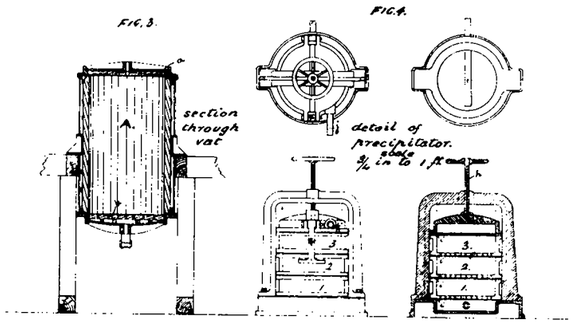








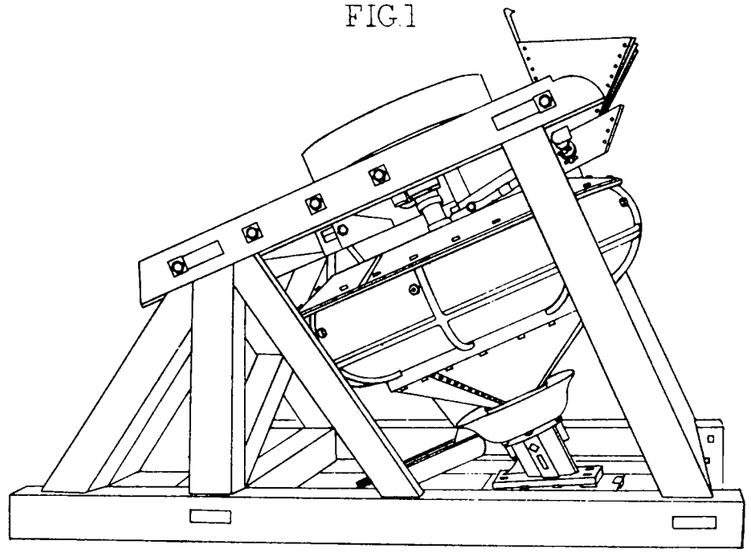




CHLORINATION PLANT.
W. D. BOHM'S patent.

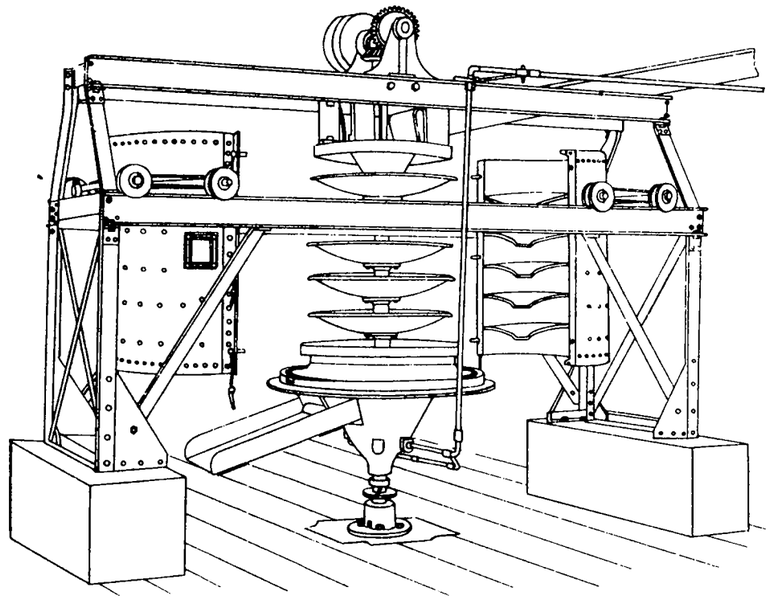
JORDAN'S CENTRIFUGAL GOLD-EXTRACTING PROCESS

FIG. 1



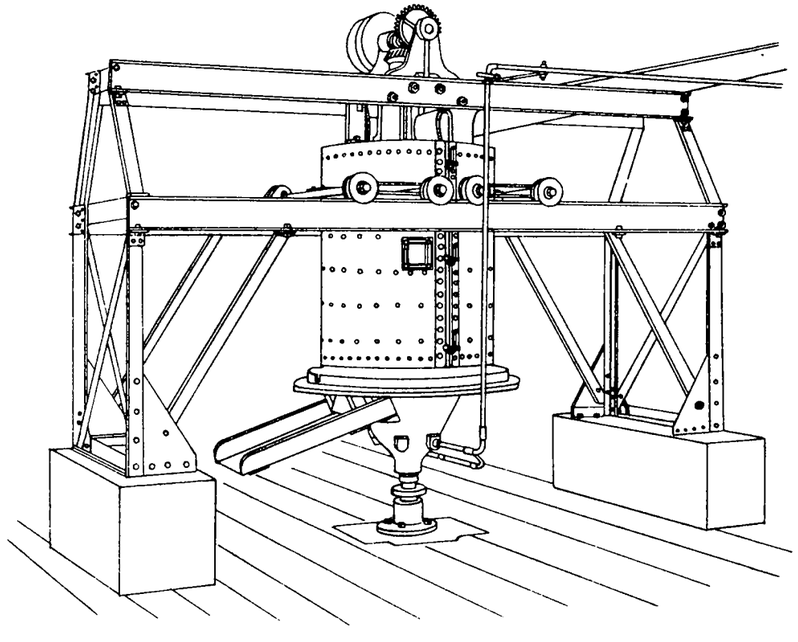
JORDAN'S REDUCER

FIG. 3



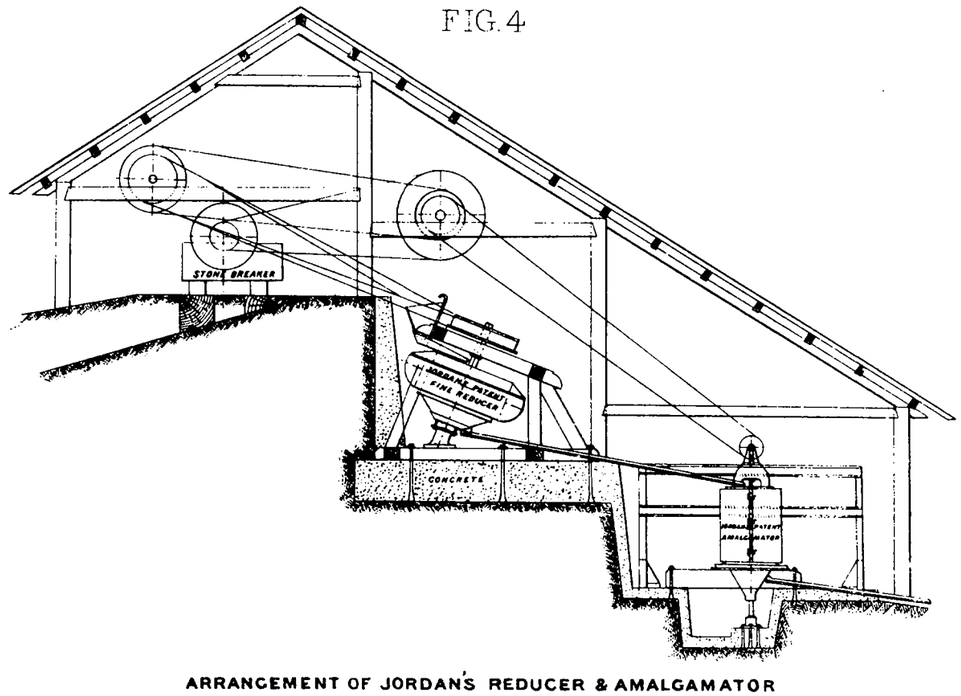
INTERIOR VIEW OF JORDAN'S AMALGAMATOR

FIG. 2



JORDAN'S AMALGAMATOR

FIG. 4



ARRANGEMENT OF JORDAN'S REDUCER & AMALGAMATOR

THE POLLOCK GOLD EXTRACTING PROCESS

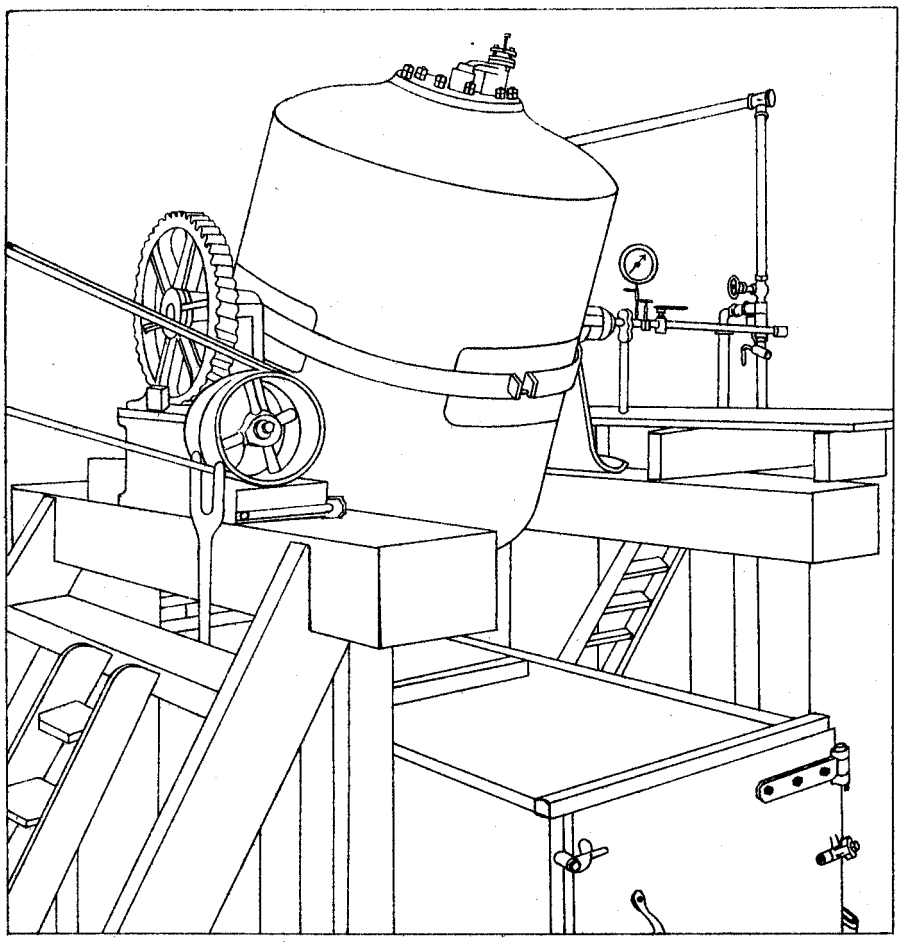


FIG.1. NEW CHLORINATOR AND FILTER BED

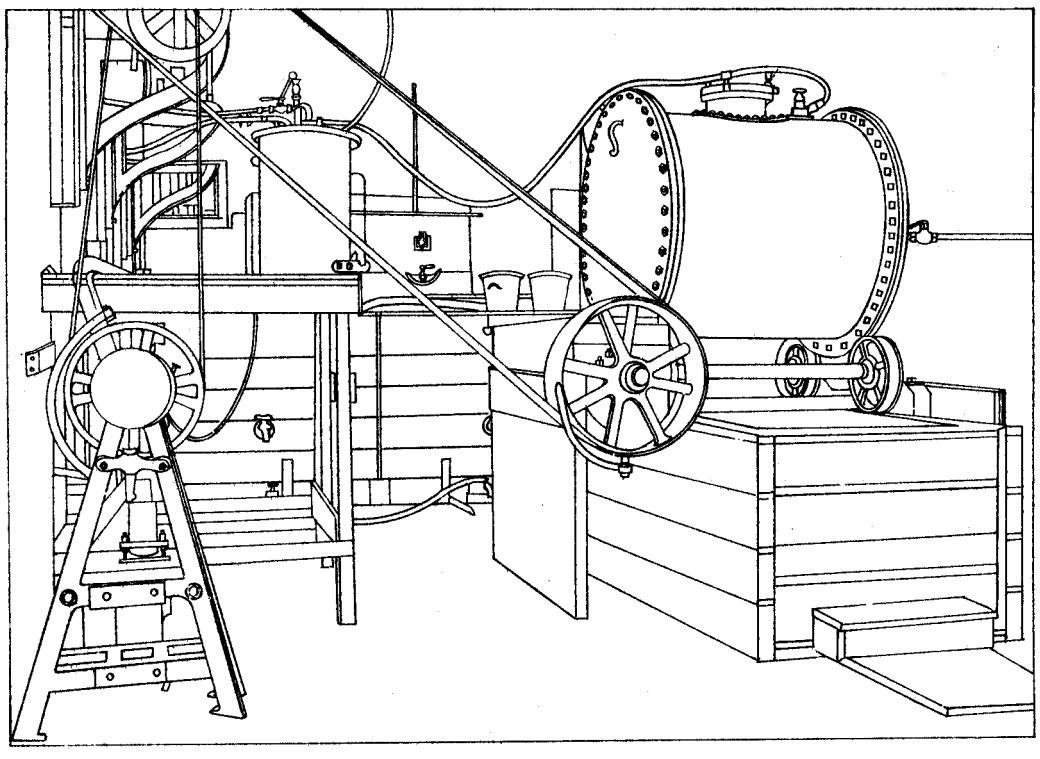
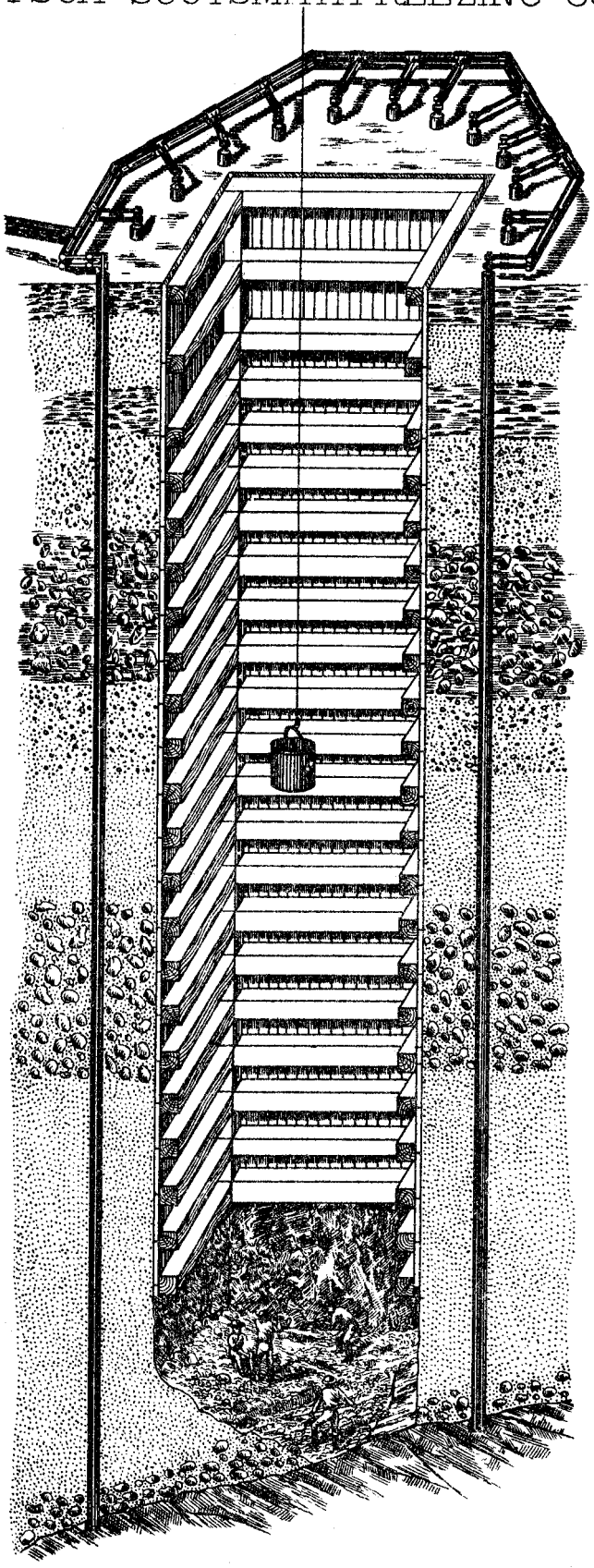


FIG.2. ORIGINAL CHLORINATOR AND PRECIPITATING PANS

THE FREEZING PROCESS IN SHAFT SINKING

as applied at the Chapin Mine, Mich., by the

PŒTSCH-SOOYSMITH FREEZING COMP'Y



speed of rotation all tend to insure intimate fractional contact between the atoms of precious metal and the amalgamated plates, so that even the finest particles of float-gold are retained, and the gentle attrition of this flowing pulp maintains the amalgamated surfaces in a constantly bright and favourable condition. Any amalgam which may become detached is caught in a well at the bottom of the machine, together with such mercury as may have escaped from the dishes, when it is thought desirable to employ it.

"To such a high state of perfection is amalgamation carried in this apparatus, that it is capable of extracting nearly all the gold even from pyritic ores without calcination or any other treatment. In making this statement, I expect to incur the condemnation of theorists; but a study of the table of actual results achieved recorded below will substantiate my opinion; and a more startling piece of evidence, which may be deducted from this same table of results, is that in all cases the patent process is far cheaper and generally more advantageous than chlorination itself, for whereas chlorination alone costs between £2 and £4 per ton, and seldom less than £3, for a return of 90 to 94 per cent. of the assay-value, the total cost by the patent process is only about 5s. to 10s. per ton, and the yield is often equal and sometimes superior to that from chlorination.

"The subjoined figures, though quoted on the authority of the inventor of the process, are, in my opinion, reliable. To verify them, I made a trial with 'Edwin Bray' ore, its refractory character affording a crucial test of the process. Three samples before treatment gave an average of 1oz. 16dwt. 2gr. of gold; and the average gold-contents of three samples of tailings, taken as they left the amalgamator, was, as nearly as possible, 3dwt., or 91·686 per cent. extracted:—

No.	Description of Ore treated.	Gold obtained in Raw Ore before Treatment.			Gold contained in Tailings after Treatment.		
		Oz.	dwt.	gr.	Oz.	dwt.	gr.
1	"Welsh" ore, sulphides of iron, copper, lead, &c. ...	0	1	12	0	0	13
2	Tailings from Transvaal	0	2	7	0	0	23
3	"Indian Consolidated" ore, refractory sulphides	0	1	23	0	0	12
4	"Australian Black Jack," arsenical sulphides, very complex	1	9	9	0	10	16
5	Tailings from "Johnson and Matthey"	1	6	3	0	1	23
6	"Devala Moyar" ore, complex arsenical pyrites	0	19	22	0	6	11
7	"Edwin Bray" ore, pyritic	2	0	22	0	3	0

"From the foregoing results of my examination of the patent process, I am of opinion that, notwithstanding the enormous capital represented by existing stamp-batteries, the patent pan possesses so many advantages that it will force its way into use and displace them, whilst for new mills, extensions, and renewals it will be adopted without hesitation.

"As to the patent amalgamator, there is not a mill in existence where it will not be found advantageous, and where it will not surely supplant the blanket-tables and miscellaneous appliances now in use for saving gold which would otherwise be lost.

"Another direction in which it will find highly profitable employment will be in reworking tailings containing much gold that has been passed over by the less efficient processes hitherto employed."—*Lock's Ore-dressing Machinery.*

Butters's Patent Grinding- and Amalgamating-pan.

This machine stands on an ordinary wooden bed-plate *A*, to which are bolted the cast-iron columns *B* that support the top framing, one column being required for each grinding-roller employed, the most suitable arrangement being from three to five rollers, according to size of pan. The cast-iron beams *C*, for carrying roller-spindles *D* and the vertical driving-shaft *E*, are bolted to a facing on the columns *B*, as shown at *x*. The compressing-springs *F'*, for giving the required pressure on the grinding-rollers, are held in position by a crosshead and columns, as shown at *y*, and are so arranged as to be adjustable by means of the hand-wheel and screw *G*, a jaum-nut being provided to hold the screw in position when the desired pressure has been obtained. On the spindles *D* the grinding-rollers *H* are placed, and revolve upon them, the spindles being stationary, held by a feather in the cast-iron beam *C*. To minimise wear, and to prevent dust getting into the bearing, a specially-designed bush and footstep *I* are provided. The grinding face of the rollers is fitted with a specially hard facing-piece *K*, so arranged as to be easily and expeditiously replaced in the event of wear through time. The cast-iron false bottom *L* is made specially hard, and is simply laid in position in the recess provided for it in the bottom of the pan on a bed of cement. The space *M*, between the outside periphery of the false bottom and the side of the pan, acts as a quicksilver-well. The pan *N* is keyed on to the vertical driving-shaft, and revolves with it, and thus driving by friction the grinding-rollers at a high speed relative to the difference in the diameters of the pan and rollers.

The machine is also fitted with a tailings-pan not shown, so arranged that the reduced materials flow through gratings in the side of the grinding-pan *N* into it.

The special advantages claimed are speed of reduction and amalgamation, a 5ft. pan with three rollers being capable of reducing half a ton of hard 2in. quartz per hour. No special foundation is required. It is easily driven; and readily adapts itself to an arrangement of automatic feeding either by elevator or other feeders.—*Victorian Mining Report.*

Phillips's Patent Rotary Stone- and Ore-crushing Machine.

In its design and construction this machine is entirely different to the old type of reciprocating crushers. The defects of the inferior types of crushers are too well known to require tedious repetition here. The one great thing that will recommend this machine to all practical men is its simplicity. The working parts consist only of two shafts, two bevel-wheels, and a bush. There are no crank shafts, no connecting-rods, no jaw-holders, no levers, no pads, no toggles, no bolster or wedge-block, no tension rods or springs. The lubrication is stated to be perfect, the working parts running continually in a bath of oil, by which means there is not only a great saving in wear-and-tear, but also in oil. There is also a patent safety device, which acts when a spawling hammer or drill gets into the machine, and thus saves a big cost in breakages. The stone or ore is fed into the top of the machine, and falls down through to the crushing-cones *L* and *K*. The counter-shaft, on which is the pulley and fly-wheel *B* and bevel pinion *G*, drives the bevel-wheel *F*. To this wheel *F* is securely fixed the phosphor-bronze eccentric bush *C*, the hole in which is out of the centre, or eccentric, as shown by the thick and thin sides. This bush as it revolves gives the shaft *A*, to which is fixed the head *K*, a gyratory or eccentric motion, and crushes the metal continuously all round the cones until it falls through and down to the shoot. The size of metal to be produced is adjusted by means of the screw *E*. The shaft *A* is a loose fit in the eccentric bush *C*, and does not revolve when there is any metal in the jaws. It is only when the jaws are empty that it is free to revolve. It is of the best steel, and supported on the bottom by the steel pad *D*, which is raised or lowered by the screw *E*. The crushing-head *K*, which is of the best white hæmatite, has two wrought-iron rings cast in it, which are bored to fit the shaft. The space between these rings is then run up with zinc, and the nuts tightened down. The outside crushing-ring *L* is also of hæmatite, and, being dropped into its place, is also run up with zinc. The bevel-wheel *F* is in halves for the convenience of removal. The eccentric bush *C*, upon which the principal work falls, works in a bath of oil, which can be run out when foul through the tube shown on the right-hand side of woodcut. The pulley and fly-wheel *B* is not keyed upon the shaft, but is loose thereon. It drives the shaft by means of the two pieces of round iron or pins, as shown, which run through and are nipped by the screws into the disc *H*, which is keyed upon the shaft. Should a crowbar or sledge introduce itself in the cone these two pins are sheared off, the machine stops, whilst the pulley runs round loosely on the shaft. There are three openings in the top of the machine, into which the metal or ore to be crushed is fed. A wooden hopper may be built around the top of the machine, and the metal trucked right into it, thus effecting a big saving in handling and feeding. The inventor claims that the patent rotary combines small cost in repairs; reduced chance of breakdown; few working parts; it is well and cheaply lubricated; it is cheap, efficient, and economical; a patent safety device to prevent accidents; small driving-power; a continuous, not intermittent, action; big crushing-surfaces easily replaced; but little foundation; all the benefits of high speed; compactness; easy to get at, but not exposed; all wearing surfaces large; good workmanship and material; advantage of large output at small expense; a good class of metal, sharp and cubical; no flakes.—*Victorian Mining Report.*

Stahl-Rew Patent Amalgamating-pan.

This patent includes both centre and outside feed, to be used as an alternate method of feed and discharge, as may be preferred. If the outside feed is used, the inner circle of sheet-iron is taken out; the slimes, tailings, &c., fed in at the top, between the outer casing of sheet-iron or cast-iron and the inner casing of the same class of iron, the rubber and iron ring on the muller making a perfectly watertight joint, compelling the slimes to be drawn under the grinding-surfaces, and by the centrifugal motion brought in direct contact and swirled about in the mercury-well under the false bottoms, thereby insuring perfect amalgamation. After grinding and amalgamation, the *débris* passes up through central hole of shoes and muller into body of pan and is brought into contact with amalgamated or electro-silvered copper plates, thence to the discharge over an electro-silvered plate, from this plate into a perforated plate with holes $\frac{1}{16}$in. diameter, and showered down by a fall of 11in. on to a slip of amalgamated copper-plate floating on a bed of mercury, the *débris* passing from this into the centre of a slowly-revolving bracketed muller, with the under-side of brackets lined with amalgamated copper revolving in basin $\frac{3}{4}$in. deep, containing a bed of mercury from $\frac{1}{4}$in. to $\frac{1}{2}$in. deep. The mercury in this basin and under the floating plate of shower-box is kept in good working-order by hydrogen gas generated by scrap-zinc, muriatic acid, and chloride of ammonia, and injected into the mercury from the generator through flexible tubes. By this means all floured mercury is recovered, and as all floured mercury is charged with the precious metals, consequently those metals are saved, as well as the mercury, at a nominal cost.

When the central feed is used, all that is required is to put on the inner circle, marked No. 3, take out the rubber joint and the top malleable-iron ring of muller, turn the feed into the central space, the *débris* passing down under the shoes and between the false bottoms, ground, amalgamated, and discharged at the periphery into the body of the pan, and undergoing the same process as described for the outside feed; the central feed renders the rubber joint unnecessary.

With the save-all and shower-box, it is of no consequence if the mercury should flour as in all other pans; it will be collected by being sprayed down on the floating plate, the residue collected in the basin by being continually rolled over and over by the copper-lined bracketed muller. The result of the Comstock trials is, from 9 tons 18cwt. tailings, over 11oz. of bullion, valued at 11s. per ounce. The result is considered so satisfactory that shareholders consider the bullion that will result from the use of the pan will alone pay dividends.

The grinding-pans are equal to treating the continuous stream from a six-head stamp-box, feeding from the outside, running at eighty revolutions per minute. With the inside feed it is anticipated that each pan will treat the tailings from ten heads, the muller running 120 revolutions.

The save-all and shower-box will be sufficient to take the tail-waters from two pans by a very slight increase of the diameter of save-all and by lengthening of the shower-box.

In the inventors' experiments they have found that all the fine flour-gold is lost through its extreme fineness and the want of suitable appliances to insure amalgamation. Assays made by Mr. Rew for a number of years showed that gold is lost in dirty water at the rate of 1gr. for each 300 gallons of water used in treating our ores, and in many instances from 1dwt. to 8dwt. per ton of ore. The lower scale of averages—namely, 1gr. per 300 gallons of water—will, by taking the quantity of tons in both quartz and alluvial mining, as shown by the Mining Registrars' reports, show that over six hundred thousand pounds' worth of gold is lost annually.

A company has been formed, under the title of the Stahl-Rew Amalgamating-pan Company, to patent the process through all the colonies, America, and Europe.

Reference to Plan, Fig. 1.

A, Inside of pan, to contain slimes after being ground and amalgamated, passing away by the overflow shoot at A^1. *a*, Inner circle, of sheet iron. a^1, Outer circle, of either cast- or sheet-iron, of pan. The space of 4in. between the two circles of iron marked a^2 is used for introducing the feed direct under the muller-shoes and mercury-well. A^2, Distributing-box, 5ft. long. A^3, Pine mercury-well, with pine check-board.

B, Outer feed shoot. B^1, Inner feed shoot.

C, Main cast-iron bottom, in four segments. *c*, False bottoms (twelve pieces).

D, Muller. *d*, Rubber $\frac{3}{4}$in. square. d_1, iron liner. 3in. deep by $\frac{3}{8}$in. thick; on the face of this liner the rubber presses to make water-tight joint, thereby insuring the feed passing under and between the grinding-surface, passing into body of pan through the centre hole.

E, Three-inch vertical driving-shaft. *e*, Driving or muller-arms. e^1, Head of driver.

F, Sleeve or column, containing brasses at top for vertical shaft. *f*, Counter sunk bolts by which centre column of sleeve is bolted down to main bottom.

G, Amalgamated copper or electro-silvered copper-plate wings. *g*, Angle-iron ribs for fastening wings to.

H, Amalgamated copper plate, floating on bed of mercury, to receive shower of tail-waste of pan. *h*, Mercury. h^1, Mercury-well.

I, Vessel for generating hydrogen gas from muriatic acid, zinc, and ammonia-chloride, for keeping mercury bright, giving it the power to dispel the air-film surrounding particles of gold, thereby insuring perfect amalgamation. *i*, Pipe for conveying hydrogen gas to mercury. i^1, Regulating-tap.

J, Valves to allow of alternate feed, centre or outside. J^1, Perforated shower-plate, drop 14in.

K^1, Save-all complete, intended to revolve slowly over a bed of mercury, whereby all floured mercury or fine amalgam may be collected if any escape the floating plate, and collect any mercury that by accident or otherwise may pass through other receptacles. *K*, Revolving disc or muller, carrying on the under-side 24 amalgamated copper-lined pine battens, with spaces of $\frac{3}{4}$in. in between each batten. This disc is for rubbing the tail-waste into the mercury below. A corrugated copper disc can be used if preferred. *k*, Bed of mercury. k_1, Head of driver and central-feed hopper, the feed falling from shoot on to perforated iron plate, for equal distribution on to mercury.

L, Collecting-tub for cleaning up and collecting mercury and amalgam. *l*, Discharge-pipes into various mercury-wells to central cleaning-up pan.—*Victorian Mining Report.*

White's Amalgamating Pan.

This pan revolves at the angle shown at thirty-five revolutions per minute. Each charge contains about 1½cwt. of tailings, with sufficient water added to bring the charge within about 3in. from the lip at low edge of pan. This is allowed to amalgamate with about 25lb. silver for one hour, and then discharged over Halley's percussion-table with an ordinary 1in. syphon-pipe. The quicksilver remains in the pan, and another charge added. This is continued generally for a few days before cleaning out, but varies according to the quality of the sand treated. To prevent the pan from wearing, the bottom and sides are covered with a layer of coarse gravel, sand, and cement, the bottom about 2in. thick. When this thoroughly sets and hardens, it not only effectually prevents any wear of the pan, but assists in amalgamating, being rougher on the surface than the cast-iron. Each coating of cement lasts about twelve months with ordinary work. The number of revolutions, quantity of stuff per charge, and time of treatment vary to a certain extent with the nature of the sand treated. These pans are in use in the Wimmera Crushing Company's works, Stawell, and are found to be preferable in every way to the amalgamating-barrel.

Mr. E. R. Meekison, Inspector of Mining Machinery in Victoria, reports as follows on this invention: "This pan, in my opinion, is much superior to barrels for amalgamating, and does away with the barrel filling and making tight joints, also collecting quicksilver, and, in consequence, a greater quantity of sand can be treated with less labour and loss of quicksilver than by the use of barrels."—*Victorian Mining Report.*

The Pollok Gold-extracting Process.

[*Industries*, 14th February, 1890.]

The Pollok process is, like the great majority of gold-extracting processes which have been hitherto patented, a *chlorination* one—*i.e.*, the reagent used for the purpose of dissolving out the

gold from its ores is chlorine. The special feature of the Pollok process is the method in which the chlorine is applied—a so-called *hydraulic* chlorination method—*i.e.*, the chlorine after being liberated is liquefied by hydraulic pressure. This process, it is claimed by the patentees, is applicable to all ores or tailings containing gold, and especially to refractory and float-gold ores. Being an eminently cheap process, the estimated cost of treating a ton of ore under present circumstances being not more than 8s. or 9s., it will be seen to be peculiarly suited for dealing with that large class of refractory ores which are unable to be treated by the older and more expensive amalgamation processes, which consequently have hitherto been allowed to accumulate in such large quantities in different parts of the world. As the process thus promises to be of great commercial importance, a more detailed account of its methods may not be without interest to our readers.

The works at Keppochhill Road, Glasgow, have been in operation for the last two months. The gold-ore at present under treatment is from Chili. It contains, according to assay, 3oz. 6dwt. per ton. Out of this quantity of gold 3oz. 1dwt. is extracted by means of the Pollok process. The following are the different operations which the ore is submitted to in this extraction process. The ore is first crushed by an ordinary crusher, and is rendered sufficiently fine to pass through a sieve containing thirty meshes to the linear inch. Too great fineness, it may be remarked in passing, is not desired in this process, as it is found to impede subsequent operations. In the case of very refractory ores a greater degree of fineness is desirable than in ordinary ores. In the case of what are known as float-gold ores, the ore is brought, immediately after being ground, to the chlorinating cylinder. In the case, however, of refractory ores containing sulphur, iron-pyrites, copper, lead, &c., the ore must be previously roasted. The object of roasting the ore in such a case is to remove the sulphur, oxidize the iron, &c., and thus to render the ore of a porous nature. The result of such previous roasting is to save the chemical reagents afterwards used, and to permit of the gold contained in the ore being more easily dissolved by the chlorine. In the case, however, of very poor refractory ores, the ore before being taken to the furnace is treated in a stamp-battery and concentrated by vanners. In this way a very poor ore, which it would be impossible to treat profitably otherwise, is concentrated some ten times. Thus, an ore containing no more than 5dwt. of gold per ton can, under favourable circumstances, be worked with profit.

The furnace at present used by the Pollok Company for roasting their ores is the common hearth furnace, and holds some two and a half to three tons at a time. It is capable of roasting about 12 tons of ordinary ore in a day, and burns in the operation about one ton and a half of coal. In working abroad, however, the company purpose using a revolving-furnace holding eight tons at a charge. This furnace, it is calculated, would be capable of roasting thirty tons of ore in a day, and would burn from two to three tons of coal. The chief benefit of a revolving-furnace, it may be here pointed out, is that it feeds, stirs, and discharges automatically, thus saving labour—a most important consideration abroad. The time required for roasting the ores varies with the nature of the ore, some requiring a very much longer period than others. The average time is from four to six hours. Ores which have been previously concentrated in the manner above described require a considerably longer time. After being roasted the ore is raked out on to a cooling-floor. It is next conveyed to the chlorinating cylinders (Figs. 1 and 2), of which there are two at present in work. One of these (Fig. 1), designed by Mr. Stephen Alley, is made of light steel—it only weighs 25cwt.—and is lined with a thin coating of indiarubber, which protects the steel from the action of the chlorine. It has an automatic valve for charging and discharging, and a delivery-pipe. There is also an escape-valve on the top of the cylinder. The other cylinder, we may mention, is lined with wood. The rubber used for the purpose of lining the cylinder it about an eighth of an inch in thickness, and is made of pure rubber, and not vulcanized. It is found that the chlorine has no action on the rubber, and that the wear and tear from friction practically amounts to nothing. It will be seen that the value of the indiarubber lining is thus very great. The chlorinating cylinders are charged as follows: First, 80lb. of nitre cake, forming about 2 per cent. of the whole charge, is dropped into the cylinder; then two tons of the ore; and lastly, 60lb. of bleaching powder—or about 1½ per cent. of the whole charge. The charging aperture is then closed, and a steam-injector is turned on, forcing in water till the pressure rises from 70lb. to 100lb. It is important that all the air in the cylinder should be allowed to escape, as the presence of air is most detrimental to the action of the chlorine, as it mixes with the gas and prevents it liquefying. The cylinder is then revolved, thus mixing up the ore with the bleaching powder and the nitre cake. The chlorine which is thus liberated goes into solution, and the pressure forces the strong chlorine liquor into the pores of the ore, previously rendered porous by roasting. The period during which the cylinder is revolved varies from one hour to one hour and a half. At the end of this time the contents of the cylinder are discharged on to a filter-bed placed below. The waste chlorine is blown off, and largely recovered by being passed through slaked lime and thus absorded. The filter is made of steel-wire lined with indiarubber. The charge after being decanted on to the filter-bed is filtered, the chlorine liquor, containing the gold, is drawn off by a specially-designed vacuum pump, by which it is pumped into the precipitating tank (Fig. 2), where the gold is precipitated by adding ferrous sulphate. The quantity of this reageant used is about 30lb. to the ton, or 1½ per cent. The precipitating-tank is fitted with a conical-shaped bottom, on which the gold precipitate settles. As soon as the liquor has become clear it is run off, and the gold paste is removed and fused, in Hessian crucibles with borax, into gold bars.

The chief advantages of this process, as claimed by the patentees, are: (1) The rapid and complete extraction of the gold by the use and application of hydraulic pressure, a machine weighing 25cwt. being able to put through twenty-four tons in twelve charges in twenty-fours; (2) The use of dry chemicals, which can all be safely and cheaply packed, shipped, and carried.

The attached table embodies some of the results obtained by the treatment of ores by the Pollok process:—

Ore.	Locality.	Gold present by Assay.	Gold extracted by Process.	Gold in Refuse.	Per-centage obtained.
		Dwt.	Dwt.	Dwt.	
Sheba tailings	Transvaal ...	48	46	2	96
Mixed lot	"	24	23¼	1	97
De Kaap tailings	"	33½	32½	1	97
Reliance Reef quartz ...	"	11	11	trace	100
Bendigo quartz	Victoria	1,789	1,760	*22	98
Day Dawn quartz, No. 1 ...	Queensland ...	130	127	3	97
" " No. 2 ...	"	22¼	22	trace	99
" " No. 3 ...	"	11	11	"	100
Concentrated tailings ...	"	22	21	"	95½
Swazieland quartz	South Africa ...	17	16	1	94
City and Suburban	Transvaal ...	250½	241½	8¾	96
Crown Ore...	New Zealand ...	76	71	4½	94
"	" (Silver)	884	779	100	88
Transvaal Gold Exp. Co. ...	Transvaal ...	30½	28	2	92
" tailings	"	7½	6½	1	87
Mount Shamrock tailings ...	Queensland ...	8¾	8½	trace	97
" ore (*a*) ...	"	17¼	14	3¼	81
" " (*b*) ...	"	915	834	*81	91
Caledonian Extended ...	New Zealand ...	105	96½	8½	92
" tailings	"	9¼	8¼	1	90
Mariner's Lode	Queensland ...	28	23¾	4¼	85
Ravenswood ore	"	40	35¾	4¼	90
Golden Egg quartz	Transvaal ...	107	102½	4½	96
Dick's Luck ore	South Africa ...	164	132	*32	80½
Glasdyre ore	Wales	42	36	5	86
Loando Mine	Dakota, U.S.A. ...	2	2	nil	100
Bethango ore	Queensland ...	54	49½	5¼	91
Cumberland tailings... ...	" ...	19¼	17¼	2	89
Arsenical pyrites	Tasmania ...	48	43	4½	90
Concentrates	Wales	4,430	4,200	*210	95
Concentrated tailings ...	Morgan Mine, Wales	25	22½	2½	90
Venus Mine	New Zealand ...	30	27	2¾	90
Concentrated river sand ...	Assam	65½	64	1½	97
Westward Ho Mine	Queensland ...	28	25	2¼	90
Lochaber Syndicated, No. 1 ...	Nova Scotia ...	4	3¾	¼	94
" " No. 2 ...	" ...	14	13¾	¼	98
Astyra Mines	Turkey	14	13¼	1½	95
Gipsy Queen Reef	Transvaal ...	143	134	10	93½
Per Mr. Jones	Spain	14	12	2	86
New Organos (arsenical pyrites)	Colombia, S.A. ...	118	91¾	3	78
Great Eastern Extended ...	New Zealand ...	194½	184½	10	95
Devala Moyar	India	20¾	18¾	2	90
Rio Grande Do Sul	Brazil	38½	36½	2	95
Indian Gold Mine Company ...	India	34½	32½	2	94
Tinnamary Mines (*a*) ...	French Guiana ...	64	61	3	95
Per Mr. Irvine	West Coast of Africa	138½	132½	4	95½
Per Mr. Stranger	Anstralia ...	10	9	¼	90
Stafford Mine	U.S.A.	17	19	trace	100
Monroe	"	21½	21¾	¼	100
Edwin Bray concentrates ...	South Africa ...	55	55	2	97
Westward Ho Mine	Queensland ...	14	11¾	2	84
Ore	Dutch Guiana ...	4	3¾	trace	93¾

* Three-fourths of this gold can be obtained by a second chlorination.

Pœtsch Freezing Process in Shaft-sinking.

This process is one of the greatest feats of mining engineering of the present age. The great difficulty that mining engineers have to contend with in sinking shafts through quicksand is entirely overcome. No iron cylinders are actually necessary. The shaft can be sunk in the ordinary manner, and either lined with strong timber or with brick or cement; that is wherever pipes can be driven down. Within the last three years two shafts were sunk at Huntly, in the Auckland District, through from 60ft. to 80ft. of quicksand, which had large logs of timber in it. Cast-iron cylinders were used in sinking, but even with these there was a difficulty in carrying these down plumb. When the logs of timber were met with, one side of the cylinder would rest upon the timber, and when this occurred the shaft would go out of being plumb. The freezing process renders shaft-sinking in any soft material containing water now comparatively easy. It was adopted by Mr. Pœtsch in sinking some shaft in connection with the Belgian coal-mines. After-

wards it was applied in America in sinking a shaft at the Chapin Mine, Michigan. The *Engineering News* describes the system adopted at that mine:—

"The owners of the American patents, the Pœtsch-Sooysmith Freezing Company, contracted to freeze, excavate, and curb up a rectangular shaft 15½ft. x 16½ft., and about 100ft. deep to the ledge. The mining company put the freezing-pipes into the ground 3ft. apart, in a circle 29ft. in diameter, and, with the exception of two of the pipes, to the ledge. This proved to be a difficult task on account of the many boulders encountered. A 10in. casing-pipe with flush joints was first drilled down by various means, a drill being worked within the pipe when necessary, and the material removed by jetting or by a sand-pump. The casing-pipe being once down to the ledge, a freezing-pipe was placed inside, and the outer casing-pipe drawn up and used for the next pipe. The freezing-pipes left in the ground were 8in. in diameter, the lower ends being closed.

"Inside of these 8in. pipes were placed pipes 1½in. in diameter, open at the bottom. These inner pipes, as well as the outer pipes, were connected together at the top of the ground, forming a complete circuit, through which a cold brine was circulated.

"The brine used was a solution containing about 25 per cent. of calcium chloride, which has a very low freezing point. The brine was coo ed with a Linde ice-machine, made by F. W. Wolf, of Chicago, having a refrigerating capacity of 50 tons of ice per day. The ammonia was compressed to about 135lb. per square inch, and cooled by passing through coils immersed in water kept cold by pumping from a brook. Then the ammonia was allowed to expand through coils immersed in brine, and finally returned to the compressor.

"The temperature of the expanded ammonia was such as to cool the brine to a few degrees below zero Fahr. This brine being circulated through the ground-pipes, was raised in temperature about 2° Fahr. After forty days' freezing an ice-wall 10ft. thick was formed around the shaft. The excavation—commenced soon after starting the ice-machine—had in the meantime reached a depth of 40ft. Thirty days more sufficed to reach the ledge.

"The shaft was, for convenience, curved as the excavation proceeded. This was, however, not necessary, as the walls would have stood vertically throughout the whole depth very well. The temperature of the air within the shaft was generally below the freezing-point, and there was no indication of the exposed material thawing. The curbing was made of horizontal sets of timber, 16in. square, placed 2ft. apart, with 4in. vertical plank behind the timbers. The cross walls were placed in afterwards.

"The timbering was supported from one set to another by bolts placed near the corners of the shaft, the whole system being suspended from cross timbers at the surface of the ground. The unfrozen area within the shaft grew less as the actual running time of the freezing-machine increased. When a stratum of boulders was encountered, the frozen area reached nearly across the shaft; but when quicksand containing a large percentage of water was passed through, the unfrozen area was greater. The reason of this is readily understood when it is remembered that the specific heat of water is about five times as great as that of any of the other materials, and therefore the strata containing most water would require more cold, and would be longer in freezing.

"The frozen quicksand resembles sandstone. The corners of broken pieces were hard and sharp. Granite boulders embedded in it showed a decided tendency to fracture across rather than break loose. The tensile strength of the frozen ground, as determined by a cement-testing machine, was equal to that of the best neat Portland cement, and varied from 350lb. to 450lb. per square inch; and its strength against crushing, as determined from inch square cubes, was 850lb. per square inch.

"This furnishes data from which the strength of the surrounding frozen wall may be computed as an arch. An ice wall 10ft. thick will be found sufficiently strong for any case likely to occur. Near the bottom the freezing extended within the circle solidly to the centre. It is not known how far it extended outside, as no borings could be made through it. A test-pit was sunk outside the shaft as far as the water could permit (some 22ft.), and from this it appeared that the freezing extended outwardly from the pipes at that point about 13ft.

"The material was mostly loosened by picks and chisel bars. Black powder was used for blasting for a considerable time, but this was discontinued for fear the concussion might injure the pipes or fracture the wall. The material was hoisted out by an iron bucket, which also took out the water which stood in the unfrozen centre. There was no appreciable inflow of water until the excavation had reached nearly to the ledge.

"On reaching the ledge it was discovered that it was so fissured and disintegrated as to allow water to come in under the frozen wall, at a corner in the vicinity of one of the pipes that did not extend to the ledge. On 20th February, the incoming stream had so worn a channel as to permit a jet of sand and water 3in. in diameter to enter.

"The shaft was allowed to flood, water being pumped into it at the same time, to prevent as much as possible the flow of water through the opening.

"An 8in. freezing-pipe was put in place in the shaft, the foot being directly at the opening, the purpose being to freeze the leak off.

"Cold brine was circulated through the whole system of freezing-pipes for ten days uninterruptedly, when the water was pumped out, and the seam was found to be quite closed; but there was still a small amount of percolation through the ledge, requiring occasional pumping to clear the shaft; ice had collected several inches thick on the side of the shaft and several feet in the corner, where the extra freezing-pipe was placed.

"The work of removing the sand which had come in with the water and the clearing up of the bottom continued for two weeks, when the water from the ledge increased at such a rate that it was decided to lay short auxiliary freezing-pipes against the leaks and freeze the ledge itself. This was done, the shaft was flooded again, and the brine was circulated thirty days. When the water was pumped out, the leakage was found to be small and the excavation was proceeded with. The soft,

shaly rock was removed until a hard bearing was obtained for the timbers, and the timbering was completed from the surface of the ground to the excavated depth.

"Water is the engineers' most troublesome enemy, and the conversion of this subtle foe into a barrier of defence is a triumph of engineering as effective as it is novel. This process can be applied to excavations for bridge piers, to tunnels, and to other general work of a difficult and expensive character, as well as to shafts. But in shaft work alone it should be invaluable, as by it numerous valuable deposits of coal and other minerals, now inaccessible on account of overlying strata of water-bearing materials, can be reached, as in the case of the Chapin mines, and in those Balgian coal-mines which first led Mr. Pœtsch to launch upon the engineering world his startling but very efficient process."

Annexed is a sketch-plan showing the process of sinking. (See page 136.)

Mudie's Quartz-crushing and Amalgamating Machine.

In reference to this machine Mr. E. R. Meekison, Inspector of Machinery for the Victorian Government, in his official report, states: "On the 15th of January I inspected at Elaine Mudie's crushing, amalgamating, and gold-saving machine, and beg to submit the following report: The machine consists of a cast-iron trough 3ft. wide, lined with boiler-plate, where the rollers work. It is divided into partitions into three divisions; in each of these a roller 2ft. in diameter and 12in. wide works. There is a fall from each division to the other one, as shown on the plans. The method of working is as follows: The quartz is first broken small, and then fed into the first division. In this part there is a quicksilver-well, into which the quartz drops, and from there passes under the first roller, where it is crushed to a size. That will allow it to pass through the grating fixed in the division into the second compartment, where it is crushed finer, and then passes through a punched grating with two hundred holes to the square inch, also fixed to a division; it then flows into the quicksilver-well, lined with amalgamated copper-plate; from there it passes under the third roller, and is still further ground, and then flows over another silver-well, also lined with amalgamated plates, and from this it flows over a short table and discharged.

"The machine, at my first visit, was driven by a horse, and after it was taken out I tried to turn the gear and found I could easily drive the machine. The speed was fifty-four oscillations per minute, and the distance it oscillated was 8in.

"Mr. Mudie informed me that the day before my visit he crushed five trucks of quartz in eight hours. These, I consider, would hold over a ton. Taking this as an average I think this small machine working continuously would crush 18 tons of ore per week.

"There is no pump used, as the water was brought in pipes from a dam on a higher level. The machine requires very little fixing, and can easily be erected without any skilled labour, and I think it would be suitable for parties of miners, especially in outlying districts, and with reasonable care there is very little chance of breakages.

"I think the machine could be improved by putting rings of hematitic iron on the rollers (wedged with wood). These could easily be renewed instead of having to provide new rollers. With these rings there would be no wear on the rollers. It would also improve the gold-saving properties of the machine if the crushed material, after it left the machine, had to pass over quicksilver and blanket tables. Any fine gold that might pass the ripples would likely be caught on these tables."

With reference to the weight and cost of the medium, the *Parkes Independent* newspaper of the 15th December last gives the following: "The entire weight of a plant capable of crushing 50 tons of quartz per week does not exceed 5½ tons; and the foundations and setting are said to be so simple that, if furnished with materials, any intelligent miner can put the whole of the machinery in position in a day. The motive force required to work a crusher of the capacity indicated is a two-horse power engine; indeed, for some time the one erected at Elaine was worked by means of one horse and a common horseworks, but this motive force was found not to be regular enough for the purpose. The cost of a plant to crush 50 tons per week is estimated at £200 to £250. Mr. C. Coote, of 172, William Street, Melbourne, showed us a plan of the machine and described its workings. He also exhibited some of the stone operated upon and a sample of the tailings; the first of these being solid quartz, and the latter were of a satisfactory degree of fineness. To us the invention appears invaluable; for it is what may almost be termed a portable crushing-plant, yet working as cheaply and effectively as the intricate and cumbrous machinery now employed to extract gold from quartz, and on this account is specially suitable for erection on fields which, from being more or less untried, do not warrant a large expenditure in the erection of a large crushing plant."

Sutherland's Concentrator and Classifier.

A very simple contrivance was patented last year by Mr. George Sutherland, of Melbourne, for concentrating and classifying metalliferous products. The appliance is so simple and cheap that it deserves attention. It is stated by the patentee that a machine to treat two tons of ore per hour only costs from £45 to £55. The following description and remarks on this machine are taken from the *Australian Mining Standard*:—

"A glance at the illustrations indicating the general principles of Sutherland's concentrator will show at once to what an extent it is a new departure in the interesting and very important problem of mechanical separation of metalliferous minerals from their gangue. In the first sketch given herewith is shown the general idea of an experiment, which may be tried very easily by any one who is desirous of testing the main principle for himself. Let the crushed ore be graded according to size by means of two sieves, of which the coarser has holes not more than, say,

half as large again as the finer. Some of the ore now being put into a strainer of wire gauze, considerably coarser than either of these two, and a tub being filled with water, and a receptacle placed at the bottom to catch the ore as it falls, let the water be set in gentle rotary motion, and the strainer held at some point midway between the centre and the edge, at the surface of the water, so as to scatter the ore to the bottom, it will be seen at once that the action of the water in motion is to spread the ore out in a fan-shaped shower as it falls. The fact is, indeed, that the lighter particles, taking a little longer to fall than the heavier ones, are carried round by the current to a greater distance, and consequently are deposited further away from the strainer than the heavier particles. The results of this simple experiment, if carefully conducted, are really striking, and look at first sight like magic.

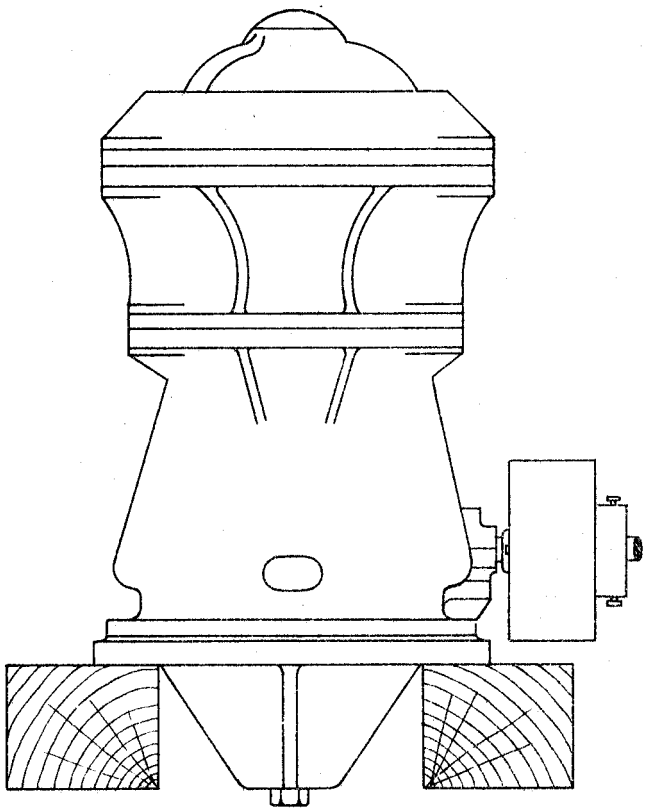
"In the machine, as now finally worked out and patented in the leading colonies of Australia by Mr. George Sutherland, M.A., many points have required attention besides the primary principle thus illustrated on a small scale. Laboratory experiments are one thing, and work on a large scale and of a commercially profitable character is quite another matter. The final result, however, is that a machine about 10ft. in diameter is now capable of putting through 50 tons per day. The ore is fed on to a distributor near the centre, this distributor having eight feeding arms, of which the plan and section are shown in the diagrams. Rapid vibration is imparted to the distributor by means of a ratchet wheel, and the ore falls through a bottom of wire gauze inclined away from the direction taken by the water, so as to give a larger distributing surface, and yet to make the section of the angle made by the ore, as it leaves the arm, as small as possible. Circular motion is imparted to the water by means of horizontal paddles, of which only the ends are to be seen in the illustration. In the working of the apparatus each arm gives out its stream of ore, which falls on a false bottom consisting of perforated metal, and thence falls immediately into compartments set below this false bottom, and intended to receive the first- and second-grade concentrates and the tailings respectively. The whole arrangements of the distributors and the receptacles are set upon a central pivot, and can be readily turned round, as in a railway turntable, so that, on the compartments being filled with ore, they can be pulled round, each set in turn, till they come over a track, which slopes down into the water, for the reception of trucks. Into these trucks the ore is tipped, still occupying separate compartments in the truck which correspond to those in the first receptacles. The trucks are withdrawn from time to time, and emptied as required. Preliminary sizing or classification, prior to treatment, is an essential of good concentration under any system whatever, and for this purpose the well-tried plan of a revolving cylindrical sieve or 'trommel' is preferred. The whole of the operations, however, are performed by means of gravitation, and the necessity for handling the ore is reduced to a minimum.

"Over twenty widely-different ores and tailings have been treated by the machine during the past year, and four distinct uses have been determined as within its sphere of work, these being—First, the extraction of mercury—amalgam from gold-tailings: In one case where tailings were tested it was found that, these being highly odidized pyritous stuff containing antimony, the mercury had been held most stubbornly. The machine brought it out remarkably well, the first grade being practically pure amalgam, and the proportion saved being 1½lb. per ton of tailings. Secondly, the saving of auriferous pyrites: Several samples have been treated, with the most successful results, Sutherland's machine being used for quickly and economically throwing out about nine-tenths of the dead sand, and the final cleaning up of the second grade being left to the vanner, either the Frue or the Lührig machine being applicable. It was found that the tailings thrown out by the machine were fully as clean of pyrites as those rejected by the Frue vanners on one of the best-managed mines in Australia. In the trials of stuff from this mine 100 parts of tailings from the stamps were reduced by the machine to thirteen parts of medium concentrates, and these were proved chemically and mechanically to contain 89 per cent. of the total pyrites in the ore. Thirdly, the concentration of auriferous copper, antimony, and other ores into a form suitable for smelting: In this class of work it was found that stuff only going 2dwt. or 3dwt. to the ton could be worked up very cheaply, so that the first grade would contain from 2oz. to 3oz. Fourthly, the very cheap grading of low-grade silver, lead, tin, or copper ores: Trials upon ores from Broken Hill and other localities show that the new machine, while using a very small quantity of water, does really more accurate work than any of the jiggers or vanners hitherto put into use. The machine is in itself practically a self-acting settling-pit, and hence it effects a great economy in water.

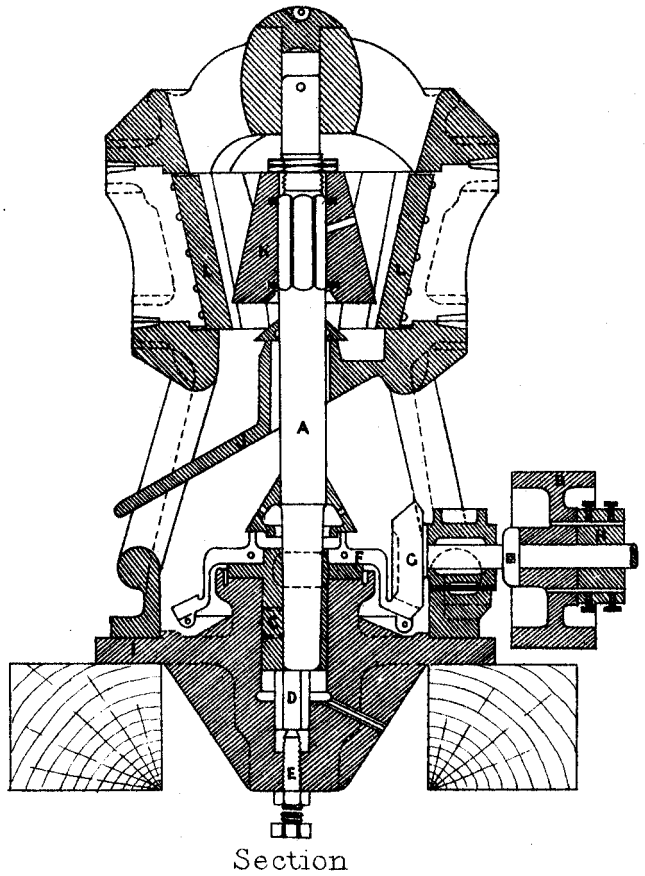
"The inventor of this new system, Mr. George Sutherland, M.A., has hitherto come before the public as an inventor of processes connected with printing and photography which have been in successful use in England and Australasia during the past seven years, and we recently printed a reference to articles by him in *Nature*, referring to the deposition of gold and silver. During the past three years he has devoted his attention to the great problem of utilising low-grade ores by means of concentration; and last July he demonstrated the main principles of his new machine before the Victorian Royal Commission on gold-mining, when it was generally acknowledged by experts that something really new and of great promise to the mining industry had been brought to light by Mr. Sutherland's labours. Invitations to send samples to the Melbourne address of the inventor at Lytton Street, Carlton, and to his Adelaide address, at Angas Street, were freely responded to, and to the courtesy of directors and managers Mr. Sutherland ascribes much of his success in ascertaining the exact field of usefulness before the new machine. The apparatus being so simple and inexpensive, it is intended that those wishing to use it will be supplied with lithographic plans of all but a few small details, which will be sent ready made, and a small fixed royalty will be charged for each year of successful working. This plan has been adopted partly because the inventor does not wish to enter into competition as a maker of machines, but to rely as far as possible upon the services of those who have already made their mark as makers of mineral-saving machinery."

Mr. Sutherland also kindly sent the following particulars in reference to the machine. Plans showing the appliances are hereto annexed (see plan next page):—

PHILLIPS' PATENT ROTARY STONE AND ORE CRUSHING MACHINE



Elevation



Section

STAHL REW PATENT GRINDING & AMALGAMATING PANS

Fig.3

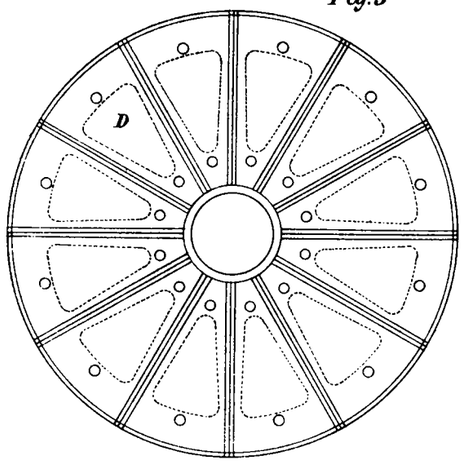


Fig.4

Fig.1

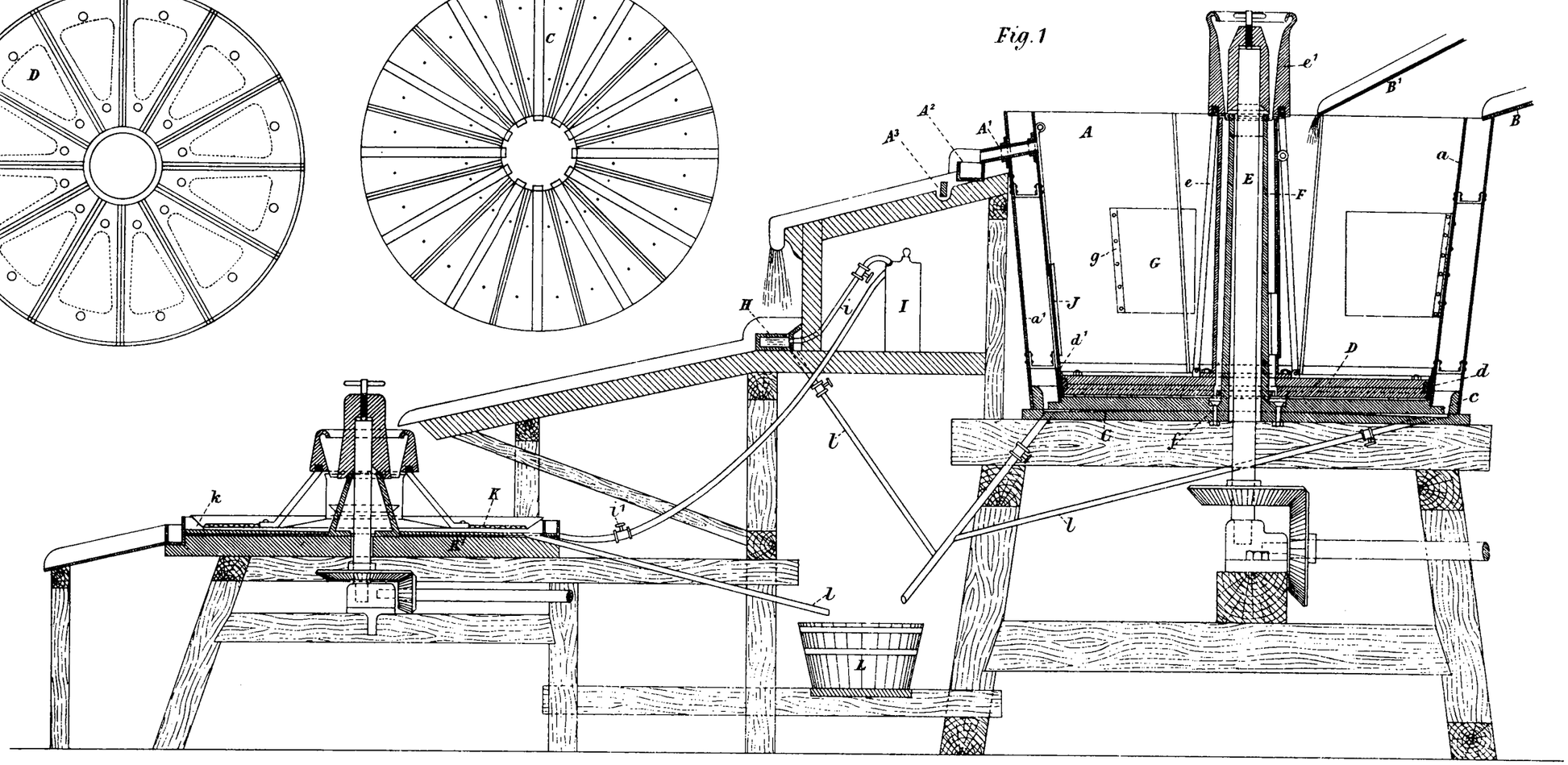
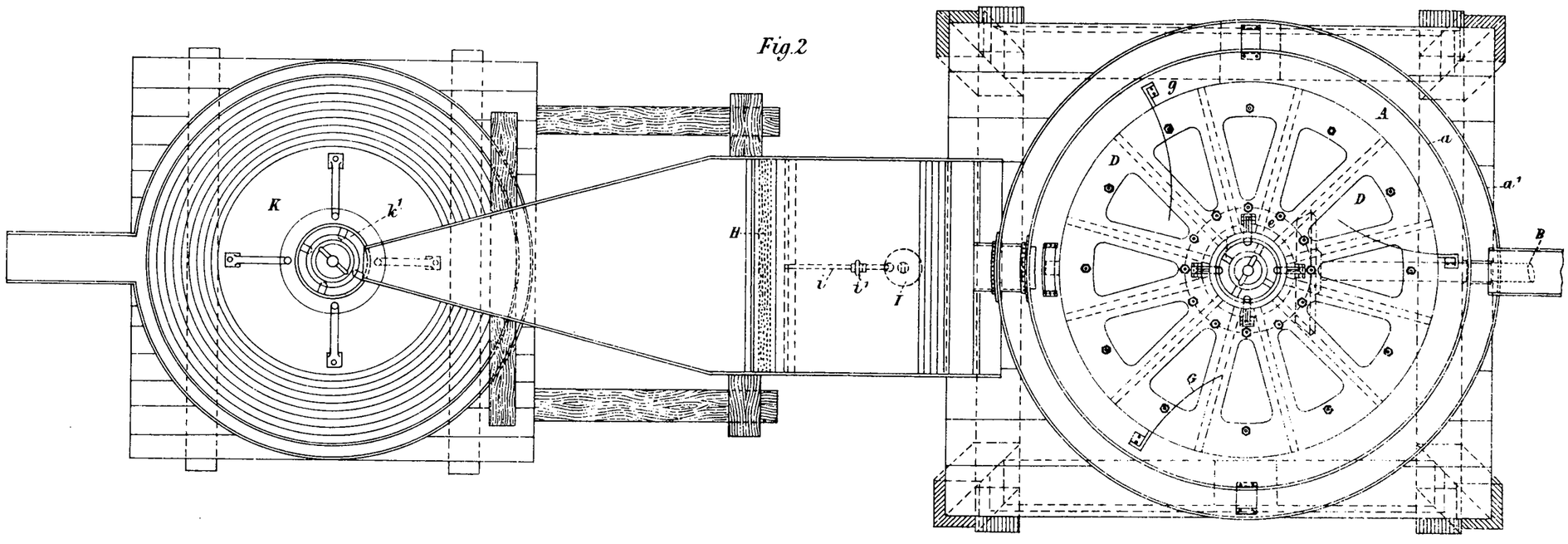
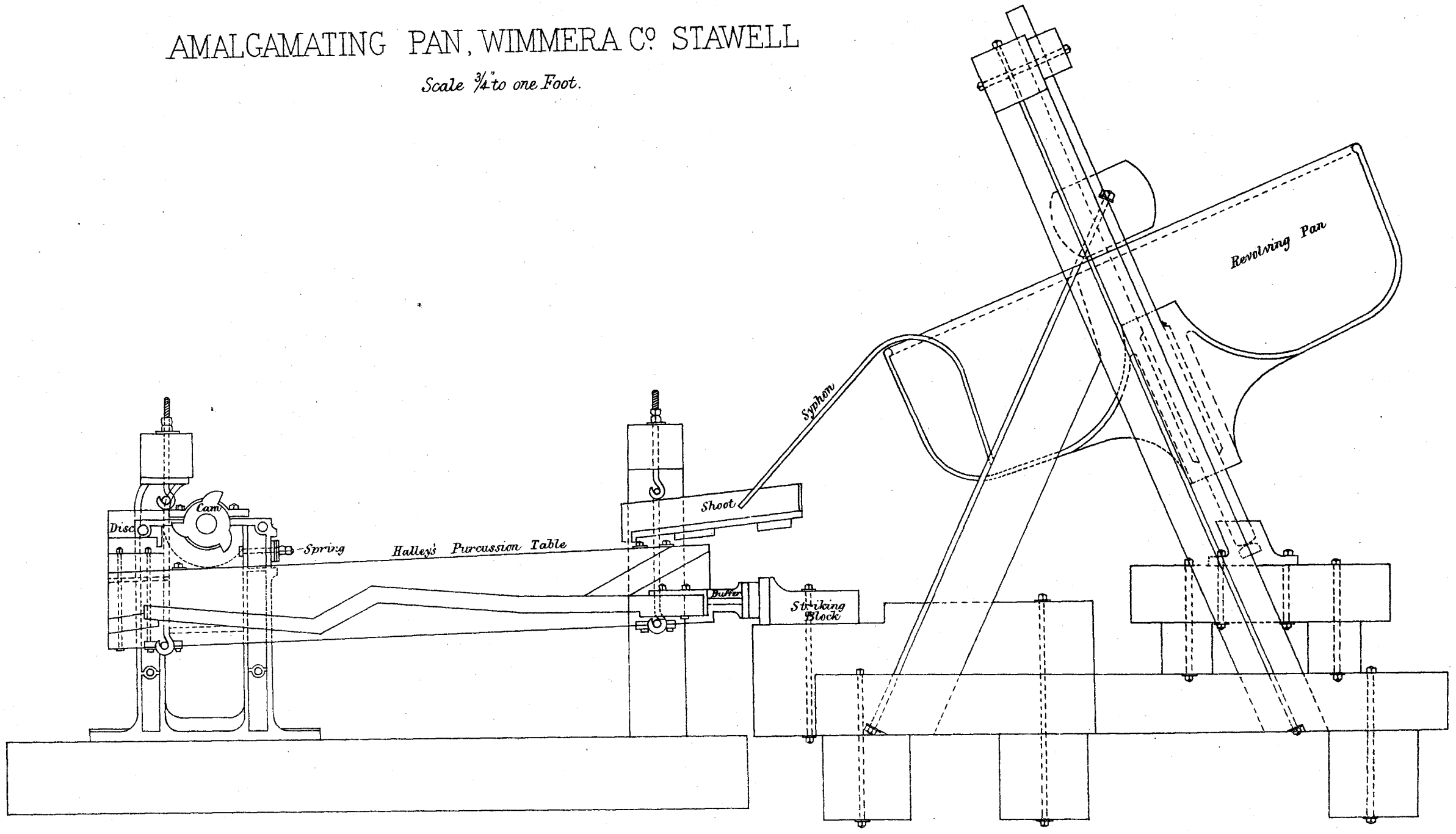


Fig.2



AMALGAMATING PAN, WIMMERA Co STAWELL

Scale ¾" to one Foot.



DAVID MUDIE'S

Patent Quartz Crushing, Amalgamating and GOLD SAVING MACHINE

THIS machine consists of three semi-cylindrical chambers each about four feet in diameter and two feet six inches long, flanged at each end for bolting together in line. Each chamber is fitted with a rocker. When the machine is set up it will be found that each chamber "sits" about two inches below the preceding one. This allows fall for the milled material from one chamber to the other.

The crushing and grinding is effected by placing in each chamber a cast-iron crusher with chilled face of a size proportionate to the capacity of the machine. The crushers work on a false bottom from side to side, in line with and right over each rocker. The feed is at the top or highest end, the material is reduced in the first chamber to pass through a grating of about 30 mesh, in the second to 80, and in the third to 200 to 250 mesh. If it is required to reduce it finer a fourth chamber can be added, which would pulverise to any degree of fineness required.

The gold saving commences after the material passes the first crusher, which consists of two copper-lined mercury wells, depressed about three inches below the bottom of the chamber running across the machine. This is repeated after each chamber, so that whatever gold is liberated in the chamber is caught and amalgamated before the material passes under the next crusher. By this process the reduction of the material is graded in each chamber, and the gold caught as soon as liberated from the quartz. All the wells are provided with covers, which can be locked.

The motion is that of a cradle from side to side on its rockers; this causes the crushers to roll from side to side with a steady crushing movement—crushing and amalgamating at the same time. The mercury in the wells has the same backward and forward motion, which keeps it bright and clean, and gives every facility for a perfect amalgamation.

The motive power required to run a plant capable of treating fifty tons of quartz per week, working 24 hours per day, would not be more than ONE HORSE, and to run a hundred ton plant two horse power.

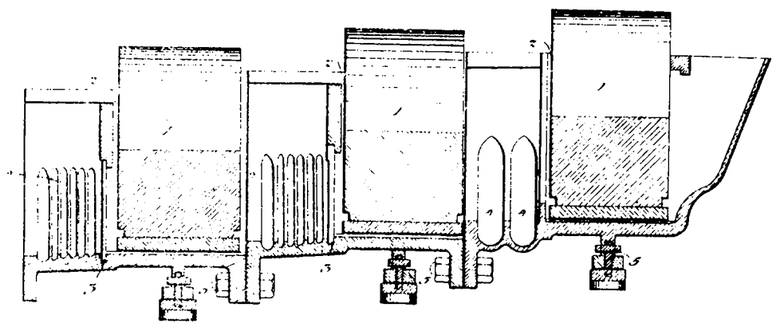
Special points and advantages claimed for David Mudie's Patent Quartz Crushing, Amalgamating and Gold Saving Machine:—

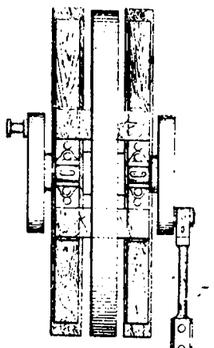
Great saving in the first cost of Machine.
Complete reduction of the quartz to the finest degree required.
Perfect and complete amalgamation of the Gold.
Great saving in cost of transit, the total weight of a fifty-ton plant not being over five and a half tons. Uses only one quarter of the water required for the tables of a Stamper Battery of the same capacity.
A saving of 75 per cent. in motive power, and 90 per cent. in wear and tear.
A return of 20 per cent. more Gold.
The process complete from beginning to finish.
A great saving in cost of erection—no large sheds required (a 100-ton plant sits on a floor space of 10 feet x 10 feet), no heavy foundations required, lay down a few logs, set your machine on, and it is ready to start.

DESCRIPTION OF PLAN.

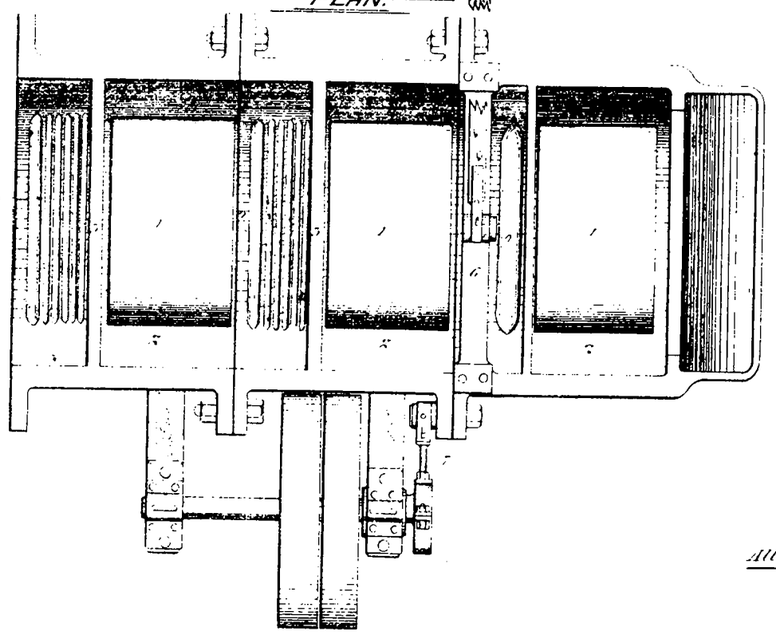
1. Roller Crusher.
2. Chambers.
3. Gratings.
4. Amalgam Wells.
5. Rockers.
6. Levers.
7. Connecting Rod with Crank or Driving Shaft.

LONGITUDINAL SECTION.

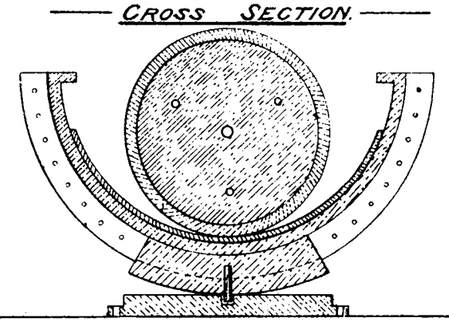


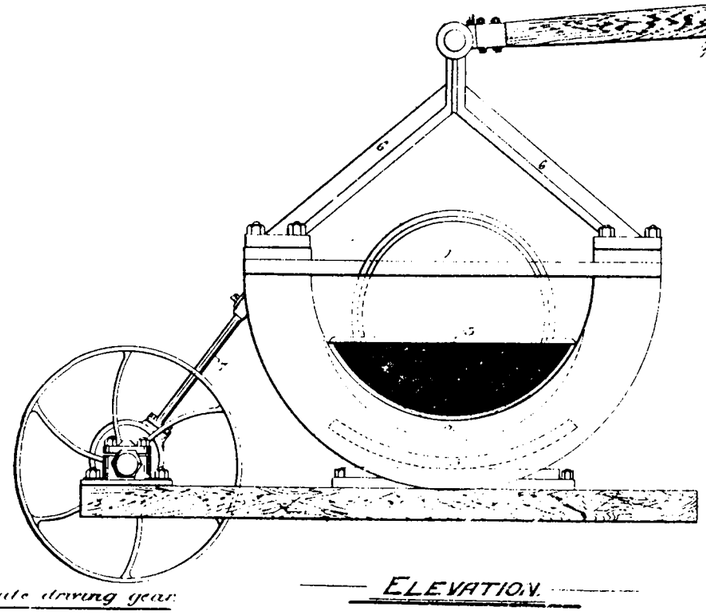


PLAN.



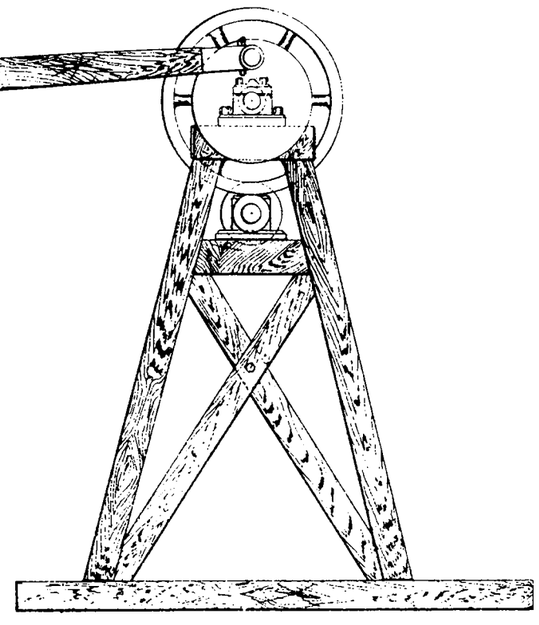
CROSS SECTION.

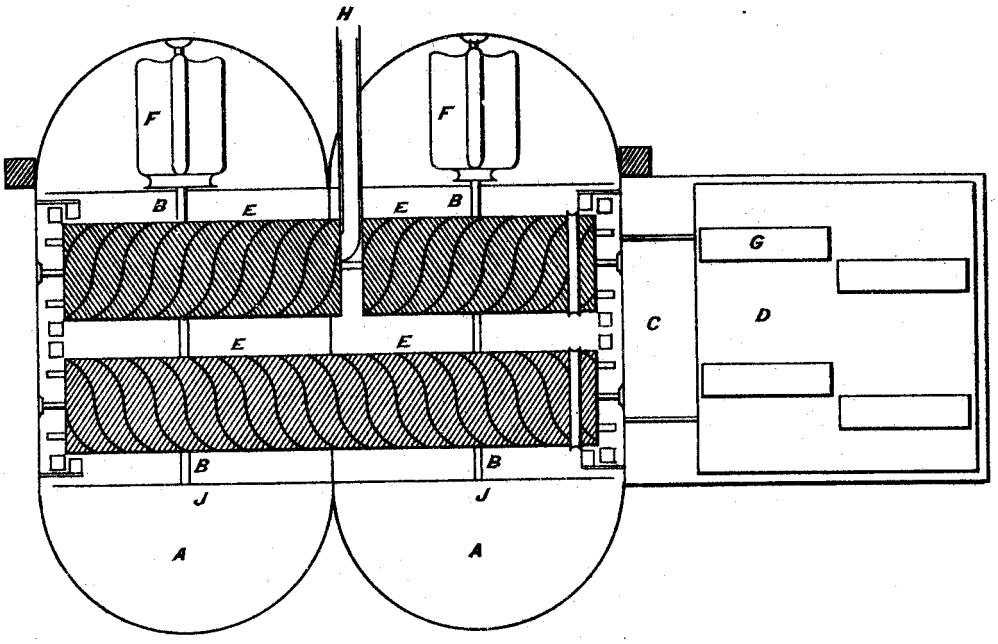


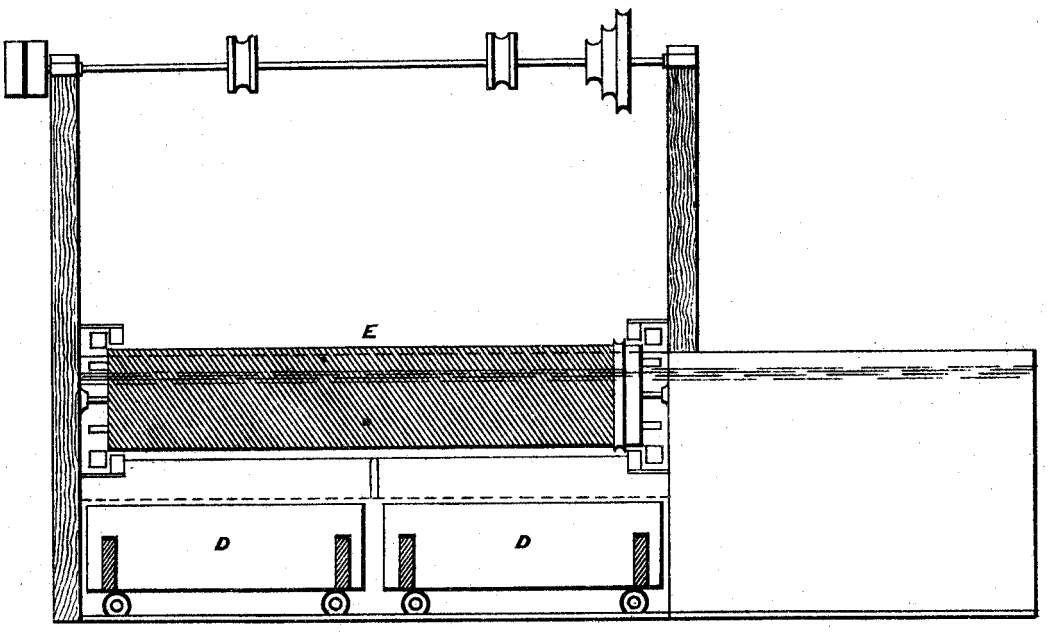


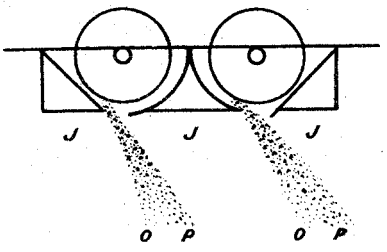
Alternate driving gear.

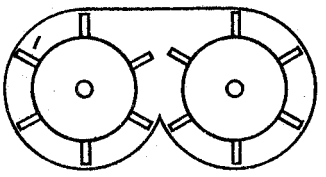
ELEVATION.











— Sketch of —

— SUTHERLAND'S CONCENTRATOR & CLASSIFIER. —

"The efficiency of this machine in the treatment of all low-grade ores tailings, &c., depends upon the combination of two operations—namely, (1) sizing or classification, and (2) concentration by simple gravitation.

"No jigging or shaking of the ore is required, and the consequence is that the machine can be made of the simplest and cheapest materials—wood, galvanised iron, and strip iron being the principal; while the power requisite is so much reduced that a machine to put through tons only demands as many horse-power as one of the older style of dressing-machines in concentrating hundredweights.

"The Sutherland machine combines all the principal advantages of those which are known as dry-air concentrators, but without the disadvantages which have prevented the general introduction of dry-machinery—that is to say, the ore is classified to quality by the simple process of causing it to fall through a resisting medium. Water must always be for this purpose a better medium than air, because gangue, such as quartz for instance, weighs in water little more than half as much as air; at the same time the Sutherland machine economizes water to such a remarkable extent that it may be said to practically rival the dry-air machines even in this, the chief point of their recommendation.

"Careful and exhaustive tests during the past two years have established the facts that the Sutherland machine is applicable in every instance where rapid and economical concentration is a desideratum in saving gold and silver, whether free or in association; its power of separating finely-crushed stuff at a very rapid rate causes it to combine the advantages of the jigger with those of the vanner. A jigger will put through two tons per hour and lose most of the fine stuff, while a vanner will catch the fine stuff, but only run at the rate of 2cwt. or 3cwt. per hour. The work of the Sutherland machine shows the quantity of the first with the quality of the second. For silver, lead, copper, tin, antimony, and all other metals which require fine crushing to liberate the gangue this point is of prime importance.

"The following are particulars of a machine to treat two tons per hour, and to cost £45 to £55, more or less, according to fineness of crushing. (See plans herewith.)

General Description.—The crushed ore is fed in by the pipe or launder *H* into the revolving trommel *E*, and is carried along by the spiral worm on the inside to the end of the machine. Here it is thrown out of one trommel and taken up by the other, which carries it by spiral worm to the opposite end, where a second transference takes place, and the ore finishes its course at the point where it started. Both trommels work three-fourths in water, and, in all, there are eight different sizes of mesh, of which the wire gauze is composed, the first division being the finest, and so on. *A*, *A* are tanks 4½ft. deep, and having a false bottom of perforated zinc 2ft. from the top. This divides the water into two portions, the upper being kept in motion and the lower being reserved for the reception of trucks to catch the ore as it falls. These trucks marked *D* are lowered into the water in a square recess forming part of the whole tank *C*, at the bottom of which runs rails to carry them under the perforated bottom and the trommels. The upper parts of the working basins are divided off by partitions *B*, *B*, *B*, and by means of paddles working on horizontal axes the water is kept in gentle motion up one side of the partition and down the other. Below the trommels is a galvanised-iron horizontal shelf, *J*, *J*, *J*, which divides off the part of the water in which they work from the part which has the current; and connected with these there are also sloping shelves which form hoppers for conducting the ore from the trommels and discharging it through narrow slits in the horizontal shelf. When the ore starts from *H* it parts with its finest size before getting to the partition, and with its next finest before getting to the end of the machine, and so on. As each grade falls through the water the shower of ore is spread out in a fan shape after passing through the slits. The coarser grades, however, require a faster current than the finer ones, and therefore the paddle in the middle division goes twice as fast as that in the outer. The ore, on falling through the perforated bottom, is already graded most accurately to quality, the best being at *O* and the tailings at *P*. All that is needed then is to place boxes at *G*, *G*, in the proper positions for catching the best as concentrates. Similar boxes are also used where a second grade has to be caught. These are lifted out from time to time as required, and the truck containing the tailings is also hoisted out and run along to be tipped over at a tailings-heap. The current should flow about 3ft. per second in the coarse grade, and from 1ft. to 1½ft. per second in the fine grade.

"*Specification.*—Galvanised-iron tank, as per drawings hereto annexed, 16ft. long over all, and 10ft. extreme width, 4½ft. deep. False bottom at depth of 2ft. from the top, and extending over all, except the square recess at side made of perforated zinc with ¼in. holes (larger holes if for very coarse crushed ore). Galvanised-iron shelf under trommels, with sloping attachments, as seen in drawings. Galvanised-iron truck with strip-iron axles attached, and cast-iron wheels; also galvanised-iron boxes for concentrates. Plain rod-iron rails at bottom of tank, full length. Strip-iron hooks at four corners of truck for grappling and raising from water; also four strips of 60-mesh wire gauze soldered into sides (see drawings), so as to let water run out after raising. Surface of ground or floor should be raised round square recess to level of top, for convenience, or rough platform erected. Paddles *F*, *F*, of wooden axis and galvanised-iron blades, with grooved pulleys for driving, the fine grade compartment having 1ft. diameter pulley, and coarse grade 6in. Two double circles of galvanised iron soldered to sides at ends of trommels, as seen in section in first drawing, and in plan in last, with round pieces of wood faced with rubber at 3in. from sides, and fitting close to circumference of trommel.

"Each trommel 18in. diameter, made by taking some very coarse-woven iron-wire—say, with 1in. meshes and 1 yard wide—and bending this into a cylinder, fixing sides together with bolts and nuts. Inside of this attach the fine wire-netting (the pieces should be soldered together) by bolts and nuts, and inside of this again make the spiral worm by means of rubber or insertion cut into strips, and fastened with bolts, having rubber washers to prevent leakage. Mount the whole on three star-shaped sets of arms attached to central shaft, of wrought iron, which is journalled to bearings soldered on sides of tank. At end of trommels place six small paddles of sheet iron *I*, *I*, *I*,

to throw the ore from one trommel to the other. On outside of trommel, and over star-shaped supports, place circle of grooved sheet iron for driving-cord.

"*Driving Gear.*—Two uprights of 3in. square timber carry a revolving shaft of 1in. square bar iron, turned round at ends, and journalled by ordinary bearings. On this are placed wooden grooved wheels, one above each of paddle pulleys, and one above grooved driving-bands of trommels, both of which are driven by the one cord passing round and under both. Three grooves are provided in this driving-wheel, so as to admit of varying relative speeds of paddles and trommels. At end of shaft are driving and loose pulley driven by motive-power. The cord driving trommels should be provided with any suitable form of tension gear as most convenient on premises. Other cords do not require this, as the strain is small.

"*Notes.*—For full and continuous working, it is advisable to attach a square recess to tank at each end, one for withdrawing one truck, and the other for other. Also four bodies of trucks should be provided adjustable to frame and wheels at bottom, so that wheels never leave rails, and bodies of trucks are removed in about a minute. By this arrangement there is no appreciable loss in keeping the machine working continuously. For the water, an overflow-pipe should be provided at any convenient point, and the amount of water displaced by the ore at each filling of trucks will thus be lost, and has to be made up either by an inflow-pipe or by buckets of water. Except in the case of ores heavily charged with argillaceous matter, this is all the water-supply that is really needed. Keep the tank full of water, and it will always be clear enough for working purposes, as the current is never fast enough to allow it to get thick.

"*Patentee's Terms.*—Mine-owners are invited to erect Sutherland's machines according to these plans and instructions, the nominal fee of 1s. royalty being charged for first six months' use of any machine, and £25 for each succeeding half-year. Further inquiries and bags of ore for trial (crushed, and carriage paid) should be sent to G. Sutherland, 11, Lytton Street, Carlton, Melbourne, or Angas Street, Adelaide."

Goddard's Patent Grinder and Gold-saver.

Considerable interest has been evinced during the last few weeks in the trials of a new gold-saving appliance, invented and patented by Mr. H. S. Goddard, engineer, of Uralla, New South Wales, who for over two years has been engaged perfecting the invention. The machine is designed to save floured silver and gold, which ordinarily are lost in tailings from batteries, and the several tests and trials, which have been of the most severe character, and have taken place at Langland's foundry, South Melbourne, resulted successfully. Goddard's patent differs from many appliances in its simplicity, efficiency, and cheapness. It consists of a circular pan, the bottom and sides of which are lined with grooved hæmatite iron, in which works a muller, also with grooved bottom and sides, the grooves being placed at opposite angles to those in the pan. The weight of the muller is about 9cwt., and it revolves in the lined pan at the rate of 150 revolutions per minute, its action on tailings running direct from the battery being to grind them fine as roller flour. The pan is fed from the centre of the muller at the rate of 9cwt. per hour, and can be automatically fed from a battery, thereby saving an immense amount of labour and attention. After grinding is completed the material passes through the inner amalgamator, charged with quicksilver, and the centrifugal action of the muller throws the fine sand over the edge of the pan into a ring-well, also charged with quicksilver; so that it is impossible for gold to pass. The sand is kept agitated by several fingers revolving in the outer well, and is there discharged with the waste water at a spot in the outer casing of the machine. The wearing parts being of white hæmatite iron, are very durable, and are easily renewed any time. It is said that the machine now at work will receive and grind as much as can be delivered from a five-head battery, with gratings of forty-one holes to the inch, thus effecting a material saving in cost of crushing and treating, leaving the residue finer than that from an ordinary battery. Tables and blankets are entirely dispensed with. The machine is further specially adapted for the treatment of fine gold, and should prove a desirable acquisition where flake or floured gold is lost. We are informed that it has been successfully tried in the Hillgrove district, in New South Wales, where a quantity of tailings from the Eleanora Gold-mine, which gave by fire-assay 5dwt. 9gr., were treated, and resulted in return of 4dwt. 15gr. Tailings from Alpine Gold-mine, at Swamp Oak, which assayed by fire 23dwt., were also put through the pan, giving a result of 21dwt. A parcel of quartz from the Great Britain claim, at the same place, which crushed about 6oz., gave 9oz. 13dwt. 1gr. Two tons of tailings from Russell's Amalgamated Company, Victoria, which had been treated at the modern battery of that company with 240-mesh gratings, gave a return of 2½dwt. per ton. Another two tons from the same company gave 4dwt. per ton, both from the new machine. Three trucks of tailings from Eaglehawk district (different claims) are being treated at present. The first lot of two tons gave 3dwt. to the ton; the others are being put through, and the amalgam promises encouraging results. A large number of other orders are on hand. The machine can be made in sizes suitable for five, ten, fifteen, or twenty head of stamps. It will feed itself, is speedier than the usual chlorination process, and does not lose a grain of quicksilver. The agents, Messrs. Thomas Scott and Company (Limited), 99, Queen Street, Melbourne, state that the patent rights in all the colonies, Great Britain, America, and South Africa have been purchased by a syndicate of Victorian and New South Wales gentlemen, who propose forming a large public company to work all the places named. The machines will be manufactured under the personal superintendence of the inventor, who is a practical engineer, and applied to the clearing up of tailings everywhere.—*Australian Mining Standard.*

The Noble Gold-mining Process.

A new process, which bids fair to be of great importance in gold-mining, is about to be introduced by the Noble Mining and Milling Company of New York, a company recently organized

for its exploitation. The process, which is the invention of the late Mr. B. D. Noble, ex-Governor of Wisconsin, an experienced chemist, who spent many years upon its development, is designed to save the very fine gold occurring in certain ores, much of which is lost as float gold in the ordinary process of amalgamation. This desideratum is accomplished by intermixing the pulp and mercury to a degree hitherto unattainable on account of the danger, and consequent loss, of flouring the mercury, this difficulty being overcome in the Noble process by the addition of a chemical, which has the effect of coalescing the almost infinitesimally fine particles of floured mercury. A series of tests with the process, which have been conducted at the company's testing-works near New York, upon a working scale, during the past six months, has given extremely successful results. By the Noble process the auriferous ore is ground so as to pass a hundred-mesh sieve, a Fuller mill having been used for this purpose at the experimental works.

The pulp, with the necessary amount of mercury for amalgamation of its gold contents, is then run into a tube called the amalgamator, which has a stirrer suspended near the iron bottom of the vessel.

The tub, which is 42in. in diameter, has a capacity of half a ton of pulp at a charge. The charge having been run into the amalgamator, the mercury, coalescing chemically, the nature of which is kept a secret, is added, and the stirrer put in motion, rotating at 250 revolutions per minute, the presence of the chemical preventing the flouring of the mercury. During this operation, which lasts fifteen minutes, the particles of pulp are brought into contact with those of mercury in the most thorough manner, and the amalgamation is effected. The pulp is then drawn off into a settler, little different from those of the ordinary type, and diluted, whence it is drawn into a second settler, and further diluted, from which the tailings are allowed to run away. In the tests which have been made various lots of ore, principally from North Caroline Mines, have been run. Ore from one mine, which is now being regularly worked by plate amalgamation, furnished the best comparative result. It was a free-milling ore, containing a very small amount of pyrites, assaying from 8s. to 16s. per ton. On the plates but 24 per cent. of the gold-value was recovered, while by the Noble process as much as 93 per cent. was saved. Equally satisfactory results have been obtained from pyritous ores. The loss in mercury in experimental runs has been about ½lb. per ton. In continuous runs this would, of course, be considerably smaller. It is claimed that in a 25-ton plant the process can be worked for 4s. per ton.—*Mining and Engineering Journal*, New York.

LIMESTONE AND COAL AT ALFORD FOREST.

A good deal of prospecting has been done in the vicinity of Alford Forest. Some years ago Mr. Jacobsen caused great excitement about diamonds being found in this locality. On visiting the field on that occasion no diamonds were shown me, but several people had small match-boxes full of small crystallized quartz, which they prized to a considerable extent. My next visit to this district was a few years later, when tin was reported to be found; but the so-called tin proved to be trachylyte. In February last, Messrs. Duncan and Stott reported that they had found a valuable deposit of coal and limestone, and the Hon. Minister of Mines desired me to visit the locality, and report as to the value of the discovery, which bears out to a great extent the representations of the lessees as to the value of the limestone; but, as to the quantity of coal in the locality, there has not been sufficient work done to enable one to judge of the extent of this deposit.

The ground is situated on the outskirts of the Alford Forest, on the slope leading up to the foot of Mount Somers, about 950ft. above the sea-level. It is about four miles distant from the Springburn Railway-station, to which there is a good dray-road for about three and a half miles, and there will be no difficulty in connecting the coal and limestone deposits with a tramway to the road for the remaining half-mile.

The belts containing the limestone and coal run parallel, in a northerly and southerly direction, about from 10 to 12 chains apart, having a moderately deep gully between them. The bottom and sides of the gully are covered with bush, from which suitable timber can be got for mining operations.

Limestone.

The limestone crops out along the surface of the ground for about 40 chains in a northerly direction from Reid's Creek, the outcrop being about one chain and a quarter in width, and dipping to the westward. The stone in the outcrop is of three different qualities. That taken from the western side of the outcrop contains black and green sand, but one of the specimens taken from the northern end of the outcrop contained a much larger percentage of oxide of iron than any of the others. The samples were analysed at the Colonial Laboratory, and the one taken from the eastern side of the outcrop shows it to be of very good quality of limestone, and well adapted for burning into lime, or for building-stone, especially for interior work. The whole of the three samples taken away are somewhat incoherent, and absorb a considerable quantity of water, which is rather against it as a building-stone.

The following is an analysis of the three samples of stone brought away:—

No. 1 sample, from the western side of outcrop on southern end—Carbonate of lime, 79·79; carbonate of magnesia, 2·86; iron-oxide, 3·14; alumina, trace; siliceous matter, 14·0; water, 20: 100·00.

No. 2 sample, from western side of outcrop, northern end—Carbonate of lime, 80·78; carbonate of magnesia, 2·89; iron-oxide, 6·22; alumina, trace; siliceous matter, 9·87; water, 24: 100·00.

No. 3 sample, from eastern side of outcrop—Carbonate of lime, 93·24; carbonate of magnesia, 2·96; iron-oxide, 1·39; alumina, trace; siliceous matter, 2·25; water, 16: 100·00.

It will be seen from the above that samples No. 1 and 2 are nearly of the same composition as regards lime, but different in respect to the quantity of iron-oxide and siliceous matter, whilst sample No. 3 shows that it has a much larger percentage of lime than any of the others.

Coal.

The coal lies to the westward of the limestone, and at a slightly higher elevation. Very little work has been done to open up the seam; the only places where it can be seen are in the different gullies, and in an adit-level driven in from the face of the hill, where it cuts the coal in the bottom, but the adit was constructed at too high a level to open out and work the seam. Very little can be said in reference to the coal, except what can be seen at the outcrops. These outcrops occur at Reid's Creek, and in several creeks and gullies. In some of these places there are three seams, with layers of mullocky clays and shale between, the largest of these seams being 7ft. in thickness. At some places the seam appears to be dipping at an angle of 45° to the westward, and in one place the seams are nearly horizontal, the latter place being in the northern side of Rata Gully.

The quality of the coal is similar to the brown coal found at Springfield, Whitecliffs, and Mount Somers, in Canterbury, and from all appearances there ought to be a sufficient deposit of it in this locality to justify it being opened up to supply coal for local consumption and for lime-burning. It is very suitable for the latter purpose, as will be seen from its analysis: Fixed carbon, 47·58; hydro-carbon, 39·95; water, 16·41; ash, 2·06: 100·00. The evaporation-power is 6·19lb.

With regard to the value of the property, it depends to a great extent on the market that can be got for lime. Taking the close proximity of the coal and limestone, the natural facilities for burning lime and getting it conveyed to the railway, into consideration, it ought to be produced at a very low figure per ton.

SPONTANEOUS IGNITION OF COAL, AND ITS PREVENTION.

The question of spontaneous combustion in coal is one on which there is a great division of opinion. Many theories are set up as to the cause of spontaneous combustion which when they come to be analysed do not sufficiently account for all the circumstances. Some coals are not liable to spontaneous combustion; while with other classes of coal it is not safe to leave any fine dust, or it may be termed rubbish, lying in quantity in old worked-out bords, or even to carry it in cargoes. The coal found in the Waikato District and in many of the coal-mines in Otago is especially liable to heat and take fire. The earliest theory was that spontaneous combustion in coal was due to the oxidation of pyrites—disulphide of iron—into sulphates, but it has long since been proved that spontaneous ignition is not due to this alone, and that coal containing but a minute trace of iron-pyrites, but containing a large percentage of water, was far more liable to spontaneous ignition than coal containing a large percentage of pyrites, which shows that the absorption of oxygen by the coal plays a prominent part in the question of spontaneous combustion.

In the *Colliery Guardian* of the 18th, and also of the 25th March last, is published a paper read by Professor Vivian B. Lewes, F.L.S., F.C.S., before the Society of Arts on the 2nd March last, which contains a great deal of interesting matter on this subject, in which Professor Vivian states:—

"Last autumn I had the honour of bringing before the Chemical Section of the British Association certain views, which are now widely gaining ground, as to the cause of the phenomenon of spontaneous ignition of masses of stored coal; and, in the discussion which ensued, Sir Frederick Bramwell expressed the hope that the paper would be followed by a second, in which methods for the prevention of this too often disastrous action might be discussed; and it is at the invitation of your secretary that I propose to bring my views on the subject before you to-night. Ever since the general adoption of coal as a fuel, the storing and shipment of masses exceeding 2,000 tons has been recognised as requiring great care; and if much small coal has been present, or if it has been stored wet, firing, or at any rate heating, of the mass has frequently taken place. On shore this has led to much inconvenience and loss, but it is during shipment that the real danger has occurred; and many a fine vessel, with all hands, has been lost from this cause, without even a record of the calamity reaching the land. In 1875 the loss of life and property from this cause became so serious that a Royal Commission was appointed to report upon the possibility of preventing these appalling disasters; but the recommendations contained in the report, although of the greatest possible value, seem to have had but little effect in checking the loss from spontaneous ignition; and, in the nine years following the publication of the report (1873 to 1883), no less than fifty-seven coal-laden vessels are known to have been lost from this cause, whilst 328 others were missing. In coal stores, and in gasworks, heating frequently takes place, but is so much more easily dealt with than at sea that cases of absolute ignition are much rarer; and it is from the evidence obtained in the case of coal cargoes that we can learn most as to the cause and prevention of this most dire plague of the coal trade. In treating the subject to-night, I will first bring to your notice the explanation of the action which eventually results in combustion, and which is founded upon the work of Richters and myself, and will consider how the incipient action can be best prevented, or at least retarded, and the steps which should be taken in case ignition should result. Coal is a substance of purely vegetable origin, formed out of contact with air by long exposure to heat and pressure, from the woody fibre and resinous constituents of a monster vegetation, which flourished long before the earth was inhabited by man; and coal may therefore be looked upon as a form of charcoal, which, having been formed at a temperature lower than that of the charcoal burner's heap, and under great pressure, is very dense, and still retains a quantity of those constituents which, in the latter case, are driven off as tar, wood naphtha, &c. These bodies consist essentially of compounds containing carbon and hydrogen, together with a little oxygen and nitrogen, and form the volatile matter and hydrocarbons of the coal. Besides the carbon and hydrocarbons, coal also contains certain mineral bodies, which were mostly present in the sap and fibre of the original vegetation, and which gives the ash which is left behind when the coal is burnt. These substances consist

chiefly of sulphate of lime or gypsum, silica, and alumina, whilst in nearly all kinds of coal is to be found a substance called disulphide of iron, coal brasses or pyrites, which has been formed by the gradual reduction of the sulphates by carbonaceous matter in the presence of iron salts, and which, during the combustion of the coal, is decomposed, giving off sulphur compounds, and leaving behind oxide of iron, which gives the reddish-brown colour to the ash of many kinds of coal. Of these constituents of coal, the only ones which play no part in the phenomena attending heating and spontaneous ignition are the mineral constituents other than the pyrites, and we have, therefore, to deal with the chemical actions which take place when the carbon, hydrocarbons, and brasses contained in newly-won coal come in contact with air and moisture.

"The Influence of Carbon in producing Heating.

"Carbon is one of those substances which possess to an extraordinary degree the power of attracting and condensing gases upon their surface, this power varying with the state of division of the particular form of carbon used. The charcoal obtained from dense forms of wood, such as box, exhibits this property to a high degree, 1 cubic inch of such charcoal absorbing:—

	Cubic inches.
"Ammonia gas	90
Sulphuretted hydrogen	55
Carbon dioxide	35
Ethylene (olefiant gas)	35
Oxygen	9·25
Nitrogen	6·5

"whilst certain kinds of coal also exhibit the same power, although to a less degree. The absorptive power of newly-won coal due to this surface attraction varies, but the least absorbent will take up one and a quarter times its own volume of oxygen, whilst in some coals more than three times their volume of the gas is absorbed. This absorption is very rapid at first, but gradually decreases, and is, moreover, influenced very much by temperature, for reasons which will be explained later. The absorption is at first purely mechanical, and itself causes a rise of temperature, which, in the case of charcoal formed in close retorts, as in preparing alder, willow, and dogwood charcoal for powder-making, would produce spontaneous ignition if it were not placed in sealed cooling-vessels for some days before exposure to air. The rate of absorption varies with the amount of surface exposed, and, therefore, able to take part in this condensing action, so that, when coal or charcoal is finely powdered, the exposed surface being much greater, absorption becomes more rapid, and rise of temperature at once takes place. If, after it has been made, charcoal is kept for a day out of contact with the air, and is then ground down into a powder, it will frequently fire after exposure to the air for thirty-six hours, whilst a heap of charcoal powder, of a hundred bushels or more, will always ignite. It is for this reason that in making the charcoal for powder it is always kept, after burning, for three or four days in air-tight cylinders before picking over, and ten days to a fortnight before it is ground. In the case of coal, this rise in temperature tends to increase the rate of the action that is going on, but is rarely sufficient to bring about spontaneons ignition, only about one-third the amount of oxygen being absorbed by coal that is taken up by charcoal; the action also being much slower, tends to prevent the temperature reaching the high ignition-point of the coal. Air-dry coal absorbs oxygen more quickly than wet coal.

"The Action of the Bituminous Constituents of the Coal in Spontaneous Ignition.

"All coal contains a certain percentage of hydrogen, which is in combination with some of the carbon, and also with the nitrogen and oxygen, and forms with them the volatile matter in the coal. The amount present in this condition varies greatly, being very small in anthracite and very great in cannel and shale. When the carbon of the coal absorbs oxygen, the compressed gas becomes chemically very active, and soon commences to combine with the carbon and hydrogen of the bituminous portions, converting them into carbon dioxide and water vapour. This chemical activity increases rapidly with rise of temperature, so that the heat generated by the absorption of the oxygen causes it to rapidly enter into chemical combination. Chemical combination of this kind—*i.e.*, oxidation—is always accompanied by evolution of heat, and this further rise of temperature again increases rapidity of oxidation, so that a steady rise of temperature is set up, and this taking place in the centre of a heap of small coal, which, from the air and other gases enclosed in its interstices, is an admirable non-conductor of heat, will often cause such heating of the mass that, if air percolate slowly into the heap in sufficient quantity to supply the necessary percentage of oxygen for the continuance of the action, the igniting-point of the coal will soon be reached. The effect of rise of temperature in increasing the rapidity of chemical actions of this kind can be realised from the effect which it has in the spontaneous ignition of oily waste or rag. If a substance like cotton-waste be rendered oily with anything except the mineral oils, it acquires the power of taking up oxygen from the air, and this oxidizing the oil gives rise to heat. At ordinary temperatures this oxidation is slow, and consequently it may be days before the rise in temperature becomes sensible; but when this point is reached the oxidation proceeds with remarkable rapidity, and in a few hours the point of ignition is reached, and the mass bursts into flame, whilst if the oily waste be placed in a warm place at first, spontaneous ignition is only a question of hours, or sometimes even minutes. Galletley found that oily cotton at ordinary temperatures took some days to ignite, whilst, if placed in a chamber warmed to 130° to 170° Fahr. (54° to 76° C.), the cotton, greasy with boiled linseed, ignited in one hour fifteen minutes, and olive oil on cotton in five hours; and in a chamber heated to 180° to 200° Fahr. (82° to 93° C.) olive oil on cotton ignited in two hours. It has been suggested that very bituminous coal, such as cannel, shale, and coals containing schist, is liable to spontaneous ignition from the fact that a rise in temperature would cause heavy oily to exude from them, which, by undergoing oxidation, might cause rapid heating. But experiment not only shows that this is

not the case, but that heavy mineral oils have a remarkable influence in retarding heating; cotton-waste, oily with easily oxidizable oils mixed with 20 per cent. of heavy mineral oil, being exempt from heating.

"*The Action of Iron Disulphide, Pyrites, or Coal Brasses in Promoting Spontaneous Ignition.*

"The earliest theory as to the cause of spontaneous ignition in coal was, that it was due to the heat given out during the oxidation of pyrites (the disulphide of iron) into sulphates, and this idea has been adopted, and has held its own in this country up to the present time, although the researches of Dr. Ritchters, some twenty years ago, clearly prove that the explanation was an erroneous one, and the late Dr. Percy, as early as 1864, pointed out that probably oxidation of the coal had a great deal to do with the action. This disulphide of iron is found in coal in several different forms, sometimes as a dark powder distributed throughout the mass of the coal and scarcely to be distinguished from the coal itself. In larger quantities it is often found forming thin golden-looking layers in the cleavage of the coal, while it sometimes occurs as masses and veins, often 1in. or 2in. in thickness, but, inasmuch as these masses of pyrites are very heavy, they rarely find their way into the screened coal for shipment, many hundreds of tons of these 'brasses' being annually picked out from the coal at the pit's mouth, and utilised in various manufacturing processes. The yellow pyrites which form the large masses in the coal, and even the dark varieties when in the crystalline form, remain perfectly unaltered, even after long exposure to moist air, but the amorphous and finely-divided portions, which probably contain lower sulphides mixed with the disulphide, will oxidise and effloresce with considerable rapidity when exposed to moisture and air, forming mixtures of ferrous sulphate and basic sulphates of iron, and it is during this process of oxidation that the heat supposed to bring about the ignition of coal is generated. In some of the coals most prone to spontaneous ignition there is only 0·8 per cent. of pyrites, and if we imagined the whole of this to be easily oxidizable, and to be concentrated in one spot instead of being spread throughout the mass, and to be entirely oxidized in a few hours, the rise of temperature would only be a few degrees; whereas, under existing circumstances, it is manifest that practically no determinable increase can be generated by the action. Under certain conditions the oxidation of masses of pyrites first gives rise to the formation of ferrous sulphate, and sulphur dioxide with liberation of sulphur, and my early experience led me to believe that, inasmuch as sulphur has an igniting point of 250° C., this free sulphur might play an important part in the action, by lowering the point of ignition. Later experiments, however, show that this could only take place with large masses of pyrites undergoing oxidation, and that with the amounts present in the coal, if the air were present in sufficient quantity to oxidize the pyrites, the small trace of sulphur liberated would be oxidized to sulphur dioxide at temperatures as low as 60° C. This oxidation of sulphur at low temperatures is not a generally-known action, but my experiments show that it takes place with considerable rapidity. The only way in which pyrites can assist spontaneous ignition is that when they oxidize they swell and cause disintegration of the lumps of coal, so exposing fresh surfaces to absorb oxygen and afterwards carry on chemical action. I have carefully determined the igniting point of various kinds of coal, and find that cannel coal ignites at 698° Fahr. = 370° C. Hartlepool coal ignites at 766° Fahr. = 408° C.; lignite coal ignites at 842° Fahr. = 450° C.; Welsh steam coal ignites at 870·5° Fahr. = 477° C. So that no stretch of imagination could endow the small trace of pyrites scattered through a large mass of coal, and undergoing slow oxidation, with the power of reaching the needful temperature. When coal is heating, it gives out a distinctive and penetrating odour, which is the same as that noticed when wood is scorched. The gases evolved by the heating coal consists of nitrogen, water-vapour, carbon dioxide, carbon monoxide, hydro-carbons of the paraffin series, and sulphuretted hydrogen, the presence of the latter gas showing beyond doubt that oxidation of sulphur had nothing to do with the action. We can now trace the actions which cumulate in ignition. The newly-won coal is brought to the mouth of the pit, and at once commences, by virtue of its surface action, to absorb oxygen from the air; but unless piled in unusually large heaps, and a great deal broken, it does not, as a rule, show signs of heating, as the exposed surface is comparatively small, and the air, finding its way freely between the lumps, keeps down the temperature. The coal is now screened, and the obtrusively large lumps of brasses picked out; it is then put in the trucks, and enjoys the disintegrating processes of joltings and shuntings innumerable, every jar adding to the percentage of small coal present, and a corresponding increase in the size of the surface exposed to the air. Arrived at the docks, it has to be transferred from the truck to the ship, which is done by one of the numerous forms of tips, shoots, or spouts employed for the purpose, and it is during this operation that more harm is done than at any other period. The coal first shot into the vessel, by reason of the distance which it has to fall, is broken down into small lumps, and having to bear the impact of the succeeding loads falling upon it from a height rapidly becomes powdered into slack, whilst the succeeding loads falling in on the cone so formed get more or less broken down, so that by the time the cargo is all taken in a dense mass of small coal is to be found under the hatchway, and it is invariably at this point that heating takes place, as the large surface exposed fresh to the air by breaking down of the coal causes rapid absorption of oxygen, and consequent rise of temperature. This sets up chemical combination between the oxygen absorbed by the coal and the hydrocarbons and coal brasses. On examining the evidence to be obtained as to the conditions under which spontaneous ignition of coal in ships usually takes place, it is found that liability to ignition increases with—

"1. *The Increase in Mass of Coal.*—Thus, in cargoes of under 500 tons the cases reported amount to a little under ¼ per cent. for shipments out of Europe; from 500 to 1,000 tons, to over 1 per cent.; from 1,000 to 1,500 tons, to 3·5 per cent.; 1,500 to 2,000 tons, to 4·5 per cent.; and over 2,000 tons to no less than 9 per cent. The evidence demonstrating this very remarkable result is to be found in the Report of the Royal Commission for 1875, p. 8, and clearly shows the influence of mass upon this action, which acts in two ways: (*a*) The larger the mass, the more non-conduct-

ing material will there be between the spot at which heating is taking place and the cooling influence of the outer air. (*b.*) The larger the mass the greater will be the breaking-down action of the impact of coal coming down the shoot upon the portions first loaded into the ship, and the larger, therefore, the fresh surface exposed to the action of the air.

"2. *The Ports to which Shipments are made.*—26,631 shipments to European ports, in 1873, only resulting in ten casualties, whilst 4,485 shipments to Asia, Africa, and America gave no less than sixty. This startling result is partly due to the length of time the cargo is in the vessel, the absorption and oxidation being a comparatively long action; but a far more active cause is the increase in the action brought about by the increase of temperature in the tropics, which converts a slow action into a rapid one, and if statistics had been taken, most of the ships would have been found to have developed active combustion somewhere about the neighbourhood of the Cape, the action developed in the tropics having raised the temperature to the igniting point of the coal by that time.

"3. *The Kind of Coal.*—Some coals being specially liable to spontaneous heating and ignition. This is a point on which great diversity of opinion exists, but I think it will be pretty generally admitted that cases of heating and ignition are more frequent in coals from east coast ports than in shipments of the South Wales coals. The idea that the percentage of pyrites present is any indication of the liability to spontaneous combustion must be entirely discarded, as experiment shows that many coals poor in pyrites frequently ignite, whilst others rich in them are perfectly safe. A much surer guide is to be found in the quantity of moisture present in an air-dried sample of coal, which is a sure index to the absorptive power. The higher the amount of moisture held by the coal, after exposure for some time to dry air, the greater will be its power of absorption for oxygen, and the greater therefore its liability to spontaneous heating and ignition. This is beautifully shown by the following table, in which the percentage of pyrites and moisture present in some coals are contrasted with their liability to self-ignition:—

Liability to Spontaneous Ignition.	Pyrites. Per cent.	Moisture. Per cent.
Very slight	1·13	2·54
	1·01 to 3·04	2·75
	1·51	3·90
Medium	1·20	4·50
	1·08	4·55
	1·15	4·75
Great	1·12	4·85
	0·83	5·30
	0·84	5·52
	1·00	9·01

The percentage of moisture shown in this table is not due to external wetting, but is moisture absorbed from the air and held by the coal, so that the amount of it present is an indication of the power of absorption possessed by the coal, and which will give it the power of taking up oxygen as well as water vapour.

"4. *The Size of the Coal.*—Small coal being much more liable to spontaneous ignition than large. This, as has been pointed out, is entirely due to the increase in active absorbent surface exposed to the air, a fact which is verified by the experience of large consumers of coal on land; gas managers recognising the fact that coal which has been stamped down or shaken down during storage being more liable to heat than if it has been more tenderly handled, the extra breakage causing the extra risk.

"5. *Shipping or Storing Coals while Wet.*—The effect of moisture upon coal is very remarkable. At first external wetting retards the absorption of oxygen by the coal, but the presence of moisture afterwards increases the action of the already absorbed oxygen upon the hydrocarbons of the coal, and so causes a serious increase in the heating. Of late years the researches of Cowper, Baker, Dixon, and others have shown so fully the important part which moisture plays in chemical combination, that it is now fully recognised as a factor of importance in actions of this kind. During last autumn a very marked case of the influence of moisture in the action taking place came under my notice. A ship took in a cargo of coal at a South Wales port, the weather being fine and dry whilst she was loading at the main hatch, and wet whilst taking in the coal at the after-hatch, with the result that the temperature after the first few days was uniformly about 10° higher in the coal that had been loaded wet than in the dry portion of the cargo, spontaneous ignition being the ultimate result.

"6. *Ventilation of the Mass of Coal.*—The so-called ventilation, which has from time to time been introduced into coal ships, is undoubtedly the most prolific causes of spontaneous ignition. For ventilation to do any good, cool air would have to sweep continuously and freely through every part of the cargo, a condition impossible to attain, whilst anything short of that only increases the danger, the ordinary methods of ventilation supplying just about the right amount of air to create the maximum amount of heating. The reason of this is clear. A steam coal absorbs about twice its own volume of oxygen, and takes about ten days to do it under favourable conditions, and it is this oxygen which, in the next phase of the action, enters into chemical combination, and causes the serious heating. A ton of steam coal occupies 42 to 43 cubic feet, and if properly loaded contains between the lumps, as nearly as possible, 12 cubic feet of air space—that is to say, of the 42 cubic feet, 12 cubic feet is air, and 30 cubic feet is coal. Thirty cubic feet of coal, with its fresh absorbing surfaces laid bare by the crushing incidental to loading, will, in the first ten days after being taken on board, absorb 60 cubic feet of oxygen, if it can get it. Now, air contains only roughly,

one-fifth of its volume of oxygen, so that 60 cubic feet represent 300 cubic feet of air, or twenty-five times as much as is present. It is therefore evident that if the air could be excluded, there would be only one twenty-fifth the quantity of oxygen present that is needed for complete action, and any heating would, in consequence, be very slight, whilst to produce the greatest heating it would be necessary to change the entire air in the cargo twenty-five times in the first ten days, and this is just about what the old method of taking a box-shaft along the keelson with venetian lattice upshafts from it would give. The most forcible illustration of the evil of such ventilation is to be found in the case of the four colliers, 'Euxine,' 'Oliver Cromwell,' 'Calcutta,' and 'Corah,' which were loaded at Newcastle under the same tips, at the same time, with the same coal, from the same seam. The first three were bound for Aden, and were all ventilated. The 'Corah' was bound for Bombay, and was not ventilated. The three thoroughly ventilated ships were totally lost from spontaneous ignition of their cargo, whilst the 'Corah' reached Bombay in perfect safety.

"7. *Rise in Temperature.*—It has been fully pointed out that anything which tends to increase of initial temperature increases the rapidity of chemical action, and in most cases of spontaneous combustion in coals stored in this country, the cause can be traced to a steam-pipe or boiler-flue in contact with the mass of coal, or even fixed to a wall against which, on the other side, the coal is heaped. Sometimes the coal-store is close to the benches of retorts in a gasworks, or even against the wall of the benches, and in such cases, with certain classes of coals, ignition would be almost certain to take place. In a paper read at the last meeting of the Gas Institute, it was proposed to lead the flues from the benches under the coal store, in order to dry the coal, a device which would infallibly lead to spontaneous ignition. On colliers there are many causes for increased temperature, amongst them being the introduction of triple-expansion engines and high-pressure boilers. Steam at 80lb. boiler-pressure has a temperature of 324° Fahr. (162° C.), and a common stoke-hold temperature, with boilers worked at this pressure, is 100° to 130° Fahr. (or 38° to 54° C.). Steam at a boiler-pressure of 155lb. has a temperature of 368° Fahr., or 186° C., and gives a corresponding increase of temperature in the stoke-hold and other adjacent portions of the vessel, the temperature in the stoke-hold under these conditions being from 110° Fahr. (43·5° C.) to 140° Fahr. (60° C.), an increase of about 10° Fahr. Then, again, donkey-boilers will often be found recessed into bunker bulkheads, and steam-pipes led alongside the bulkheads, with the cargo close up against them on the other side. The effect of temperature due to climatic influences has already been dealt with under the influence on ignition of ports to which shipments are made.

Precautions to be taken.

"Having now discussed the chemical and physical conditions which lead to the phenomenon known as 'spontaneous ignition,' we can formulate precautions which will tend to prevent such disasters:—

"1. *The Choice of Coal for Storage or Shipment.*—The coal should be as large as possible, free from dust, and with as little 'smalls' as can be helped. It is better as free from pyrites as possible, and it should contain, when air-dried, not more than 3 per cent. of moisture.

"2. *Precautions to be taken in Storing or Loading.*—The coal store should be well roofed in, and have an iron floor bedded in cement. All supports passing through and in contact with the coal should be of iron or brick; if hollow iron supports are used they should be cast solid with cement. The coal must never be loaded or stored during wet weather, and the depth of coal in the store should not exceed 8ft., and should only be 6ft. where possible. Under no condition must a steam- or exhaust-pipe or flue be allowed in or near any wall of the store, nor must the store be within 20ft. of any boiler, furnace, or bench of retorts. No coal should be stored or shipped to distant ports until at least a month has elapsed since it was brought to the surface. Every care should be taken during loading or storing to prevent breaking or crushing of the coal, and on no account must a large accumulation of small coal be allowed. These precautions, if properly carried out, would amply suffice to entirely do away with spontaneous ignition in stored coal on land, and we have now to consider a far more important phase of the question.

"3. *Precautions to be taken on Board Coal-laden Ships.*—This phase of the question is undoubtedy the most important, and in order to insure any successful treatment of the coal cargo at sea, to prevent undue heating and ignition, the means adopted must be as nearly automatic in their working as possible, as it is useless to expect the master or any officer on board a collier during rough weather, &c., to comply with any instructions, such as daily taking the temperatures in various parts of the cargo, and so on. The iron bulkheads dividing the coal storage from the other parts of the vessel should be made double, and spaced 6in. to 1ft. apart, with openings (which could be closed water-tight) every few feet, to allow of the interior being from time to time coated with protective compositions. Through this double casing sea-water would be allowed to circulate, and would not only effectually prevent any penetration of heat from the stokehold, boilers, or engine-room to the coal, but also do away with any chance of leakage of gases from the coal cargo into other portions of the vessel, and so would minimise the danger of explosions. A similar double partition should run down the centre of that portion of the vessel in which the coal was stored, and it would be sufficient if this were packed with silicate wool; this partition would serve to prevent any heating which might take place in one part of the cargo being communicated to the other half, whilst it would also perform the important function of helping to prevent shifting of the cargo during heavy rolling. When the coal has all been taken in it should be battened down, and the hatches should not be again opened until the vessel reaches her destination, the only ventilation allowable being a 2in. pipe just inserted into the crown of each coal compartment, and led 12ft. up the nearest mast, the top being left open. This would be quite sufficient to allow free egress to any gases evolved by the coal, but would not allow undue excess of air. Into the body of the coal cargo itself would be screwed, at regular intervals of about 10ft., iron pipes, closed at the bottom and containing alarm thermostats, so

arranged that when a rise of temperature causes expansion of the mercury in rising in the tube it makes a contact; and the wires from these tubes are in connection with an electric bell, index-board, and battery in the captain's room; so that the moment the temperature is reached to which the thermometers have been set the bell rings, and will continue to ring, until the temperature again sinks, the spot in which the heating is taking place being indicated by the index-board. In the evidence given before the Commissioners in 1875, Mr. J. Glover strongly advocated the use of carbon dioxide, or carbonic-acid gas, as it is more usually termed, for extinguishing ignition when it had broken out in a coal cargo, and for stopping heating when it had reached a dangerous pitch. His proposal was to generate the gas by the action of hydrochloric acid upon chalk, and to lead it by gas pipes to the compartment affected; and this gas, being heavier than air, and a non-supporter of combustion, was to displace the air and its contained oxygen, and so to prevent further action by surrounding the coal with an atmosphere which could not carry on combustion. The idea was a good one, but there were many difficulties in the way of carrying it out, one being that, for every 1,000 tons of coal carried, 80 cwt. of hydrochloric acid would have had to be shipped; also the gas could not have been driven down into the hold if any serious heating had taken place, as an up-current would have been formed, and would have carried it away; whilst in the state of gas, it fails to give any great cooling effect, and so would have exercised but little influence upon the mass of red-hot fuel. These objections weighed so strongly with the Commissioners that, in their final report, we find the following sentences: 'Several methods for generating carbonic-acid gas, and applying it to the ignited portion sf a coal cargo, have been proposed for our consideration. We consider, however, that although this gas might be useful for excluding atmospheric air (which is essential to support combustion), yet it will not, as water does, exert any very sensible cooling effect, which is a point of vital importance in the case of a mass of ignited coal. We are of opinion that water and steam are the only agents practically available for the purpose of extinguishing fire in coal cargoes.' Applied in the way which was suggested, there is no doubt but that the carbonic-acid gas would have been practically useless; but there is another way in which it could be used, which would make it a most powerful cooling agent, an instantaneous quencher of fire, and would prevent any further tendency to heat on the part of the coal treated with it. If carbonic acid gas is compressed under a pressure of 36 atmospheres at a temperature of 32° Fahr. (0° C.), it is condensed to the liquid state, and can be obtained in steel vessels closed with screw-valves. On opening the valve some of the liquid is ejected into the air, and, in coming into the ordinary atmospheric pressure, is in a moment converted in a large volume of gas. Conversion from the liquid to the gaseous state means the absorption of a large amount of heat; and so great is this, that everything near the stream of new-born gas is cooled down, and some of the escaping liquid is frozen to a solid, having a temperature of —78° C., or —108·4° Fahr. This liquid carbonic-acid gas is now extensively manufactured, and is used abroad to a large extent for aërating waters, driving torpedoes, and for freezing-machines; and I should suggest its use in the following way for the checking of ignition in the coal cargo: The nozzle attached to the screw-valve on the bottle of condensed gas should have a short metal nose-piece screwed on to it, the tube in which should be cast in solid, with an alloy of tin, lead, bismuth, and cadmium, which can be so made as to melt at exactly 200° Fahr. (93° C.). The valve should then be opened, and the steel battle buried in the coal during the process of loading. The temperature at which the fusible metal plug will melt is well above the temperature which could be reached by any legitimate cause, and would mean that active heating was going on in the coal; and under these conditions the pressure in the steel cylinder would have reached something like 1,700lb., and the moment the plug melted the whole contents of the bottle would be blown out of it into the surrounding coal, producing a large zone of intense cold, and cooling the surrounding mass to a comparatively low temperature. The action, moreover, would not stop here, as the cold, heavy gas would remain for some time in contact with the coal, diffusion taking place but slowly through the small exit-pipe.

"When the coal has absorbed as much oxygen as it can it still retains the power of absorbing a considerable volume of carbonic-acid gas; and when coal has heated, and then been rapidly quenched, the amount of gas so absorbed is very large indeed, and the inert gas so taken up remains in the pores of the coal, and prevents any further tendency of heating; indeed, a coal which has once heated, if only to a slight degree, and has then cooled down, is perfectly harmless, and will not heat a second time. It is not by any means necessary to replace the whole of the air in the interstices of the coal with the gas, as a long series of experiments show that 60 per cent. of carbonic-acid gas prevents the ignition of the most pyrophoric substances. One hundred cubic feet of gas can be condensed in the liquid state in a steel cylinder 1ft. long and 3in. diameter, and it has been shown that a ton of coal contains air-spaces equal to about 12 cubic feet; therefore, one of these cylinders would have to be put in for every eight tons of coal, as, although the gas formed at the first moment would only occupy a small space, on account of its low temperature, it would rapidly expand in contact with the hot coal. These cylinders should be distributed evenly throughout the cargo and near the alarm-thermometers, which should be set to ring a degree or two below the point at which the fusible plug would melt. The bell ringing in the captain's room would warn him that heating was taking place, and the bell would continue to ring until the cylinder had discharged its contents, and had cooled the cargo down to a safe degree, so that the whole arrangement would be purely automatic, and yet the officers would know if everything was safe. This liquid is now being made at a comparatively cheap rate, and, with any demand for it, machinery could be put up at the principal coaling-ports to charge empty cylinders at a very low rate; so that, the initial cost of the steel cylinders once got over, the expenses would not be worth considering, more especially as only one, or two at most, of the cylinders in use would be likely to go off. If the precautions advocated were taken no danger could arise until the arrival of the ship at her destination, and the commonest precautions would then suffice. On removing the hatches no naked light must be allowed near them, and no one

must be allowed to descend into the hold until all the gases have had time to diffuse out into the air. If the cylinders have gone off there will be but little fear of explosion, as a high percentage of the carbonic-acid gas lowers the explosive-power which the admixture of marsh-gas (given off from some coal) and air possess; but the carbonic-acid gas would overcome and suffocate a man descending into an atmosphere containing any considerable percentage of it. When a safety-lamp lowered into the hold continues to burn as brightly as it did in the open air, then it is perfectly safe to descend. When once coal in a cargo has fired, pumping in water is of practically no use, as the fire is, as a rule, near the bottom of the mass of coal, and the flow of water is so impeded by the caking of the heated mass above the fire, that in percolating through the interstices of the heated coal, it is converted into steam before it can reach the seat of combustion. The most effective way to apply water would be to have 3in. pipes laid along the floor of the coal-compartments, about 6ft. apart, these tubes having a ¼in. hole bored in the upper side every foot or so, and each pair of pipes coming through the bulkhead, and connecting on to two 6in. pipes passing through the side of the vessel, the sea-water being prevented from entering by means of screw valves. As soon as the alarm-thermometer gave notice that heating had reached a dangerous point, these valves could be opened and the lower portion of the cargo drenched with salt water. This, evaporating rapidly, would give large volumes of water vapour, which, passing up through the heated coal, would lower its temperature, but would not be nearly as effective as the method before advocated. It might, however, be used in conjunction with that method, and would in many cases save the carbonic-acid gas. In the case of coal-bunkers in modern steamers and warships, the conditions under which the coal is placed are so totally different from those existing in a collier that no comparison can be drawn between them. In the coal-bunker, the question of mass, which plays so important a part in a hold laden with coal, is almost entirely eliminated, as 50 to 400 tons would be about the capacity of any ordinary bunker, and it has been before shown that the cases of spontaneous ignition in masses of coal less than 500 tons does not amount to more than ¼ per cent., and the question of initial temperature becomes the most important factor. A few years ago such an occurrence as a coal-bunker on fire was rare, whilst at the present time hardly a week passes without some more or less serious cases occurring on the fast liners, and it is evident that there must exist some well-defined cause for the enormous increase in cases of spontaneous ignition. On collecting evidence on this point, the first thing that strikes one is that bunker-fires are almost entirely confined to vessels in which the bunker bulkheads are only separated from the funnel by a narrow air-space, or in close proximity to the boilers themselves; but where the bunkers are stepped back from the funnel-casing and boilers spontaneous ignition is a great rarity. Taking the case of a fast liner, it is found that the temperature in a coal-bunker varies very considerably, according to its proximity to the air-channel round the funnel-casing. Close to the outside of the bulkhead the temperature is often as high as 200° Fahr. (93° C.) whilst inside 120° would be a fair estimate, and from the centre of the bunker to the side of the vessel it is seldom above 75° Fahr. (24° C.); the temperature, however, being higher nearer the iron decks, which, being in contact with the heated bulkhead, conduct the heat through the coal, and raise the temperature often up to 100° Fahr. It has been pointed out that if coal be kept at a high temperature, even though it be far below its igniting-point, ignition is only a question of time; and if the bunker-coal next the bulkhead be kept at 120° Fahr., any coal with a tendency to absorb oxygen will run a great chance of igniting within a few days. It is manifest that, if this is the real cause of ignition, the seat of the fire ought to be found close to the heated bulkhead; but this is very often not the case, the mass of fire being found near the centre of the bunker, and sometimes even towards the sides of the vessel; but careful examination soon reveals the cause of this, as a line of charred coal is mostly to be found running from the heated bulkhead to the seat of active combustion, showing that the fire, started by the high initial temperature, has not had sufficient air near the bulkhead to do more than smoulder, but that, as soon as it came in contact with a current of air passing up through the coal from the hatches in the decks, the smouldering mass began to burn fiercely. In order to prevent spontaneous ignition of the coal under these circumstances, all that is necessary is to reduce the temperature of the bulkhead in contact with the coal, as, if this is kept at a temperature not exceeding 82° to 90° Fahr., there is little or no fear of the oxidization of the hydrocarbons of the coal proceeding with such rapidity as to cause ignition in such a quantity of coal as can be carried in the bunkers—the iron decks, by subdividing the mass, also helping to reduce any risk. In order to reduce the temperature to the required extent, it would be necessary to make the bulkheads close to any heating-surface, such as the funnel-casing, double. Through this double casing sea-water would be allowed to circulate very slowly, and would effectually prevent any undue rise of temperature; whilst to make the arrangements complete, a thermostat should be fixed on the inner plate of each bulkhead, which, if the temperature rose to 100° Fahr. (38° C.), would ring a bell in the captain's room, when the rate of flow of water could be increased until the required fall in temperature took place. Should this arrangement prove impossible from any structural cause, then a rapid current of air forced through the bunkers by means of a fan, or even an up-current formed by a good air-pump ventilator in the crown of the bunker, would go far to keep the temperature within safe limits. In a coal-cargo perfect ventilation is impossible, on account of the mass of coal present, and, thereofre, the hold should be battened down, and everything done to prevent imperfect ventilation, gas-tight bulkheads being a necessity for this purpose. In coal-bunkers, on the other hand, on account of free access being obtained to both top and bottom of the coal, and also the small mass present, perfect ventilation is possible, and should be attempted, whilst the water bulkheads will do away with any undue rise of temperature. Chemists have been repeatedly asked if analysis gives no indications by which a coal liable to spontaneous heating can be distinguished from another which is perfectly safe for storage or shipment in bulk; but up to the present time the action has been so little understood that no such differentiation was possible, but with a clear conception of the causes which lead to heating

it should be quite possible to do so. As I have shown, all coals, when heated to a temperature a little above that of boiling water, have their power of absorbing oxygen so increased that they will in a few hours absorb sufficient to give a perceptible increase in weight, and the greater their absorption-power the greater will the increase be; and as it is upon this that the liability to heat depends, the amount of increase in weight would give a sure indication of the liability to spontaneous ignition. We have at present, however, no data to show what is a safe amount of absorption and with what amount danger commences; and the owners of collieries yielding coal liable to heating are so anxious to prevent the fact leaking out that there will be considerable difficulty in obtaining authentic samples to make the determination with. My own experience, however, leads me to think that if an air-dry coal does not contain more than 3 per cent. of moisture, and when powdered and heated to about 250° Fahr. in an oven for three hours does not increase more than about 2 per cent. in weight, it may be looked upon as a safe coal to store in bulk. I am perfectly aware that the precautions I have suggested will never, unless pressure is brought to bear upon them, be adopted by the owners of colliers, on account of the slight extra expense and trouble they would involve; but if Lloyds could be prevailed upon to lower the rate of insurance upon coal-cargoes treated in this way, and substantially increase the rate upon cargoes in which these precautions had not been adopted, a class of disaster as appalling in nature as it is destructive in result would soon be entirely done away with."

EXPLOSIONS IN COAL-MINES.

In his presidential address to the Mining Institute of Scotland, on the 22nd April, 1892, J. B. Atkinson states, in reference to explosions in coal-mines,—

"No industry has been subject to disasters involving so large a loss of life as coal-mining, and these disasters have been principally due to explosions. The magnitude of colliery explosions has strongly directed public attention to the dangers of mining, and has led to the passing of Mines' Regulation Acts, each more stringent in its provisions than its predecessor.

"It is now held by many persons that the extension of nearly all the larger explosions has been caused by coal-dust, and even that some explosions have been wholly due to the combustion of that agent. The words 'coal-dust' do not occur in any Mines' Regulation Act except that of 1887. It is evident, therefore, that an important factor in colliery explosions has been overlooked, and it is probable that many explosions have occurred simply from a want of knowledge in which all connected with mining have shared. The influence of firedamp in explosions has been twofold, it is itself the cause of explosions, and it has diverted attention from another factor—coal-dust. We may even go further, and say that one of the precautions, large currents of air, adopted to lessen the danger of firedamp, has directly assisted in increasing the danger of coal-dust by rendering the mines drier, and promoting the formation of the most dangerous class of dust-deposits, those due to the fine upper or wind-borne dust and common on many main intake and haulage roads. If these considerations be true it is clear that our knowledge of the causes of colliery explosions, and of means for their prevention, will require to be recast, and in this paper attention will be especially directed to coal-dust as the cause of explosions that is least understood.

"Explosion may be defined as the sudden large increase in volume of matter.

"In practice accidental explosions are of the following kinds:—

"(*a.*) The expansion of gunpowder and allied explosives on combustion.
(*b.*) " dynamite and allied explosives on disassociation.
(*c.*) " mixtures of inflammable gases or vapours with air on combustion.
(*d.*) " mixtures of inflammable dusts with air on combustion.
(*e.*) " gases or vapours under pressure on the rupture of retaining-walls.

"*a*, *b*, *c*, and *d* may be called chemical explosions, and are accompanied by flame; *e* may be called a mechanical explosion, and is not accompanied by flame.

"Explosions under the above heads occur in mines. This paper will, however, be confined to the consideration of the explosion of mixtures of firedamp and air, and of mixtures of coal-dust and air, and also of gunpowder and other explosives, so far as they initiate the two former classes of explosions.

"A true explosive is a body containing within itself the power of explosion. Thus gunpowder, on the application of heat, or nitro-glycerine compounds, on detonation or shock, explode without the assistance of any other body. These are true explosives. Firedamp and coal-dust are not explosives. Mixtures of firedamp and air or of coal-dust and air are explosive, but the oxygen of the air is as essential to the explosion as the firedamp or coal-dust. It is scientifically incorrect to speak of the explosion of firedamp or coal-dust. Gunpowder is an example of a solid explosive, nitro-glycerine of a liquid explosive, and there are explosive gases, but they are never met with out of the laboratory. Thus, one of the oxides of chlorine (hypochlorous acid) is an explosive gas. When slightly heated it decomposes with explosion. Firedamp is usually a mixture of marsh-gas, with nitrogen, oxygen, and carbonic-acid gases. The marsh-gas or light carburetted hydrogen is the combustible constituent. Firedamp is pent up in the strata at high pressures, and issues into the workings of a mine, usually as a steady flow, but sometimes as a sudden outburst. In elevated unventilated parts of mines it collects, and often issues from such places in large volume on a fall of the barometer. When flame is applied to firedamp issuing as a jet into the atmosphere it burns at the point of issue like ordinary lighting-gas. There is combustion, but no explosion. If mixed with air in certain proportion flame passes rapidly through the mixture, and explosion results, the explosion being wholly due to the expansion of the resultant gases, caused by the heat of combustion. There is no absolute increase in volume of the mass, such as takes place when gunpowder is fired, when the resultant products, apart from the expansion due to the heat of combustion, occupy many times the volume of the original gunpowder. The temperature of ignition of an inflammable mixture of firedamp and air, the speed of the passage of flame, the

temperature of combustion, the increase in volume of the resultant gases if free to expand, the increase of pressure if confined, and the composition of the resultant gases are all points for consideration to which it is not proposed to direct attention. Recent researches, however, have shown that, as regards the speed of flame, the pressure developed, and the composition of the resultant gases of an explosion of firedamp and air, the older text-books are not altogether correct.

"Coal-dust is more or less prevalent in all dry coal-mines. When the heat of a mine raises the temperature of the air entering the mine its capacity for absorbing moisture, or its drying-power, is increased; and if the quantity of the moisture in the strata mined, and that due to the respiration of men and horses, and to the combustion of lights, is not sufficient to saturate the air, the mine becomes dry. The temperature of the strata increases with the depth, while the quantity of moisture usually decreases. Deep mines are, therefore, drier than shallow mines. Some coal-seams produce more dust than others—the more friable the coal the more dust. Coal-seams are traversed by joints or cleavage planes running at right angles to the plane of stratification, and by partings parallel to the stratification. The latter planes of division are very generally coated with a dull, black, friable substance, known as mother of coal, dant, or mineral charcoal, which probably is largely present in fine coal-dust. The hewing, filling, and leading of the coal are the principal causes of coal-dust deposits in mines. Two other causes are: (1) the falling of coal from the sides of the passages, and its subsequent *tituration* by the feet of men and horses, and (2) the carrying-down of coal-dust from the screens on the surface of the air-current descending the down-cast shaft.

"If a pound of ordinary coal is placed upon a fire it burns and is eventually consumed; first, the combustible gases that are driven off combine with the oxygen of the air, producing flame and heat; next the solid carbon is consumed until nothing but ash remains. It can be shown by calculation that if the combustion of the pound of coal took place suddenly the heat given off would so expand the resultant gases that explosion would result, exactly as in the case of the combustion of firedamp. If the pound of coal was in the form of fine dust, and suspended in air, under some conditions such rapid combustion will take place, and this is a coal-dust explosion. The explosions of firedamp and air and of coal-dust and air are therefore in some respects a similar phenomena; in each case the explosion depends on the heat of combustion expanding the resultant gases, and each explosion is accompanied by flame and a vitiation of the atmosphere. A mixture of firedamp and air readily takes place—the motion of the air in a mine, the mobility of the firedamp, and the property of diffusion which gases possess, even when stationary, all favour the mixture. The firedamp is readily ignited, and does not require to be broken up before combustion takes place.

"With coal-dust and air the conditions are different, and opposed both to the ready formation of an explosive mixture and its subsequent ignition. Coal-dust is a solid body; it is not present in the air of a mine under ordinary conditions in any considerable quantity, but requires to be raised from the floor or dislodged from the sides and roof before a cloud is formed; it requires to be broken up, or the gases it contains driven off, before combustion takes place. The combined effect of these conditions makes it difficult to initiate an explosion of coal-dust and air. The fact that it requires special conditions to obtain an inflammation of a cloud of coal-dust in an air free from firedamp does not, however, prove that the extension of an explosion in such a mixture is equally difficult to obtain, because the conditions are then different. After an explosion is started in a mine the coal-dust is no longer quiescent, but is blown into the air by the explosion, and forms a dense cloud; behind this cloud is heat, flame, and pressure.

"The behaviour of coal on an ordinary fire resembles somewhat that of coal-dust in an explosion. The first step to start a coal-fire is to ignite paper. The paper ignites wood, which in turn ignites the coal; once a coal-fire is thoroughly kindled it is self-supporting, but the coal cannot in the first instance be readily ignited without the assistance of heat from other material. The heat and consequent force developed by the inflammation of a mixture of firedamp and air in such proportion as to secure complete combustion is greater than the heat and force developed by a similar mixture of coal-dust and air.

"Mixtures of firedamp and air are, however, only capable of transmitting flame within certain limits. There must be from 5 per cent. to 20 per cent. by volume of firedamp in the mixture. The case, with respect to coal-dust and air, does not appear to be parallel. 1lb. of coal-dust and 160 cubic feet of air are required for complete combustion. Assuming an air-way to be 8ft. by 5ft. sectional area, and taking coal-dust to weigh 26lb. per cubic foot, then for each 160 cubic feet of air in such a road to be supplied with 1lb. of coal-dust, the surfaces of the road would require to be coated with a film of dust $\frac{1}{228}$in. thick. Such a quantity is far below what in practice is present on ordinary dusty roads, along many of which it has been observed that an explosion has passed with great force. These roads would, at the time of the explosion, have suspended in the air a quantity of dust in excess of 1lb. to 160 cubic feet of air, and in no case where the dust was pure has the writer seen any evidence that the passage of an explosion has been checked by an excess of dust. It seems that in a coal-dust explosion a minimum quantity of dust must be present, which is probably much greater than the quantity named as being required for perfect combustion, but practically no maximum. If this be true, it has an important bearing on the question. The minimum quantity of coal-dust occurs constantly over long lengths of roads in mines, and consequently the conditions are present for the propagation of a coal-dust explosion. That is to say, many roads in mines, in their normal condition, contain the necessary agents for an explosion of coal-dust and air; while a similar state of things, due to the presence of firedamp and air, is an abnormal condition.

"With regard to the force developed by an explosion of coal-dust and air, as compared with the force developed by the explosion of firedamp and air, the following is worth consideration: In an explosion confined to coal-dust and air, traversing a road in a mine containing a large excess of fine coal-dust, there will probably be only coal-gas distilled from the dust consumed; the combustion of coal-gas results in more heat than the combustion of an equal volume of firedamp, the coal-

gas containing free hydrogen; if this excess of heat is equal to the heat absorbed in distilling the coal-gas from the dust, then the heat available to expand the resultant gases will be as great in the one case as in the other. Experience in actual explosions shows that, where there is a large excess of fine coal-dust, the force developed is greatest. In an explosion of either firedamp and air or coal-dust and air, a limiting factor is the quantity of air the road contains; firedamp, if present in volume so as to form the most explosive mixture, occupies one-tenth of the air-space; coal-dust may be present in excess, and yet practically leave the road full of air.

"Sir F. A. Abel, when experimenting on coal-dusts, observed that one of the samples of dust, consisting largely of stone-dust, had the property of determining the ignition of a mixture of firedamp and air not inflammable *per se*. This led him to experiment under similar conditions with non-inflammable dust, such as calcined magnesia, and he obtained similar results—that is to say, a mixture of firedamp and air not inflammable *per se* became so on the addition of a non-inflammable dust. This shows that coal-dust may act in two ways in explosions: 1st, it may supply combustible matter; and 2nd, it may cause mixtures of firedamp and air not inflammable *per se* to become capable of transmitting flame.

"Having satisfied ourselves that firedamp and coal-dust are the only bodies that, in conjunction with air, cause explosions in mines, we can investigate the subject (1) by the study of actual explosions, and (2) by experiment.

"Explosions may be studied by observation made in the mine after their occurrence, or by the perusal of published accounts. The writer has visited the scene of a large number of explosions in mines, most of which were caused by the ignition of small quantities of firedamp, and were not generally followed by any death, or caused much damage to the mine. Some of these ignitions resulted in one or two deaths—the persons injured usually living for a few days after the accident. In a few cases of undoubted firedamp explosions, lives were lost in the mine, but this was exceptional. The most considerable explosion of firedamp which the writer has personally investigated occurred at Whitehaven Colliery on the 25th April, 1885.* In a few cases of minor explosions, investigated by the writer, coal-dust had some influence, more as extending the flame of a gunpowder shot. The writer has had opportunity of becoming acquainted with the circumstances attending the large explosions described in Table I., soon after the occurrence, and he at the same time made more or less complete examinations of the mines; he believes that in these explosions coal-dust played a leading part. The explosions in the table are, it must be noted, not selected, but comprise all the large explosions the writer has personally investigated.

"TABLE I.

No.	Colliery.	Date.	Lives lost.	Flame causing Explosion.	Agent first inflamed.	Agent causing Extension of Explosion.	Point of Origin of Explosion.
1	Seaham ..	25th October, 1871 ..	26	Gunpowder shot	Coal-dust ..	Coal-dust ..	Intake airway.
2	" ..	8th September, 1880	164	"	" ..	" ..	"
3	Trimdon Grange	16th February, 1882	74	Open light ..	Firedamp ..	" ..	Engine landing next drowned workings.
4	Tudhoe ..	18th April, 1882 ..	37	Gunpowder shot	Coal-dust ..	" ..	Intake airway.
5	West Stanley ..	19th April, 1882 ..	13	"	Coal-dust and percentage of firedamp	" ..	Working-face.
6	Usworth ..	2nd March, 1885 ..	42	"	Coal-dust ..	" ..	Intake airway.
7	Altofts ..	2nd October, 1886 ..	22	"	" ..	" ..	"
8	Elemore ..	2nd December, 1886	28	"	" ..	" ..	"
9	Walker ..	24th October, 1887 ..	8	"	Coal-dust and percentage of firedamp	" ..	Working-face.
10	St. Helen's ..	19th April, 1888 ..	30	Fire in the mine	Firedamp ..	Firedamp, coal-gas, and coal-dust	"

"The reasons that led to the conclusion that coal-dust was the principal factor in these explosions will be stated shortly. First, there are reasons of a negative character depending on the apparent impossibility of ascribing the explosions to the combustion of firedamp, the only body other than coal-dust likely to cause them. In Nos. 1, 2, 4, and 7, the explosions were entirely confined to the intake airways; in Nos. 3, 6, and 8, the principal effects of the explosions were observed on the intake airways, although some of the working-faces were traversed, and the return airways were affected to a very limited extent. In No. 5 the intake airways, the working-faces, and the return airways were all traversed. In No. 9, a small explosion, the working-face and return airway of one district were affected. In No. 10 the working-face of one district and intake airway were traversed; but owing to operations that were being carried out to isolate a fire at the working-face the direction of the air-current had been changed shortly before the explosion, and a part of the intake airway was return airway at the time. On the whole, the explosions had traversed longer distances of intake airways than other parts of the mines, in some cases being entirely confined to such roads—that is to say, the roads least likely to contain firedamp were most affected.

"Experience in mines would justify the expectation that an immensely greater proportion of explosions of firedamp would extend along the return airways than along the intake airways, whereas the reverse was the case in these explosions.

* This explosion, as well as Nos. 2, 3, 4, 5, and 6, in Table I., are described in detail in a book entitled "Explosions in Coal-mines," prepared by Mr. W. N. Atkinson and the writer.

"In the North of England, where this feature had long ago been observed, it has been customary to say, with what has been termed 'the unlearned wisdom of experience,' that explosions of firedamp always faced the fresh air, or that the gas sought the purest air.

"In some of these explosions it was observed that the blast, on arriving at points on the intake airways where the air-current split, had afterwards traversed one of the splits only. If the air-current, before dividing, and in one of the splits, was in an explosive condition through the presence of firedamp, how did the other split escape being in a similar state? In one case it was observed that the split which escaped was a continuation of the straight line which was the course of the explosion up to that point, the split traversed by the explosion deflecting to one side. In Nos. 1, 2, 3, 4, 5, 6, 7, 8, and 9, so far as judgment could be formed, no person in the mine was in a state of alarm at the moment of the explosion. In No. 10 the mine was on fire, and all the ordinary workmen had left the pit. The persons who were in the mine at the time of the explosion, engaged in isolating the fire, were, however, under no apprehension of a larger explosion taking place likely to injure them; they were 600 yards from the fire. It does not seem possible in the first nine cases that firedamp could have entered the air-currents in such volume as to have made the explosions possible without the officials or workmen observing it. In Nos. 1, 2, 4, 5, 6, 7, 8, and 9, a shot was fired, and was the point of origin of the explosions; had firedamp been present in the air-current in sufficient quantities to make the explosions possible through its agency alone, it is highly improbable that any shot would have been fired.

"In the collieries where the ten explosions given in the table occurred, safety-lamps only were used at the working-face, and in some of them also on the intake airways; therefore we must go to other explosions for a condition which supplies a negative reason why firedamp is not the principal factor in some large explosions.

"In many mines worked entirely, or nearly so, with naked lights, a great explosion has swept over the whole pit. Scotland affords an example of this in the explosion at Blantyre in the splint coal. It does not seem possible that any great area of a seam in which naked lights are scattered here and there could be so charged with firedamp as to render an extensive explosion possible. A sudden fouling of the air-current from any cause would lead to an explosion at the first open light encountered, and so would limit its extent. Yet an Blantyre, Clifton Hall, in Lancashire, and Llanerch, in Monmouthshire, and in many other cases, the mines were working with open lights, and all at once an explosion traversed the whole seam, causing in the cases just mentioned the death of 207, 178, and 176 persons respectively.

"On exploring the mines after the occurrence of the explosions given in the table there was no evidence of any outburst of gas or failure of the ventilation to account for the presence of firedamp in sufficient quantity to cause the explosions. In No. 9 a single issue of firedamp could have explained the explosion. In the other cases the course taken by the blast could not be explained by supposing that firedamp had entered the air-current at any particular point. On such an assumption roads that should have been traversed were missed out, and roads were traversed that should have escaped. By no reasoning could the explosions be ascribed with any degree of probability to firedamp only.

"The positive reasons that support the view that coal-dust was the principal factor in these explosions are as follows: The intake airways were in all the cases except No. 9 also used as haulage-roads. In Nos. 1, 2, 3, 4, 6, 7, 8, and 10, mechanical haulage was in use on these roads, the main and tail rope system in all except No. 7, where the endless chain was in use. In No. 5 horses were employed. These roads were dry, they were traversed by large currents of air, and coal-dust was blown off the trains of laden hatches passing—often at high speeds—in the opposite direction to the air-current. The result was that fine coal-dust accumulated on the roof and sides, as well as coarser dust on the floor. Near the downcast shafts coal-dust, carried down with the air from the screens, assisted materially in forming these deposits. The writer has not seen a road in a colliery in Scotland containing so much of the upper or wind-bourne dust as occurs on similar roads in the dry mines of the north of England. These dust-laden, intake air roads were the roads principally affected by the explosions, and, as already stated, in Nos. 1, 2, 4, and 7, the explosions were entirely confined to them. In Nos. 1, 2, 4, 6, 7, and 8 the explosions originated on them.

"The inner portions of the haulage-roads, where the laden hutches, drawn by horses and ponies moved at slower speeds against feebler currents of air, contained little of the upper dust, and often the coal-dust on the floor was much mixed with stone-dust. The explosions were often checked on reaching such points. In some cases, however, where these roads and the working-face contained a considerable quantity of coal-dust they were traversed by the explosions.

"The explosions were in many cases stopped by damp ground. This was specially noticeable with regard to the explosions which extended to the downcast shafts, which was the case in Nos. 2, 3, 4, 5, 6, 7, 8, and 10. Where the downcast shafts were wet the explosions were arrested, and did not cross them. In No. 2 the shaft was dry, and the explosion crossed it. In No. 3 the downcast shaft was very dry, and the explosion entered it and extended upwards to the surface, and downwards to four levels below. A dampness in the floor, it was observed, was not sufficient to arrest an explosion if upper dust existed. In Nos. 3, 5, and 9 short lengths of the return air ways were affected principally next the working face where coal-dust was present in quantity greater than is usual in such roads. The return airways on the whole could be said to be free from coal-dust, and were not so dry as the intake airways. At Altofts the return airways were used as travelling roads for the colliers, and were full of stone-dust ground up from the floor of the seam.

"If the explosions were caused by the combustion of coal-dust the absence of alarm on the part of the workmen can readily be understood. The mines were in their normal state up to the moment of the explosion, and there was no new condition present calculated to cause alarm. Naked lights could be in use all over a dusty mine and be a source of no immediate danger, although the necessary elements for propagating an explosion in the shape of coal-dust resting on the floor, roof, and sides, and pure air were everywhere present. The fact that some of the explosions were originated by the firing of a shot is strong evidence that the air-current was not in an explosive condition

from the presence of firedamp alone where the shots were fired, and affords some presumption that coal-dust, either alone or in conjunction with such a proportion of firedamp as not to be considered dangerous by the person igniting the shot, was the agent first inflamed, as the danger of coal-dust is not understood.

"The personal experience of the writer points strongly to the preponderating influence of coal-dust in large colliery explosions. How far this may be true for other large explosions it is in many cases now almost impossible to say. Until a few years ago coal-dust was not recognised as a factor in these disasters, and in published accounts of earlier explosions it is only mentioned incidentally. The explosions were always referred to firedamp, and theories to account for its presence in sufficient quantity by a sudden outburst, the leaving open of ventilating doors, or some other cause, were put forward with more or less confidence. There are, however, so many points of resemblance between the explosions briefly described and most other large explosions that the writer does not hesitate to express the opinion that in almost all widespread explosions the influence of coal-dust has been predominant. It is not, however, probable, that so large a proportion of other large explosions have been caused by coal-dust in air practically free from firedamp being the agent first inflamed, as in the cases tabulated. Firedamp ignited by the flame of a naked light or safety lamp or a mixture of coal-dust and air containing a small percentage of firedamp ignited by the flame of a shot, have probably been the origin of most large explosions.

"The experimental investigation of the influence of coal-dust in colliery explosions has been undertaken by individuals, committees, and Government Commissioners, both at home and abroad. Mr. H. Hall, H.M. Inspector of Mines for the West Lancashire District, and Mr. Clark, mining engineer, described in a paper read before the North of England Institute of Mining Engineers, in June, 1876, some experiments they made with coal-dust in a mine from the surface. The mine was 45 yards long, and 30ft. sectional area. They scattered coal-dust on the floor and fired a cannon at the face to represent a blown-out shot. The most decisive result obtained by them may be given in their own words:—'Coal-dust having been scattered on deals the whole length of the slant (the thill being very wet), fired 2½lb. powder; in this case flame issued strongly at the mouth of the slant, having travelled 45 yards. The blast was very fierce, and would certainly have proved fatal to any one struck by it in its course.' In 1890 Mr. Hall experimented by firing a small cannon at the bottom of shafts after coal-dust had been emptied into them, and caused explosions extending to the surface, or, in one instance, 180 yards. These are the only experiments on a large scale in Great Britain.

"Mr. Wm. Galloway, who was probably the first to recognise the great influence of coal-dust in large explosions, has conducted and published the results of many experiments on a small scale, in which he demonstrated the inflammability of coal-dust. The Chesterfield and Derbyshire Institute of Engineers conducted experiments on a small scale, but obtained no very definite result, and appear to have been led by the negative results obtained to underestimate the importance of the question.

"Sir F. A. Abel carried out experiments with coal-dust on a small scale, at the request of the Home Secretary, in connection with the inquiry into the Seaham Colliery explosion (No. 2 in list). He obtained no decisive results as regards inflammability of coal-dust and air alone, but he discovered, as already mentioned, the effect of dust, as dust and apart from its inflammability, in promoting the inflammation of mixtures of firedamp and air. He also conducted some experiments in larger galleries with coal-dust and blown-out shots, which showed that coal-dust 'will feed the flame projected by a blown-out shot so as to carry it on to a comparatively considerable distance.'

"The most important experimental work in connection with this question is that of the Prussian Firedamp Commission, a translation of whose report will be found in Vol. xxxiv. of the Transactions of the North of England Institute of Mining and Mechanical Engineers. The experiments were made in an elliptical gallery, 167·3ft. long, and having a sectional area of 17½ square feet. A side gallery 32·8ft. long was added to the main gallery at a later period. Shots were fired at one end of the gallery from cannons to represent blown-out shots. The Commission sum up the result of their labours at considerable length. They state—

"'(1.) The presence of coal-dust in more or less abundance in the immediate vicinity of the working face gives rise to more or less considerable elongation of the flame projected by a blown-out shot, whether small quantities of firedamp be present in the surrounding air or not.

"'(2.) *a*. In the complete absence of firedamp, the elongation or propagation of flame is generally of limited extent, however far the deposits of dust may extend in the mine-ways.

'*b*. There are, however, certain descriptions of coal-dust which, if ignited by a blown-out shot, will not only continue to carry on the flame, even to distances extending considerably beyond the confines of the dust deposits, but will also give rise to explosive phenomena or results, in the complete absence of any trace of firedamp, which, in character and effects, are similar to those produced with some other dusts in air containing 7 per cent. of firedamp.

"'(3.) *a*. All the phenomena produced by the burning of and propagation of flame by coal-dust are intensified by the presence in the air of small proportions of firedamp.

'*b*. Certain dusts which, under favourable conditions, appear to have the power of propagating flame to an indefinite extent in a dust-laden area, the air being free from firedamp, will, if only sparsely suspended in air containing firedamp in some proportion below 3 per cent., render such a gas-mixture susceptible of explosion by a blown-out shot.

"'(4.) Special experiments, in which the branch gallery, described as opening into the main gallery near its extremity, was charged with a firedamp mixture (retained by brattice-cloth), demonstrated that a coal-dust ignition or explosion, developed in the complete absence of firedamp, can communicate ignition to an explosive gas-mixture existing at a very considerable distance from the point of first ignition.'

"The Royal Commission on Explosions from Coal-dust in Mines now sitting will probably experiment on a large scale. From the volume of evidence issued by the Commission, it appears probable that an artificial gallery, 200 yards in length, will be erected. This length will not be sufficient to test all the questions that arise. The writer's suggestion to the Commission was that some experiments should be made in a gallery not less than half a mile long.

"From actual observations in mines, it appears that a coal-dust explosion proceeds from 50 to 100 yards from the point of origin before developing its maximum force. It is doubtful if this can be illustrated in a gallery 200 yards long. The arresting of a coal-dust explosion, travelling with maximum force and velocity, by a space free from dust could not be tested in such a gallery.

"*Remedial Measures.*

"The first step in this direction is to obtain a proper conception of the causes of explosions in mines. The danger arising from firedamp is well known, and also the precautions necessary to prevent its accumulation and ignition, such as sufficient ventilation and the absence of naked flame. The danger of coal-dust is not so generally understood or admitted, but it is hoped that this will be secured by the labours of the Royal Commission now sitting. The danger arising from coal-dust in mines may be met (1) by precautions to prevent its ignition, and (2) by the adoption of means to prevent its accumulation or to render it innocuous. The formation of a cloud of coal-dust in mines and its subsequent ignition is practically caused by the disturbance and flame attending the explosion of shots or of mixtures of firedamp and air; both of these will, it is believed, under some conditions raise and inflame a cloud of coal-dust in air, and initiate a coal-dust explosion which becomes self-supporting. Most shots are fired at the working face, and in mines deep enough to be dry and dusty some firedamp is nearly always present in the air in such situations, and firedamp may be liberated by the shot; the coal-dust, however, is confined to the floor, and is not so fine as the wind-borne dust on main haulage roads. At the working face a blown-out shot fired near the floor, or pointing to the floor, is most dangerous, and the dust must be present in considerable quantity before a coal-dust explosion is possible, and then the effect of the probable volume of firedamp present in the air is to be considered. On main haulage roads where, after their completion, it must be noted comparatively few shots are fired, and where firedamp is practically absent, coal-dust of the finest character is often found on the roof and sides, as well as coarser deposits on the floor, and strong currents of air are usually present to sustain any cloud formed. The effect of a shot in disturbing dust on such roads is twofold. The powder gases rushing from the shot agitate the air in its vicinity, and shock or tremor is communicated to the solid sides of the passage. At the working face, the first cause only operates. Any tremor given to the floor on which the dust there rests would have no effect in raising a cloud; but where dust is on the roof and sides as well as on the floor, both causes assist in forming a cloud. The combined effect of these conditions appear to make it much more dangerous to fire a shot on an old haulage road, where there is much dust than at the working face. Nos. 1, 2, 4, 6, 7, and 8 explosions were, it is believed, caused by shots, which were not blown out, fired in stone on old intake and haulage roads, where the air was practically free from firedamp. Nos. 5 and 9 explosions were caused by shots fired at stone at the working face. In these cases there was an unusual quantity of coarse dust on the floor near the shots, and there would probably be from 1 to 2 per cent. of firedamp in the air. In No. 5 the position of the shot hole could not be determined; in No. 9 the shot was partially blown out, and pointed to the floor. The raising of a cloud of coal-dust by shots may be prevented by removing or damping the dust in their immediate neighbourhood, as is required by the present Mines Act, without resorting to any general system of removal or damping.

"The use of a flaming explosive in conjunction with some material to kill the flame, or the use of a flameless explosive (if such exist) are remedies adopted.

"The danger arising directly from explosions of firedamp and air is a sufficient reason for adopting every reasonable precaution to prevent their occurence. In dusty mines, where such explosions may be indefinitely extended by coal-dust, even greater precautions are necessary.

"No. 3 explosion was probably originated by a local explosion of firedamp at an open light; No. 10 was caused by firedamp ignited by the flames of a fire. The fire-damp had collected in passages near the working face from which the air current had been cut off by the erection of a stopping in the intake in order to isolate the fire, the initial explosion so caused being extended to the downcast shaft by coal-dust.

"Means to prevent the formation of dust deposits, or to render them innocuous, will be briefly glanced at. Main roads are watered on the floor, and in some cases mechanical sprayers are used, so as to damp the roof and sides as well. Water-pipes are laid along the main roads, the water issuing under pressure as a fine jet at intervals. Compressed air is used in connection with the water so as to secure a fine spray, and both damp the roads and saturate the air current with moisture. In some cases the water-pipes are simply provided with cocks at intervals, to which a hose-pipe is attached when watering is necessary. At some collieries the laden hutches are watered at the engine landings. More attention is paid to the construction of the hutches, so as to prevent coal and coal-dust being shaken out of them. By the use of steam the temperature of the air descending the downcast shaft has been raised to the temperature of the mine and at the same time saturated with moisture; the air-current passing round the mine then ceases to have any drying power. Hygroscopic or water-absorbing salts have been sprinkled on the roads to secure dampness. Coal-dust from the screens on the surface should be prevented as far as possible from descending the downcast shaft with the air current.

HYDRAULIC PIPES.

During my inspection of the various hydraulic mining claims, it has on many occasions been suggested to me by the miners to publish a table of the strength of wrought-iron and steel pipes required under various conditions. These conditions vary with the head of water to which they are subjected and the diameter of the pipe used. The diameter of the pipes has an important bearing, especially if the head of water be limited—that is to say, taking the total or hydraulic

head as being 300ft., the quantity of water discharged at the lower end may be such, if the pipe be at a high inclination, that the actual hydrostatic head may be only 250ft., which means that 50ft. of the hydraulic head is lost in friction; or, if we convert it into actual horse-power, a sluice-head of water coming through a pipe 300ft. in height—omitting friction—would be equal to $\frac{60 \times 62{\cdot}5 \times 300}{33{,}000}$, or thirty-four theoretical horse-power, but if 50ft. of this head were absorbed in friction it would only give 28·3 theoretical horse-power. It will be seen from this that where water is used for hydraulic elevators the supply-pipe should be as large as compatible with other conditions, so as to get as much of the available power of the water as possible.

In calculating the strength of wrought-iron and steel pipes, 3·5 has been taken as the factor of safety. This is fully one-half per cent. higher than is generally adopted in America for such pipes, the principle being that it is cheaper and more economical to use lighter pipes and to replace one even should it burst, than to make the whole of the pipes with a large factor of safety.

It must be understood that the rivetting of wrought-iron and steel pipes has a great bearing on their factor of safety. If the rivets are not of a diameter and distance apart in accordance with the gauge of the iron used the factor of safety is reduced. The plates may give the factor of safety, but the strength of the joints may give a far less factor if the rivetting be deficient or the rivets not properly proportioned. It is on the assumption that these proportions are taken into account in the manufacture of the pipes, and that the workmanship has been good, that the tables have been calculated.

In the following tables the tensile strength of steel plates has been taken as 75,000lb. per square inch, and wrought-iron plates as 48,000lb. per square inch, and that the percentage of strength at joints was equal to 0·5 for single-riveted joints and 0·7 for double-riveted. The formula used in calculating the strength of the plates is that used by Professor Rankine—namely, $\frac{T \times t}{R}$, where T is the tensile strength of the plates in pounds per square inch, t the thickness of the plate in inches, and R the radius of the pipe in inches. It is possible there may be some slight errors in some of the calculations, as my figures have not been checked by any one, and most of them were done during any spare time in the evenings whilst travelling about; but they can be taken as being correct enough for all practical purposes. Any slight discrepancy will not affect the strength of the pipes to any appreciable extent.

In the manufacture of wrought-iron pipes care should always be taken that the plate is not rolled lengthways, as that greatly affects the strength of the longitudinal seams. Thus, if a plate were 3ft. wide and 6ft. long, the pipe should be made in 3ft. lengths, and not in 6ft. lengths. When the plate is rolled lengthways the tendency is to split open along the line of rivets. This was the case with the pipes in a siphon across Ballarat Creek, on the Argyle Water-race, at Charleston, which caused continual trouble in replacing. The plates used were of sufficient thickness had the pipes been rolled across the grain of the iron instead of with it. When pipes are manufactured of thin material provision should be made for having plenty of air-valves, and, as these can be made simple in construction and inexpensive, there is no excuse for not having a sufficient number of them. An air-valve has been adopted at Kumara which is very effective and cheap, it merely being a plate of iron, covered with leather, and bolted on the inside of the pipe, on the same principle as the clack of a pump-bucket, the hole in the pipe being about 2in. in diameter. The flap, or clack, opens on the down-stream side of the water, so that when the water goes out of the pipe at the place where the clack is placed it falls down and admits the air, and in the same way, when the water is again turned on, it forces up the iron and leather against the pipe, keeping it water-tight.

The reason for publishing these tables is that they may assist the miners in arriving at the thickness of pipes they require to use when once they know the head or pressure of water they will be subjected to, for the quantity of water that pipes of a given diameter and inclination will discharge can be got from my "Miner's Guide." It is very evident that pipes will be largely used in the future in hydraulic mining, and also in lieu of fluming across deep gullies. The cost of a wrought siphon is much less in the first instance than a high timber flume, and it is more durable; but where wrought-iron siphons are used, in long lengths of pipes, provision will always have to be made for a sufficient number of expansion-joints. Where a siphon crosses a deep gully the pipes should be made fast at the top of the bank at each side, and have the expansion-joints below. When this is not done the pipes, as they expand with the hot weather, gradually creep down the declivity, and when they contract again with the cold weather the weight of water in the pipes prevents them moving up hill back to their original position. This has proved the case in some of the siphons across gullies in Otago: the pipes got to a certain extent buckled, and thereby damaged.

Whenever pipes of large diameters have to be used it is not advisable to get them made of very thin plates, notwithstanding that the tensile strength of such plates may be sufficient. The weight of water in a large pipe is very considerable, and, at the place where it is bedded on chocks or otherwise, the pipes are liable to get dinged in. Take, for instance, a pipe 3ft. in diameter: the weight of water in each foot of this pipe is about 442lb., and the plate is much easier dinged in large pipes than it is in a small one made of a plate of a less thickness. Therefore, although thin plates might be actually strong enough to resist the bursting-pressure, they are not of sufficient thickness to resist the weight of water in the pipes unless they are bedded in concrete, which would make a siphon expensive.

It is also an important element in the life of pipes to have them well coated with tar or other substance, and this applies with great force to steel pipes. Care should be taken to always keep them well coated both inside and outside, to prevent oxidation taking place. Steel is more susceptible to oxidation than wrought-iron, and the latter is more so than cast-iron. When once rust begins to show on the surface of a thin plate it is not long before there is a small hole in the pipe, but so long as the coating is maintained the pipes will last for a long period.

The following tables give the strength of steel and iron pipes from 10in. to 36in. diameter, showing the thickness of plates required to be used in their construction in proportion to their diameter and head of water they will be subjected to:—

B.W.G. No.	Steel Pipes, single rivetted.			Iron Pipes, single rivetted.		Steel Pipes, double rivetted, longitudinal Seams.		Iron Pipes, double rivetted, longitudinal Seams.	
	Diameter of Pipes.	Safe pressure, in Pounds, per Sq. Inch.	Safe pressure of Head.	Safe pressure, in Pounds, per Sq. Inch.	Safe pressure of Head.	Safe pressure, in Pounds, per Sq. Inch.	Safe pressure of Head.	Safe pressure, in Pounds, per Sq. Inch.	Safe pressure of Head.
	In.	lb	Ft.	lb	Ft.	lb	Ft.	lb	Ft.
8	10	359	835	230	535	501	1,165	320	745
9	10	321	747	205	477	450	1,046	288	670
10	10	291	677	186	433	408	948	261	607
11	10	261	607	167	389	365	849	233	541
12	10	237	541	151	352	331	770	212	493
13	10	206	479	131	305	289	672	185	431
14	10	180	418	115	268	252	586	161	375
15	10	156	363	99	229	219	509	140	559
16	10	141	327	90	209	198	462	127	296
8	11	322	749	206	479	450	1,046	288	690
9	11	288	669	184	429	404	939	258	600
10	11	261	607	167	389	365	849	233	541
11	11	234	544	149	347	327	761	209	486
12	11	212	495	135	314	297	691	190	446
13	11	185	430	116	270	259	602	166	386
14	11	161	374	103	240	226	525	145	238
15	11	140	325	89	207	196	456	124	289
16	11	126	293	80	186	177	413	113	263
6	12	362	841	231	537	507	1,179	324	754
7	12	321	723	205	477	451	1,048	289	670
8	12	294	683	188	438	412	908	264	600
9	12	264	614	169	393	370	862	237	552
10	12	239	556	153	356	335	779	214	498
11	12	214	499	137	319	300	699	192	445
12	12	194	451	124	289	272	633	175	408
13	12	169	393	108	252	237	551	152	354
14	12	148	344	95	220	207	482	132	307
15	12	128	299	82	190	180	420	115	268
16	12	116	270	74	172	165	384	105	245
6	13	334	777	213	495	468	1,087	296	688
7	13	298	693	191	445	416	966	266	618
8	13	271	630	174	406	380	885	243	565
9	13	244	567	156	363	341	794	218	507
10	13	220	511	141	329	309	719	198	462
11	13	197	458	126	293	277	645	177	413
12	13	179	416	115	268	251	584	161	375
13	13	156	363	100	234	219	509	140	327
14	13	136	316	87	202	191	445	122	284
15	13	118	274	75	174	166	386	106	247
16	13	107	249	68	157	150	351	96	225
6	14	311	723	199	464	434	1,008	277	645
7	14	276	642	177	412	386	898	247	575
8	14	252	586	162	377	353	822	226	525
9	14	226	524	145	338	317	741	202	470
10	14	205	477	131	305	287	668	184	426
11	14	184	428	118	275	257	598	164	389
12	14	167	388	107	250	233	541	149	347
13	14	145	337	92	213	203	472	130	303
14	14	127	295	81	188	178	415	114	266
15	14	110	256	71	165	152	354	97	225
16	14	99	230	64	149	139	323	89	207
6	15	290	675	185	431	406	943	260	605
7	15	257	598	165	385	361	840	231	537
8	15	236	548	152	354	330	863	211	491
9	15	211	491	135	314	296	688	189	441
10	15	191	444	122	284	268	623	171	400
11	15	171	399	110	258	240	559	153	356
12	15	155	362	99	232	217	505	138	321
13	15	135	314	86	199	190	443	121	328
14	15	118	275	75	174	166	386	103	240
15	15	103	239	66	154	144	336	92	213
16	15	93	215	60	132	130	303	83	192
6	16	272	633	174	408	381	888	244	568
7	16	241	561	154	359	338	787	216	502
8	16	221	515	142	331	309	720	198	462
9	16	198	461	127	296	277	645	177	413
10	16	179	417	115	268	251	584	161	375
11	16	160	373	102	238	225	523	144	336
12	16	146	340	93	215	204	475	131	305
13	16	137	319	87	202	178	415	114	266
14	16	111	259	71	165	155	361	99	230
15	16	96	222	61	141	135	314	86	199
16	16	87	202	55	127	121	282	78	181
6	17	256	595	164	382	358	834	229	532
7	17	227	528	145	338	318	741	203	472
8	17	208	484	133	309	291	677	186	433
9	17	187	436	119	277	261	607	167	389
10	17	169	393	108	251	236	548	151	352
11	17	151	352	97	225	211	491	135	314
12	17	137	319	86	197	192	447	123	286
13	17	120	280	77	179	167	389	106	247
14	17	104	243	67	155	146	340	93	215
15	17	91	211	63	145	127	296	83	192
16	17	82	190	52	120	114	266	70	166

B.W.G. No.	Steel Pipes, single rivetted.			Iron Pipes, single rivetted.		Steel Pipes, double rivetted, longitudinal Seams.		Iron Pipes, double rivetted, longitudinal Seams.	
	Diameter of Pipe.	Safe pressure, in Pounds, per Sq. Inch.	Safe pressure of Head.	Safe pressure, in Pounds, per Sq. Inch.	Safe pressure of Head.	Safe pressure, in Pounds, per Sq. Inch.	Safe pressure of Head.	Safe pressure, in Pounds, per Sq. Inch.	Safe pressure of Head.
	In.	lb	Ft.	lb	Ft.	lb	Ft.	lb	Ft.
6	18	241	561	154	359	338	787	216	502
7	18	214	498	137	319	301	701	193	449
8	18	196	456	126	293	275	640	176	410
9	18	176	410	113	363	247	575	157	366
10	18	159	370	102	238	223	518	143	333
11	18	142	331	91	211	200	466	128	298
12	18	129	300	83	192	181	422	116	270
13	18	113	263	72	167	158	368	101	236
14	18	98	227	63	145	135	314	86	200
15	18	86	199	55	127	120	280	77	179
16	18	77	179	50	116	108	252	69	161
6	19	229	532	147	343	320	744	205	477
7	19	203	472	130	303	285	663	182	424
8	19	186	433	119	278	260	605	156	363
9	19	167	389	106	247	233	541	149	348
10	19	151	352	97	228	211	491	135	314
11	19	135	314	86	200	189	441	121	282
12	19	123	286	79	184	172	401	111	259
13	19	107	250	69	161	150	350	96	225
14	19	93	215	59	137	131	305	84	195
15	19	81	188	52	120	114	266	72	167
16	19	73	169	47	110	102	238	66	152
6	20	217	505	139	323	304	708	194	451
7	20	193	449	124	289	271	631	174	406
8	20	177	413	112	261	247	575	157	365
9	20	158	368	101	236	222	516	142	331
10	20	143	333	91	211	201	468	129	300
11	20	128	298	82	190	180	420	115	268
12	20	116	270	74	172	163	379	104	343
13	20	101	236	65	150	142	331	90	209
14	20	89	207	56	129	124	288	79	184
15	20	77	179	49	114	108	252	69	161
16	20	69	161	44	102	97	225	63	145
6	21	207	481	132	307	290	675	185	430
7	21	183	426	117	273	258	600	165	384
8	21	168	391	107	250	236	548	151	352
9	21	151	352	97	228	211	491	135	314
10	21	136	316	87	203	191	445	122	284
11	21	122	284	78	182	171	399	110	257
12	21	111	259	71	165	155	361	99	232
13	21	97	228	61	141	135	314	86	200
14	21	84	195	53	122	118	275	75	174
15	21	73	169	47	110	103	240	66	154
16	21	66	152	42	97	93	215	59	137
6	22	197	458	126	293	276	642	177	413
7	22	175	408	112	264	246	572	157	366
8	22	160	373	102	238	225	523	144	336
9	22	144	336	91	211	202	470	129	300
10	22	130	303	83	192	182	424	117	273
11	22	117	273	74	171	163	379	104	243
12	22	106	247	68	159	148	345	94	218
13	22	92	213	58	135	129	300	83	192
14	22	81	188	52	120	113	263	72	167
15	22	70	163	45	104	98	230	62	143
16	22	63	145	40	93	89	207	56	129
6	23	189	440	121	282	264	614	169	393
7	23	168	391	107	250	235	546	150	350
8	23	153	356	98	230	215	500	137	319
9	23	137	319	87	203	193	449	124	289
10	23	125	291	80	186	175	408	112	259
11	23	112	261	72	167	156	363	100	234
12	23	101	236	65	150	142	331	90	209
13	23	88	205	56	130	124	289	79	184
14	23	77	180	49	114	108	252	69	161
15	23	67	157	42	97	93	215	59	137
16	23	60	139	38	89	85	197	54	125
6	24	181	421	116	270	253	588	162	377
7	24	161	375	103	240	226	526	145	338
8	24	147	343	93	215	206	479	132	307
9	24	132	307	85	197	185	431	118	275
10	24	120	280	77	179	167	389	106	247
11	24	107	250	68	159	150	350	96	222
12	24	97	228	62	143	136	316	87	202
13	24	85	197	54	125	119	278	76	176
14	24	74	172	47	110	103	240	66	152
15	24	64	148	40	93	90	209	57	132
16	24	58	135	37	85	81	188	52	120
¼	25	214	500	137	316	300	697	192	447
5	25	189	439	121	282	264	614	168	391
6	25	174	404	111	259	244	566	155	361
7	25	154	359	98	230	216	503	138	321
8	25	141	329	90	209	198	460	127	296
9	25	127	295	81	188	178	413	114	266
10	25	115	267	73	169	161	374	103	240

B.W.G. No.	Steel Pipes, single rivetted.			Iron Pipes, single rivetted.		Steel Pipes, double rivetted, longitudinal Seams.		Iron Pipes, double rivetted, longitudinal Seams.	
	Diameter of Pipe.	Safe pressure, in Pounds, per Sq. Inch.	Safe pressure of Head.	Safe pressure, in Pounds, per Sq. Inch.	Safe pressure of Head.	Safe pressure, in Pounds, per Sq. Inch.	Safe pressure of Head.	Safe pressure, in Pounds, per Sq. Inch.	Safe pressure of Head.
	Inches.	lb	Ft.	lb	Ft.	lb	Ft.	lb	Ft.
11	25	103	239	66	152	144	335	91	211
12	25	93	217	59	137	130	304	83	192
13	25	81	189	52	120	114	265	72	167
14	25	71	165	46	107	99	232	63	145
15	25	62	143	39	91	86	201	55	127
16	25	56	129	36	82	78	181	50	116
¼	26	207	481	132	307	288	671	184	428
5	26	181	422	116	270	254	590	162	378
6	26	167	389	106	247	234	545	149	347
7	26	148	345	94	218	208	484	133	309
8	26	136	316	87	203	190	443	121	282
9	26	122	284	78	182	171	397	110	257
10	26	110	257	70	163	155	360	99	232
11	26	99	230	63	145	138	322	88	205
12	26	90	209	57	133	126	292	81	188
13	26	78	183	50	116	110	255	70	163
14	26	68	159	43	99	96	223	61	141
15	26	59	138	38	89	83	193	53	122
16	26	53	125	34	78	75	174	48	112
¼	27	199	463	127	295	278	646	178	414
5	27	175	406	112	261	244	568	155	361
6	27	161	375	103	240	226	526	145	338
7	27	143	332	91	211	200	466	128	298
8	27	131	305	84	195	183	426	117	273
9	27	117	273	74	172	164	382	105	245
10	27	106	247	68	159	149	346	95	220
11	27	95	221	60	139	133	310	85	197
12	27	86	201	55	127	121	281	78	182
13	27	75	175	48	112	106	245	68	159
14	27	66	153	42	97	90	210	57	157
15	27	57	133	36	82	80	186	51	118
16	27	51	120	33	75	72	168	46	107
¼	28	192	447	122	284	268	623	171	399
5	28	168	392	107	252	236	548	151	352
6	28	155	361	99	232	217	506	138	321
7	28	138	320	88	205	193	450	124	289
8	28	126	294	81	188	177	411	113	263
9	28	113	263	73	169	159	369	101	236
10	28	102	238	65	150	144	334	91	211
11	28	92	213	59	137	129	299	83	192
12	28	83	194	53	122	117	271	71	172
13	28	73	169	47	110	102	237	66	152
14	28	63	148	40	93	89	207	56	129
15	28	55	128	35	80	77	179	49	114
16	28	50	116	32	73	70	162	45	104
¼	30	179	417	115	268	250	582	160	372
5	30	157	365	100	234	220	512	141	329
6	30	145	337	92	213	203	472	130	303
7	30	129	299	83	192	180	420	115	268
8	30	118	274	75	174	165	384	105	245
9	30	106	246	68	159	148	344	94	218
10	30	96	223	61	141	134	312	85	197
11	30	86	199	55	127	120	279	77	180
12	30	78	181	50	116	109	253	70	163
13	30	68	158	44	102	95	221	60	139
14	30	59	138	37	85	83	193	53	122
15	30	51	120	33	75	72	167	46	106
16	30	46	108	29	27	65	151	41	95
¼	32	171	398	110	257	239	555	153	358
5	32	150	349	96	225	210	488	134	302
6	32	138	322	88	205	194	451	125	291
7	32	123	285	79	184	172	401	121	282
8	32	112	261	71	165	158	366	100	234
9	32	101	235	65	150	141	329	90	209
10	32	91	212	58	134	128	297	82	190
11	32	82	190	52	120	115	267	73	169
12	32	74	173	47	110	104	242	66	152
13	32	65	151	41	95	91	212	58	135
14	32	57	132	36	82	79	184	50	116
¼	34	158	368	101	236	220	513	146	340
5	34	139	322	89	207	194	451	124	289
6	34	128	297	82	190	179	416	115	268
7	34	113	264	72	167	159	370	101	236
8	34	104	242	66	152	146	239	93	215
9	34	93	217	59	137	130	304	83	192
10	34	84	196	53	122	118	218	75	174
11	34	76	176	49	114	106	246	68	159
12	34	69	160	44	102	96	223	61	141
¼	36	149	348	96	222	208	485	133	309
5	36	131	304	84	195	183	426	117	296
6	36	120	281	77	179	169	393	108	252
7	36	107	249	68	159	150	350	96	225
8	36	98	228	50	116	137	320	87	203
9	36	88	205	56	129	123	287	79	184
10	36	80	185	51	118	111	260	71	165
11	36	71	166	46	106	100	232	64	148
12	36	64	151	40	93	91	211	58	134

MINE MANAGERS' EXAMINATIONS.

The following are the questions which were used at the last examination for Mine Managers' Certificates, under "The Coal Mines Act, 1891," and under "The Mining Act, 1891," in February, 1892:—

UNDER "THE COAL-MINES ACT, 1891."

FIRST DAY.—TIME: 9 A.M. TO 12 NOON.

SUBJECT 1.—*On the Sinking of Shafts and the Construction of Main Roadways, opening out a Mine, and the Division of a Mine into Districts.*

1. What is the object of ribs and flanges in cast-iron tubbing?
2. If you met a feeder of water at depth of 30 fathoms in a shaft which was to be sunk to a depth of 95 fathoms, and in which no tubbing or barring was needed, state your arrangements.
3. Give the reasons why the bottom stoop or pillar may be left smaller on the dip than on the rise side of the shaft.
4. Describe your operations in detail in sinking through the following strata: Surface clays and gravel, 12ft.; strong sandstone, 60ft.; soft clay, 40ft.; strong sandstone, 20ft.; conglomerate, 40ft.
5. Describe how you would timber and work a seam of the following section: 10ft. strong shale roof, 2ft. coal, 6in. coaly shale, 1ft. 6in. coal, floor soft under clay.
6. How would you work a large pillar-area in a 6ft. seam with a roof inclined to weight? and describe the manner of taking out one of the pillars.
7. In opening out a mine in a 40ft. seam liable to spontaneous combustion, what arrangements would you make to prevent and cope with it?

SUBJECT 2.—*The various Methods adopted in securing Shafts and Workings in a Mine, showing the relative Advantage and Efficiency of each Class of Material used.*

1. Would you have a bevel or butt joint for your barring in timbering in a rectangular shaft? Give your reasons.
2. With what would you secure a shaft—(*a*) if 600ft. deep, with the strata alternate bands of weak shales, fireclays, and sands, with little or no water; (*b*) and how if only 100ft. deep?
3. What are the objects of blind shafts in coal-seams?
4. Whether would you fear the creep most, in a 4ft. or 20ft. seam; and why?
5. Give sizes and kinds of timber you would use in a main road 9ft. wide and 6ft. high; roof poor.
6. Sketch how you would timber a seam lying at 1 in 3; roof good, but floor poor.
7. Sketch how you would lay off a long-wall working in relation to the dip in a highly-inclined seam

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TIME: 2 P.M. TO 5 P.M.

SUBJECT 3.—*The various Methods of hewing and cutting Coal of different Classes to Advantage, and securing the Ground whilst so engaged.*

1. How would you work a coal-seam 12ft. thick, with good roof and pavement lying at 1 in 20? Give all dimensions, and state what percentage of coal you consider you could win.
2. What area would you leave supported on timber in working the pillars in a 6ft.-thick seam of hard coal with an ordinary sandstone roof? Explain when and how you would draw the props.
3. How would you work a seam of the following section: Floor, soft pipeclay, underlain by strong sandstone; coal, 1ft. 6in.; hard stone, 5in.; coal, 2ft. 3in.; roof, strong shale? Give full details.
4. Give the reasons for and against holing on the floor, or near the centre, of a 20ft.-thick coal-seam.

SUBJECT 4.—*The varions Methods of Ventilation, and the Construction of Airways so as to produce a good Circulation of Fresh Air in any Part of a Mine.*

1. What is the horse-power of a fan circulating 80,000 cubic feet of air per minute, with a water-guage of 1·5in.?
2. Describe fully ventilation by water-jet, and explain in what circumstances it would be suitable.
3. An upcast 20 fathoms deep has a chimney 60ft. high added to it: what is the difference in water-gauge and volume of air circulating if 5,000 cubic feet was passing at first?
4. An airway is passing 70,000 cubic feet per minute, with a pressure of 5lb. per square foot, and is split into two, measuring 8ft. by 10ft. by 1,000ft. and 8ft. by 6ft. by 800ft.: how much does each split pass?
5. Give a sketch in section and plan showing ventilative arrangements in the neighbourhood of the furnace and upcast.
6. What do you understand by the term "horse-power in the air"?
7. If 50,000 cubic feet of air are circulated by a pressure of 1·8in. water-gauge, how much would be put in motion by a water-gauge of 2in.

SECOND DAY.—TIME: 9 AM. TO 12 NOON.

SUBJECT 5.—*On the Areas of Airways, the Velocity and Divisions of Currents, and the Deductions to be made for Friction.*

1. If you treble the volume of air in a given airway, how much will the resistance be increased? State the law of friction applicable to this, and explain why it is so.
2. A Waddle fan circulates 10,000 cubic feet of air per minute, and this quantity of air is increased to 30,000 cubic feet: how much has the horse-power to be increased?
3. Explain fully why the ratios of increase are different in the two preceding questions.
4. Describe fully any style of ventilating-fan with which you are acquainted, and explain its action.
5. How do you find the horse-power of a furnace? Explain the formula and its use.
6. A furnace of 30-horse power gives a pressure of 4·5lb. per square foot: what volume of air is it passing?

SUBJECT 6.—*On the Nature and Composition of Explosive and Dangerous Gases occurring in Coal-mines, and on Spontaneous Combustion.*

1. Will a light continue to burn if put into pure white damp?
2. What is the condition in the character of a coal that renders it liable to spontaneous combustion, and what condition of the mine is chiefly instrumental in allowing this property in the coal to come into action?
3. Would you consider it safe to work in a dusty mine with 2 per cent. of firedamp present; and, if so, under what conditions?
4. Describe as fully as you can the nature of a mixture of equal volumes of firedamp and air.
5. Would you ever expect to find black damp next the roof?
6. Tell what you know of sulphuretted hydrogen and its occurrence in coal-mines.
7. If you found your light go out when you raised it to the roof, how would you explain it?

TIME: 2 P.M. TO 5 P.M.

SUBJECT 7.—*On the Drainage of Mines and Pumping Appliances.*

1. The travel of plunger is 40ft. per minute in a 14in. working barrel: what is the number of gallons discharged per hour?
2. The growth of water is 80,000 gallons in the twenty-four hours: describe fully what arrangements you would make for drawing this water—(*a*) in a shaft 85 fathoms deep; (*b*) if only 20 fathoms deep.
3. What thickness of metal would be required for 10in. diameter cast-iron pipes in a shaft 160ft. deep?
4. What are the advantages and disadvantages of the plunger form of pump?
5. What is the horse-power required to raise 25,000 gallons of water per hour 180ft., and how much do you allow for friction?
6. Whether would you make the suction- or delivery-pipe larger; and why?

SUBJECT 8.—*The Haulage on Planes and in Shafts, also the Different Systems of Underground Haulage, with Horse-power required to do the Work.*

1. You wish to draw 1,000 tons per day of eight hours up a drive 1,500ft. long lying at 1 in 5: what horse-power would be required for the engine, and what would you allow for friction, ropes, and empty tubs in the system of haulage you would adopt?
2. Give a sketch of a pit-head frame, and show how you arrive at the angle of inclination given to the spurs or inclined supports for the uprights.
3. Give a detailed description of some system of haulage which you have fitted up or are acquainted with.
4. Explain the manner of using, and give sketch of, the clip you prefer in endless-rope haulage.
5. How would you arrange for the rope and boxes going round curves in (*a*) endless- and (*b*) tail-rope haulage?

THIRD DAY.—TIME: 9 A.M. TO 12 NOON.

SUBJECT 9.—*The Theoretical and Effective Power of Steam-engines and Boilers; also on the Strength of Hauling-ropes and Chains.*

1. What size of cylinder is needed to give 250 E.H.P. in a coupled engine, with 54lb. pressure and 200ft. travel per minute?
2. What is the horse-power of a Cornish boiler 5ft. diameter, tube 2ft. 6in. diameter, and 20ft. long?
3. With cut-off at five-eighths of the stroke, what is the mean pressure?
4. In winding 50 tons per hour from a depth of 75 fathoms, what horse-power would your engine require to be? Give sizes of drums and pulleys, weight of cages, rope, &c., and allowance for friction.
5. What circumference of steel-wire rope is needed for a working-load of 7 tons?
6. What is a throttle-valve?

SUBJECT 10.—*The Incrustations in Steam-boilers, and the Cause of same, and Remedy therefor.*

1. What is the object of putting zinc in boilers, and how should it be used?
2. Is the incrustation of carbonate of lime in a boiler a good or bad conductor of heat? and explain how this affects the boiler.
3. What is the safe working-pressure of a double-rivetted iron boiler, 6ft. diameter, $\frac{1}{2}$in. plates, and tenacity 55,000?

SUBJECT 11.—*Tapping Water in Mines, and the Mode of constructing Dams in Underground Workings to keep Water back.*

1. Describe and give sketches with sizes of dam you would put in in a stone-mine to withstand a pressure of 80lb. per square inch.
2. How would you approach a large pillar-area lying at 1 in 5 and full of water—(*a*) from the dip, (*b*) on the level?

TIME: 2 P.M. TO 5 P.M.

SUBJECT 12.—*Blasting and Use of Explosives.*

1. Why are the fumes from discharges of dynamite more injurious at one time than another?
2. Which explosive would you prefer for use in a fiery mine, and which for shaft-sinking?
3. At what temperature does dynamite become frozen? Explain the mode of thawing it.
4. What composition is used in detonators?
5. Describe any safety-fuse you are acquainted with.

SUBJECT 13.—*The Effect that Faults produce in Coal-seams, and how to ascertain the Direction of a Coal-seam when severed by a Fault.*

1. Sketch a downthrow fault, and show how you would measure the amount of displacement.
2. Describe the different kinds of fault.
3. Would you expect to find the coal harder or softer near a fault; and why?
4. If you met a displacement of the strata, how would you prove it was not a reversed fault?
5. If you found the coal suddenly cut off, how would you determine whether it was a fault or the edge of the coal-basin?

SUBJECT 14.—*A Knowledge of the Composition and Character of the Different Classes of Coal, and also of the Character of the Rocks and Formation of the Country where Coal is likely to be found.*

1. Does the workable coal of New Zealand occur in one or more positions in the coal formation?
2. Give the composition of an average lignite and of a brown-coal. What is their distinguishing feature from a bituminous coal, apart from caking?
3. What rocks are most characteristic of coal in your district?
4. Describe the structure of the coal formation in any district with which you are acquainted.
5. Would you consider limestone, basalt, or greensand any indication of coal in your district?

FOURTH DAY.—TIME: 9 A.M. TO 12 NOON.

SUBJECT 15.—*A Knowledge of Surface and Underground Surveying, and of making Plans showing System of Working, Inclination of Seams, Faults, and System of Ventilation.*

1. The candidate must produce a plan showing the style of workings in a colliery, with the surface taken up for at least 20 acres in the vicinity of the shaft, and the underground workings in different-coloured ink. He must describe how he would connect them with the surface in the event of their being only one shaft. The levels and main heading must have assumed traverse calculated in detail, and showing latitude and departure for each bearing.
2. What is meant by the term "20 or 30 scale"?
3. 10°, 200 links; 92°, 160 links; 165°, 80 links; 90°, 100 links; 359°, 100 links: what is the distance between start and finish by computation?
4. 2°, 500 links; 4°, 700 links; 3°, 200 links; all rising at an angle of 8°; thence a drive runs 186°, 1,000 links, also rising, and at an angle of 10°: what are the vertical and horizontal distances between start and finish?
5. You sink due south of an air-shaft 1,000ft. distant, with the dip running S. 30° W. at an angle of 11°: what depth will you require to sink if the air-shaft is 147ft. deep and the surface level?
6. Describe (1) how you would find the difference of level between two points underground (2) the instrument you would use, and its adjustments.
7. Show how you would calculate the area of a five-sided figure.

TIME: 2 P.M. TO 5 P.M.

SUBJECT 16.—*A Knowledge of Arithmetic and the Method of keeping Accounts.*

1. A pillar of coal is 54ft. by 60ft. by 10ft.: how many tons will it contain?
2. What is the $\sqrt{130421}$ and the $\sqrt[3]{29791}$?
3. A 20ft. coal-seam is continuous throughout 500 acres: what is the number of tons it contains?
4. A shaft 12ft. diameter is sunk 173 fathoms: what is the cubic amount excavated?
5. Logs for engine-seat are 13in. by 15in. by 20ft.: what is the amount of their cubic contents?
6. Divide $1\frac{7}{10}$ by $\frac{5}{9}$.
7. Forty men at 12s., five at 14s., and three at 15s. per day: how much is required for the week's pay?
8. What pressure per square inch is caused by a column of water 600ft. high?
9. What is the total pressure on a 12in. piston if steam is admitted at 45lb?

SUBJECT 17.—*A Knowledge of the Provisions of "The Coal-mines Act, 1891."*

Oral.

SUMMARY OF WORKS CONSTRUCTED.

The following statement shows the whole of the different classes of works constructed by the department, either by direct grants or by subsidies to local bodies, during the last ten years (the votes for this purpose having been under the control of the Hon. the Minister of Mines, for the purpose of opening up the mineral belts throughout the colony and also for the development of the mining industry:—

Nature of Work.	Total Cost of Construction, or Amount authorised to be expended.	Expenditure, by way of Subsidy or otherwise, by Mines Department.	Amount of Liability by Mines Department on Works in Progress.
Up to Years 1882–83 and 1883–84.	£ s. d.	£ s. d.	£ s. d.
Water-races	29,252 1 11	14,853 9 5	14,398 11 6
Roads on goldfields	21,437 11 2	13,089 16 0	8,347 15 2
Roads and tracks undertaken by County Councils, subsidised by Mines Department	52,841 17 0	21,844 16 7	10,207 15 9
Works undertaken by prospecting associations, subsidised by Mines Department	13,216 13 4	3,350 0 0	3,400 0 0
Construction of drainage- and sludge-channels, subsidised by Mines Department	5,750 0 0	2,468 15 4	781 4 8
	122,498 3 5	55,606 17 4	37,135 7 1
1884–85.			
Water-races	4,846 1 9	14,596 2 9	4,648 11 6
Roads on goldfields	13,667 10 1	9,630 9 6	12,384 15 9
Roads and tracks undertaken by County Councils, subsidised by Mines Department	13,566 14 1	6,293 16 6	12,739 17 6
Roads to mines, other than gold, subsidised by Mines Department	4,594 10 0	111 19 0	2,888 1 0
Works undertaken by prospecting associations, subsidised by Mines Department	850 0 0	108 0 0	3,692 0 0
Construction of drainage- and sludge-channels, subsidised by Mines Department	4,050 0 0	1,050 0 0	1,931 4 8
Diamond and other drills	3,600 0 0	1,858 0 0	..
	45,174 15 11	33,648 7 9	38,284 10 5
1885–86.			
Water-races	3,660 4 9	6,063 2 3	6,964 4 4
Roads on goldfields	27,543 18 8	12,360 14 9	27,567 19 8
Roads undertaken by County Councils, subsidised by Mines Department	14,773 2 3	13,043 15 9	12,477 9 2
Roads to mines, other than gold, subsidised by Mines Department	1,551 19 10	4,327 0 10	490 12 8
Works undertaken by prospecting associations, subsidised by Mines Department	11,860 18 0	1,999 5 7	6,389 5 9
Construction of drainage- and sludge-channels, subsidised by Mines Department	10,051 14 9	3,994 16 6	6,995 9 9
Schools of Mines	2,160 9 7	1,260 9 7	900 0 0
	71,602 7 10	43,049 5 3	61,785 1 4
1886–87.			
Water-races	..	1,928 14 4	3,466 0 8
Roads on goldfields	12,453 3 5	22,229 16 1	17,791 7 0
Roads and tracks undertaken by County Councils, subsidised by Mines Department	12,613 4 8	7,415 19 6	10,455 1 5
Roads to mines, other than gold, subsidised by Mines Department	..	306 1 0	110 13 1
Works undertaken by prospecting associations and companies, subsidised by Mines Department	15,671 19 6	4,521 7 3	4,618 4 7
Construction of drainage- and sludge-channels, subsidised by Mines Department	5,549 14 6	6,207 18 0	672 6 10
Diamond and other drills	422 15 6	422 15 6	..
Schools of Mines	3,183 7 1	3,383 7 1	700 0 0
	49,894 4 8	46,415 18 9	37,813 13 7
1887–88.			
Water-races	6 6 6	6 6 6	..
Roads on goldfields	6,860 4 3	17,281 11 3	7,370 0 0
Roads and tracks undertaken by County Councils, subsidised by Mines Department	2,998 15 0	8,012 5 2	3,942 4 2
Roads to mines, other than gold, subsidised by Mines Department	..	14 5 4	..
Works undertaken by prospecting associations and companies, subsidised by Mines Department	6,456 8 0	2,703 19 3	924 8 0
Construction of drainage- and sludge-channels, subsidised by Mines Department	..	1,110 4 11	2,054 10 6
Schools of Mines	1,859 3 7	2,221 19 4	337 4 3
Aids to treatment of ores	1,200 0 0	390 18 3	209 1 9
	19,380 17 4	31,741 10 0	14,837 8 8

VALUE OF WORKS CONSTRUCTED—*continued.*

Nature of Work.	Total Cost of Construction, or Amount authorised to be expended.	Expenditure, by way of Subsidy or otherwise, by Mines Department.	Amount of Liability by Mines Department on Works in Progress.
1888–89.	£ s. d.	£ s. d.	£ s. d.
Roads on goldfields	10,253 5 3	4,304 3 9	13,218 11 6
Roads and tracks undertaken by County Councils, subsidised by Mines Department	7,318 1 0	2,466 16 8	5,195 6 1
Works undertaken by prospecting associations and companies, subsidised by Mines Department	474 0 0	236 0 0	687 8 0
Construction of drainage- and sludge-channels, subsidised by Mines Department	..	54 10 6	..
Wharves, contributions by Mines Department	589 19 5	96 6 0	343 13 5
Aids to treatment of ores, subsidised	..	209 1 9	..
Schools of Mines	895 16 10	1,188 6 10	44 14 3
	19,531 2 6	8,555 5 6	19,489 13 3
1889–90.			
Roads on goldfields	3,834 9 7	9,148 5 9	8,005 5 4
Roads and tracks undertaken by County Councils, subsidised by Mines Department	8,507 15 8	3,451 17 11	5,928 1 3
Works undertaken by prospecting associations and companies, subsidised by Mines Department	..	..	663 0 0
Water-races	2,200 0 0	719 0 0	681 0 0
Wharves	..	150 0 0	193 13 5
Schools of Mines	1,040 0 8	1,034 0 11	50 14 0
Aids to treatment of ores	142 8 9	142 8 9	..
Tracks to open up mineral lands	1,000 0 0	207 3 6	792 16 6
Diamond drills	425 14 5	425 14 5	..
	17,150 9 1	15,278 11 3	16,314 10 6
1890–91.			
Roads on goldfields	8,811 14 4	10,815 14 8	5,201 5 0
Roads and tracks undertaken by County Councils, subsidised by Mines Department	2,703 5 0	2,252 5 5	5,027 8 4
Work undertaken by prospecting associations and companies, subsidised by Mines Department	..	..	663 0 0
Water-races	5,542 19 8	6,234 4 6	..
Wharves	..	39 9 9	..
Schools of Mines	3,847 10 0	3,898 4 0	..
Tracks to open up mineral lands	..	78 4 7	419 19 5
	20,905 9 0	23,319 2 11	11,311 12 9
1891–92.			
Roads on goldfields	14,226 5 1	8,460 0 3	11,767 9 10
Roads and tracks undertaken by County Councils, subsidised by Mines Department	3,162 0 0	1,720 18 6	4,937 10 2
Work undertaken by prospecting associations and companies, subsidised by Mines Department	1,455 5 5	336 15 9	1,663 0 0
Water-races	2,256 13 6	2,256 13 6	..
Wharves	..	..	..
Schools of Mines	1,370 19 9	1,370 19 9	..
Tracks to open up mineral lands	40 0 0	41 16 0	418 3 7
	22,511 3 9	14,187 3 9	18,786 3 7
SUMMARY.			
Roads on goldfields	119,088 1 10	107,320 12 0	11,767 9 10
Subsidised roads and tracks	118,484 14 8	66,502 12 0	4,937 10 2
Subsidised roads and tracks other than on goldfields	6,146 9 10	4,759 6 2	..
Prospecting	49,936 8 3	13,256 8 6	1,663 0 0
Water-races	47,764 8 1	46,657 13 3	..
Wharves*	435 15 9	285 15 9	..
Schools of Mines	14,357 7 6	14,357 7 6	..
Drainage-channels	21,401 9 3	14,885 5 3	..
Diamond drills	4,448 9 11	2,706 9 11	..
Treatment of ores	1,342 8 9	742 8 9	..
Tracks to open up mineral lands†	745 7 6	327 4 1	418 3 7
	384,151 1 4	271,801 3 2	18,786 3 7

* £154 3s. 8d. deducted on wharves, which was included in previous statements, but since cancelled.
† £444 12s. 6d. included in previous statements for Port Pegasus track has been cancelled.

The foregoing statement shows that works to the value of £22,511 3s. 9d. were authorised last year, as against works to the value of £20,905 9s. for the previous one; while the actual money paid, either by direct grants or by way of subsidies, was £14,187 3s. 9d., as against £23,319 2s. 11d. for the former year. The total liabilities of the department on works authorised and in course of construction on the 31st March last amount to £18,786 3s. 7d., while the total value of works authorised and also those in progress during the last ten years that the votes have been placed under the control of the department amounts to £384,151, and the actual expenditure £271,936, with liabilities as previously stated. The balance has been paid by local bodies on works constructed and for those in course of construction. The local bodies have a liability of £6,600. It will be

seen that the liabilities set against certain classes of works in the statement are more than that stated in the column of total cost; but some of these liabilities are on works which were authorised in previous years and not yet completed.

A large expenditure on works of different characters has already been made by the department; but a great deal more will yet have to be made to fully open up the auriferous, argentiferous, and mineral lands of the colony. Previous to the votes being placed under the control of the Hon. Minister of Mines there were scarcely any roads and tracks on the goldfields. While the goldfields were under the Provincial Government the revenue derived from them was spent, in some instances, in entirely a different portion of the province, as in the case of the Nelson South-west Goldfields. One has only to travel through the Waimea Flat, near Nelson, to see the network of roads constructed there—the land divided into square blocks, with good macadamised roads between each of them; and on inquiry from an old Nelson settler how they managed to have so many good roads he replied that those were constructed in the good old days, when the Provincial Government were deriving a large revenue from the goldfields. At the same time those who were opening up the country on the West Coast had to carry their provisions for miles on their backs over bush tracks, which in wet weather were next to impassable. When the provinces were abolished it became a matter of necessity to open up this portion of the country as well as in other goldfields to further the mining industry.

Almost the whole of the auriferous lands of the colony, with the exception of some parts of Otago, are in very mountainous and broken country, especially is this the case in the North Island and on the west coast of the Middle Island. At Puhipuhi, numerous argentiferous lodes are known to exist, but these, unfortunately, have not yet proved payable for working. Nevertheless, the knowledge that these lodes contain silver will in time cause the country to be prospected; but, in so doing, men will have to carry their provisions in many instances for long distances with no roads or tracks, with the exception of the one road leading in from the main Whangarie-Kawakawa Road to the heart of the Puhipuhi forest, this road is a great boon to those who are carrying on prospecting operations in this locality.

The Coromandel Peninsula, especially on the east coast, has yet very few roads. Gold is found in different portions of the auriferous belt, from Cape Colville to Te Aroha; but the whole of this country, with the exception of a small portion in the vicinity of the Thames, as well as at Waihi, is covered with dense forest and undergrowth, having steep and, in many instances, precipitous hills rising from about 1,000ft. to 3,000ft. above sea-level, consequently prevents individual miners prospecting the country. The mines in the older mining localities are getting far more difficult to work as they get deeper, and the lodes in most instances are not so rich as they were in the early days; hence, money is not so plentiful, and men cannot afford to lose the same time as they did in the early days of the goldfields in carrying on systematic prospecting operations.

The same remarks apply with greater force on the West Coast goldfields. Large areas of auriferous land in this locality will yet lie for many years unprospected; and very little of the land where gold, silver, or other minerals exist is adapted for pastoral or agricultural pursuits—it is only valuable for its forest, and the metals and minerals it contains. During my recent visit to Cedar Creek, in the Totara district, claims were pointed out to me that were being worked for gold on the slope of the Rangitoto Range, facing the Mikonui, giving fair returns; yet there are no tracks into this portion of the country. The same thing applies through the whole of the mineral belt southwards from the Mikonui River. There is only the one road, which is termed the "Great South Road," following the low-lying lands between the ranges and the ocean-beach.

Again, at Preservation Inlet, gold has been found on Coal Island and also on the mainland, and the track, which was in course of survey last year and partially cleared, has had the effect of causing prospecting to be carried on between Preservation Inlet and the Waiau River, where gold has been found in payable quantities. This portion of the country has heretofore been almost a *terra incognita*—miners could not get into the country; and even yet, although payable gold has been found, very little prospecting can be carried on inland.

The gold-mining industry has been far more prosperous during the past year than it has been for some years previously. The value of the produce last year was £1,107,177, as against £685,321 for the year 1890–91, £803,174 for 1889–90, £831,907 for 1888–89, £922,600 for 1887–88, and £931,628 for the year 1886–87. The yield of gold last year was greater than it has been for the last four years, notwithstanding that a certain quantity of the gold entered for exportation last year should be credited to the previous year on account of the banks holding it back until the duty was abolished, in March, 1891. This quantity, as far as can be ascertained, was about 39,000oz., which still leaves an increased yield last year of 66,455oz., representing a value of £265,820, from every goldfield in the colony.

It is extremely satisfactory to find that the outlying districts in the northern goldfields are likely to contribute largely in the future to the yield of gold, namely, Waihi, Karangahake, and Kuaotunu, as well as on the West Coast and on the Otago fields in the Middle Island. In every class of gold-mining improved methods of working the ground are year after year being employed, and lodes and alluvial drifts which a few years ago were considered too poor to work are now being made to give payable returns. Dredging operations, although not so successful as was anticipated by some, are beginning to be made profitable ventures. More attention is being given to the gold-saving appliances, which are in many cases yet very defective; but this will eventually be remedied, and large areas of shallow wet flats and river-beds will be made, by the use of dredges, to yield up their treasures, which for thousands of ages have lain buried in sands and drifts. Improved methods are also steadily coming into force for the treatment of auriferous and argentiferous ores, whereby a larger percentage of the precious metal is saved. The technical education that the miners are now receiving on some of the goldfields, especially at the Thames, has a tendency to cause our mines in future to be more scientifically worked, as almost every miner has a much better knowledge of mineral-ores now than they had a few years ago, and a great many can analyse ores and ascertain

their value. It is also gratifying to find that the yield from auriferous lodes has been considerably increased, there being a slight increase in the North Island to the extent of 1,894oz.; while at Inangahua, the principal quartz-reefing district in the Middle Island, the increased yield last year amounted to 15,653oz.

Taking the mining industry as a whole throughout the colony it will compare favourably with any other pursuit, and, seeing that the gold-mining branch of the industry supports about one-tenth the population of the colony, the mining community deserves to receive some assistance in getting access into the back country, so that they may continue to carry on their avocations more successfully. New Zealand offers many advantages to gold-miners that are not found in other gold-mining countries in the world. It possesses an abundant supply of water—the whole country being traversed by large rivers, creeks, and streams. The auriferous alluvial drifts are in ground situated in such positions that hydraulic sluicing can be carried on in almost every place where these drifts are found, and it is well known that when this system of mining can be adopted with a good supply of water payable returns are generally got from the claims. Indeed, there is every facility for carrying on mining operations in every branch of the industry. The large rivers are capable of supplying the motive-power for machinery. By adopting electrical transmission of power, as is done at Skipper's Creek, and the Sandhills Dredge on the Shotover River, the cost of fuel in generating steam as a motive-power can be entirely done away with: while the climate of this colony, which is equal, if not superior, to any other country in the world, holds out inducements that are not found elsewhere. Taking all these things into consideration, together with the fact that the colony contains an abundant variety of minerals, the mining industry will maintain its prestige for many years to come as the leading industry in the colony.

I have, &c.,

HENRY A. GORDON, M.A.Inst.M.E.,
Inspecting Engineer.

LIST of WORKS on GOLDFIELDS undertaken wholly by the Mines Department, or by Subsidies to County Councils, Local Bodies, and Prospecting Associations, in Progress on the 31st March, 1892.

Locality and Nature of Works.	Total Cost, or Amount authorised.	Amount of Contribution paid by Mines Department.	Amount due by Mines Department on Works still in Progress.
NORTH ISLAND.			
ROADS (SUBSIDISED).			
Bay of Islands County.	£ s. d.	£ s. d.	£ s. d.
Road from Tuamarere Railway-station to Puhipuhi Township	482 0 0	110 0 0	131 0 0
Coromandel County.			
Mercury Bay Road	1,300 0 0	420 0 0	230 0 0
Wainaru to Kuaotunu Road	450 0 0	190 0 0	35 0 0
Sea-beach to Kuaotunu	600 0 0	200 0 0	100 0 0
Kuaotunu–Coromandel Road	300 0 0	..	150 0 0
Pumpkin Flat–Just in Time Road	300 0 0	120 0 0	30 0 0
Just in Time Road extension	300 0 0	..	150 0 0
	3,250 0 0	930 0 0	695 0 0
Thames County.			
Puru Creek to Horne and Wilson's Claim	50 0 0	..	25 0 0
Hikutaia towards Maratoto	200 0 0	..	100 0 0
Thames to Tapu Road	600 0 0	..	300 0 0
Upper Tararu to Sylvia Mine	750 0 0	342 3 6	32 16 6
Te Papa Gully Road	100 0 0	..	50 0 0
Thames to Hikutaia	52 4 10	..	26 2 9
Road to Puriri Battery	100 0 0	..	50 0 0
Upper Tararu Road to Vulcan's Workings	300 0 0	..	150 0 0
Waiomo to Puhoi Creek	200 0 0	..	100 0 0
Tairua, track to connect with road constructed by Survey Department	300 0 0	..	150 0 0
	2,652 4 10	342 3 6	983 19 3
Ohinemuri County.			
Waitekauri Lower Road	360 0 0	166 17 0	13 3 0
Karangahake Hill Track	200 0 0	16 9 0	83 11 0
Karangahake and Waihi Road	600 0 0	..	300 0 0
	1,160 0 0	183 6 0	396 14 0
Piako County.			
Premier Mine to Katikati	500 0 0	..	250 0 0
MIDDLE ISLAND.			
ROADS (SUBSIDISED).			
Waimea County.			
Repairing horse-track, Baton to Karamea Road	100 0 0	..	50 0 0
Track from Dove River to Baton Saddle and from Rolling River to Wangapeka Saddle	120 0 0	..	60 0 0
	220 0 0	..	110 0 0
Inangahua County.			
Globe Hill to Merrijigs	1,560 0 0	698 13 0	81 7 0
Larry's Creek to Lyell Road	1,220 0 0	530 17 6	79 2 6
Mangles Valley to McGregor's Station	1,200 0 0	300 0 0	300 0 0
Horse Terrace to Hunter's Station	1,280 0 0	..	640 0 0
Golden Lead to Battery	300 0 0	..	150 0 0
Extension of road, Cumberland machine-site	400 0 0	..	200 0 0
Extension of dray-road to Boatman's *viâ* Painkiller	100 0 0	..	50 0 0
	6,060 0 0	1,529 10 6	1,500 9 6
Buller County.			
Waimangaroa to sea-beach	390 0 0	120 0 0	75 0 0
Cedar Creek Road towards Coalbrookdale	100 0 0	..	50 0 0
Road from the Basin, Charleston, to Ballarat Creek	100 0 0	..	50 0 0
Track from county road to United Alpine Mine, Lyell	100 0 0	..	50 0 0
	590 0 0	120 0 0	225 0 0
Grey County.			
Track to New Rush, Cape Terrace	200 0 0	..	100 0 0
Westland County.			
New Rush, south side Hokitika River	100 0 0	18 19 3	31 0 9
Widening Seddon's Terrace Track	150 0 0	..	75 0 0
	250 0 0	18 19 3	106 0 9
Lake County.			
Pembroke Flat to County Nursery	240 0 0	..	120 0 0
Taieri County.			
Nenthorn Road	600 0 0	..	300 0 0
Southland County.			
Repairing bridges, Waikaia Bush	38 13 4	..	19 6 8

List of Works on Goldfields, &c.—*continued.*

Locality and Nature of Works.	Total Cost, or Amount authorised.	Amount of Contribution paid by Mines Department.	Amount due by Mines Department on Works still in Progress.
Roads constructed wholly by Mines Department.	£ s. d.	£ s. d.	£ s. d.
Repairs to Nile Bridge	600 0 0	300 0 0	300 0 0
Waitekauri Battery to New Find at Komata	100 0 0	..	100 0 0
Dray-road, Devil's Creek to Big River	1,000 0 0	..	1,000 0 0
Mokihinui to Wanganui Road	100 0 0	50 0 0	50 0 0
Burnett's Face to Coalbrookdale Road	200 0 0	..	200 0 0
Deadman's to Christmas Terrace Road	20 0 0	..	20 0 0
Oparara, through Gorge to gold-workings	150 0 0	..	150 0 0
Low-level, Alpine Claim, Lyall Road	80 0 0	..	80 0 0
Extending horse-track to Blackball Creek, and improving track over hill to creek	500 0 0	..	500 0 0
Track, Bell Hill to Kopara Lake	500 0 0	..	500 0 0
Cedar Creek dray-road to Upper Mokonui	500 0 0	..	500 0 0
Tucker's Flat Road	250 0 0	..	250 0 0
Track, Wakamarina Forks to Wairau Valley	150 0 0	..	150 0 0
Road up Dart River	200 0 0	..	200 0 0
Tereohanga Gorge to Puhipuhi	800 0 0	..	800 0 0
Cabbage Bay to Port Charles	200 0 0	..	200 0 0
Coromandel to Kuaotunu	200 0 0	..	200 0 0
Kuaotunu to Mercury Bay	350 0 0	..	350 0 0
Tiki to Mahikarau	250 0 0	..	250 0 0
Thames to Manaia	500 0 0	77 10 0	422 10 0
Bridge over Ohinemuri River at Karangahake	350 0 0	..	350 0 0
Hampden to Horse Terrace	2,000 0 0	100 0 0	1,900 0 0
Cobden to Seventeen-mile Beach	400 0 0	250 0 0	150 0 0
Bridge over Mahinapua Creek	500 0 0	..	500 0 0
Great South Road	1,500 0 0	37 5 6	1,462 14 6
Track up Waiho River	100 0 0	18 2 6	81 17 6
Haast Ferry or Glue-pot Track	120 0 0	..	120 0 0
Piers, Victoria Bridge	250 0 0	..	250 0 0
Arrowtown to Macetown	250 0 0	..	250 0 0
Wakatipu–Milford Sound Road	3,251 7 8	3,251 7 8	..
Waiau to Preservation Inlet	356 13 4	356 13 4	..
Aorere Valley to Karamea and Mokihinui	27,860 17 3	27,586 10 11	274 6 4
Garston to Nevis	1,545 18 8	1,469 17 2	76 1 6
Deviation, Pleasant Creek Track	130 0 0	..	130 0 0
	45,264 16 11	33,497 7 1	11,767 9 10
Schools of Mines.			
School of Mines	10,857 7 6	10,857 7 6	..
School of Mines (Otago University)	3,500 0 0	3,500 0 0	..
	14,357 7 6	14,357 7 6	..
Prospecting Subsidies.			
Kapanga Gold-mining Company (Limited)	20,000 0 0	337 0 0	663 0 0
Westland County	..	..	..
Ohinemuri County	100 0 0	..	100 0 0
John Halligan and party	300 0 0	..	300 0 0
Due-north Tail-race	190 10 0	..	190 10 0
Frying-pan Tail-race	109 10 0	..	109 10 0
Totara Mining Association Low-level Tunnel, Donnelly's Creek	300 0 0	..	300 0 0
	21,000 0 0	337 0 0	1,663 0 0
Tracks to open up Mineral Lands.			
Foot-bridge, Ngakawau River	500 0 0	81 16 7	418 3 5
Water-races.			
Nelson Creek Water-race	957 16 9	957 16 9	..
Waimea–Kumara Water-race	17,992 17 11	17,992 17 11	..
Mount Ida Water-race	3,990 0 0	3,990 0 0	..
Mikonui Water-race	14,279 16 4	14,279 16 4	..
Contingencies	659 12 8	659 12 8	..
	37,880 3 8	37,880 3 8	..

Summary of Works.

	£ s. d.	£ s. d.	£ s. d.
Roads (subsidised)—			
Bay of Islands County	482 0 0	110 0 0	131 0 0
Coromandel County	3,250 0 0	930 0 0	695 0 0
Thames County	2,652 4 10	342 3 6	983 19 3
Ohinemuri County	1,160 0 0	183 6 0	396 14 0
Piako County	500 0 0	..	250 0 0
Waimea County	220 0 0	..	110 0 0
Inangahua County	6,060 0 0	1,529 10 6	1,500 9 6
Buller County	590 0 0	120 0 0	225 0 0
Grey County	200 0 0	..	100 0 0
Westland County	250 0 0	18 19 3	106 0 9
Lake County	240 0 0	..	120 0 0
Taieri County	600 0 0	..	300 0 0
Southland County	38 13 4	..	19 6 8
	16,242 18 2	3,233 19 3	4,937 10 2
Roads constructed wholly by Mines Department	45,264 16 11	33,499 7 1	11,767 9 10
Schools of Mines	14,357 7 6	14,357 7 6	..
Prospecting subsidies	21,000 0 0	337 0 0	1,663 0 0
Tracks to open up mineral lands	500 0 0	81 16 7	418 3 5
Water-races	37,880 3 8	37,880 3 8	..
	135,245 6 3	89,389 14 1	18,786 3 5

LIST of WORKS on GOLDFIELDS constructed wholly by the Mines Department, or by Subsidies to County Councils, Local Bodies, and Prospecting Associations, and completed prior to the 31st March, 1892.

Locality and Nature of Works.	Total Cost.	Amount of Contribution paid by Mines Department.
	£ s. d.	£ s. d.
NORTH ISLAND.		
ROADS (SUBSIDISED).		
Bay of Islands County.		
Tiriwhanga Gorge to Galbraith's Road, Puhipuhi	237 0 0	118 10 0
Air-line Road to battery-site, Puhipuhi	73 0 0	36 10 0
	310 0 0	155 0 0
Coromandel County.		
Improving road to Iona and Just in Time Companies' Mine	200 0 0	133 6 8
Making and improving track from Tokatea towards Kennedy Bay	320 0 0	213 6 8
Golden Belt Track	100 0 0	50 0 0
Tokatea Road (repairs)	300 0 0	150 0 0
Making and improving track from Golden Belt to Tiki	239 3 3	159 8 10
Making road from Ring's Bridge to Kapanga Mine	150 0 0	100 0 0
Making road to Kapanga Mine	132 0 0	88 0 0
Temporary track from Tokatea Saddle to Waikoromiko	50 0 0	33 6 8
Continuation of track from Success Company's Mine to top of main range	80 0 0	53 6 8
Completion of road from Tokatea Saddle to Tokatea Battery	50 0 0	33 6 8
Widening road from Matawai to Vaughan's Claim	357 0 0	238 0 0
Improving track, Mercury Bay to Waitai	100 0 0	66 13 4
Continuation and improving Waikoromiko Track	150 0 0	100 0 0
Emily Battery to Rocky Creek	60 0 0	40 0 0
Track, Bismarck Battery to Kennedy Bay	200 0 0	123 6 8
Road up Manaia	675 10 6	450 7 0
Extension of Vaughan's and Vizard's Tracks	150 0 0	100 0 0
Vizard's towards Marebel	200 0 0	133 6 8
Extending and widening Waitaia Road	100 0 0	66 13 4
Makarau to Waiau	1,600 0 0	1,066 13 4
Waikawau to Tiki	500 0 0	333 6 8
Paul's Creek to Cabbage Bay	200 0 0	133 6 8
Waikawau Creek Track	100 0 0	50 0 0
McLaughlin's Road	100 0 0	50 0 0
Manaia to McGregor's new find	100 0 0	50 0 0
Manaia to Tiki	500 0 0	250 0 0
Old saw-mill towards Matawai	200 0 0	100 0 0
Extension of Paul's Creek Track	300 0 0	150 0 0
Matarangi Track	400 0 0	200 0 0
Thames–Coromandel Road, *viâ* Manaia	300 0 0	150 0 0
Harbour View extension	210 0 0	105 0 0
Kapanga to Paul's Creek	200 0 0	100 0 0
Mercury Bay to Kuaotunu	360 0 0	180 0 0
	8,683 13 9	5,260 15 10
Thames County.		
Making new road from Ohinemuri River to Karangahake Quartz-mine	650 0 0	433 6 8
Dray-road to connect Otanui Mines with crushing-battery at Maungawherawhera Creek	710 0 0	473 6 8
Improving roads from Waitekauri Road to Katikati Road	250 0 0	166 13 4
Improving road up Karaka Creek to Lucky Hit Company's Mine	263 1 0	175 7 4
Improving road to upper mines, Waitahi	258 18 10	172 12 7
Karangahake to battery	300 0 0	200 0 0
Ralph's Battery, Waitekauri	399 1 0	199 10 6
Otanui Road to mines	299 18 0	199 18 8
Road to Wick's Battery	70 0 0	46 13 4
Rocky Point Road, Tararu	300 0 0	200 0 0
Thames Borough boundary to hæmatite mine	350 0 0	233 6 8
Widening road from bridge over Hape Creek to Otanui Mines	183 17 0	122 11 4
Track, Karangahake Goldfield	784 1 0	522 14 0
Kauaeranga Valley to Otanui	470 7 0	313 11 4
Tapu Road to mines	81 17 9	54 11 10
Tauranga Road to Karangahake Bridge-site	341 5 0	227 10 0
Karangahake Bridge	229 6 6	152 17 8
Track up Maungakerikeri Creek	93 4 4	62 2 11
Thames Borough boundary to Hape Creek No. 2	600 0 0	300 0 0
Upper Karaka Road	179 13 0	119 15 4
Repairing flood-damages, Waiotahi, Moanataiari, Karaka, and Collarbone Roads	350 0 0	175 0 0
Sea-beach to Waiomo	750 0 0	375 0 0
Te Papa Gully Road	75 0 0	37 10 0
New Find to Waiomo Battery	110 0 0	55 0 0
Rocky Point Road	429 11 10	214 15 11
Waiotahi towards Mercury Bay	522 11 0	261 5 6
Te Mata Road	178 17 6	89 8 9
Waiomo Creek to Tapu	1,499 0 0	749 10 0
Alabama Creek Track	100 0 0	50 0 0
Road from Prospectors' Mine, Puriri, to battery	50 0 0	25 0 0
Karaka Creek to Lucky Hit	365 0 0	182 10 0
Bullion Mine, Tapu, to battery	36 5 0	18 2 6
Track to Hikutaia Goldfield	147 15 2	73 17 7
	11,428 10 11	6,683 10 5

LIST of WORKS on GOLDFIELDS, &c.—*continued.*

Locality and Nature of Works.	Total Cost.	Amount of Contribution paid by Mines Department.
	£ s. d.	£ s. d.
Ohinemuri County.		
Jubilee Mine Track	118 0 0	59 0 0
Track up Tui Creek	306 0 0	153 0 0
Prospecting-track, Whangamata and Waitekauri	200 0 0	166 13 4
Tramway, Karangahake to Railey's reduction-works	400 0 0	200 0 0
Strengthening bridges, Waihi Road	200 0 0	133 6 8
Paeroa to Hikutaia	400 0 0	200 0 0
Repairs, flood-damages	34 13 8	17 6 10
Hikutaia River to Maratoto Mine	180 15 0	90 7 6
Karangahake through Gorge (bridge and culverts)	200 0 0	100 0 0
	2,039 8 8	1,119 14 4
Piako County.		
Extension and completion of Te Aroha Tramway	18,000 0 0	12,000 0 0
Tramway to Fergusson's battery, Waiorongomai	1,500 0 0	1,000 0 0
Road, Waiorongomai	497 17 0	331 18 0
Track to claims at Buck's Reef	55 5 6	36 17 0
Track, Fern Spur to Butler's Spur	231 17 9	154 11 10
Tracks up Stony Creek, Te Aroha Goldfield, &c.	54 0 0	36 0 0
	20,339 0 3	13,559 6 10
Hutt County.		
Road to connect Otorongo Bay with Albion Company's battery, also to connect Terawhiti Quartz-mine with battery	509 16 6	210 17 0
Road, Makara Junction to Terawhiti	450 0 0	225 9 0
	959 16 6	435 17 0
SOUTH ISLAND.		
ROADS (SUBSIDISED).		
Marlborough County.		
Track, Deep Creek to Dead Horse Creek	68 0 0	45 6 8
Mouth of Gorge to Forks, Cullensville to Mahakipawa Diggings	450 0 0	225 0 0
Formation of road at Cullensville, Mahakipawa	217 4 0	108 12 0
	735 4 0	378 18 8
Waimea County.		
Road to open up Table Diggings	260 0 0	130 0 0
Punt over Motueka River	100 0 0	50 0 0
Repairing Baton to Table-land Track	40 0 0	20 0 0
	400 0 0	200 0 0
Collingwood County.		
Road, West Wanganui	300 0 0	200 0 0
Bridge over Aorere River	173 14 0	115 16 0
Extending Anatoki Bridle-track	160 0 0	80 0 0
	633 14 0	395 16 0
Buller County.		
Deviation of road from Candlelight Flat to Deep Creek, Charleston	370 0 0	246 13 4
Road from Orowaiti Lagoon to North Terrace	256 18 6	171 5 8
Prospecting-track from Razorback to Paparoa Range	100 0 0	66 13 4
Track from Seatonville to Larrikins'	438 9 6	292 6 4
Waimangaroa to Denniston	787 0 0	393 10 0
Road to connect alluvial workings with Charleston Road	400 0 0	266 13 4
Track, Four-mile Creek towards Grey Valley	300 0 0	200 0 0
Road to connect alluvial diggings north of Deadman's Creek	278 0 0	185 6 8
Ngakawau to Mokihinui, *vid* beaches	100 0 0	66 13 4
Road to connect Ngakawau Railway with Mokihinui Coal Company's workings	193 0 0	128 13 4
Lyell Bluff to Victor Emmanuel Claim	650 0 0	433 6 8
Beach, Little Wanganui to Mokihinui	300 0 0	100 0 0
Cape Foulwind Road	450 0 0	300 0 0
Road up Nile Valley	56 16 4	28 8 2
Denniston extension	850 0 0	425 0 0
Promised Land towards Motueka	380 0 0	190 0 0
Road over Gentle Annie	200 0 0	100 0 0
Extension, Lyell Creek to Low-level Tunnel	60 0 0	30 0 0
Extension of track 50 chains south of Brighton	140 0 0	70 0 0
Continuation of road, Deadman's Creek	437 17 0	218 18 6
Ngakawau Railway-station to Mokihinui	50 0 0	25 0 0
Addison's Flat towards ranges	20 0 0	10 0 0
North Terrace to Oparara Diggings	500 0 0	333 6 8
Extension of Croninville Road	100 0 0	50 0 0
Waimangaroa to sea-beach	80 0 0	40 0 0
Extension of track, Oparara to Fenian Creek	100 0 0	50 0 0
Con's Creek to Beaconsfield	80 0 0	40 0 0
Addison's Flat to Caroline Terrace	200 0 0	100 0 0
	7,878 1 4	4,561 15 4

LIST of WORKS on GOLDFIELDS, &c.—*continued.*

Locality and Nature of Works.	Total Cost.	Amount of Contribution paid by Mines Department
	£ s. d.	£ s. d.
Inangahua County.		
Dray-road from Soldier's Creek to Devil's Creek	647 0 0	431 6 8
Dray-road from Inangahua to Rainy Creek Battery	900 10 0	606 6 8
Dray-road from Capleston up Little Boatman's Creek	379 0 0	252 13 4
Dray-road from Capleston up Main Boatman's Creek	697 0 0	464 13 4
Dray-road from Westport Road to Inangahua River	224 5 0	149 10 0
Track from Devil's Creek to Big River	134 3 6	89 9 0
Track from Waitahu River to Capleston	358 0 0	238 13 4
Survey and expenses	250 0 0	166 13 4
Track from Cariboo to Big River	728 0 0	364 0 0
Dray-road up Murray Creek to United Inglewood Claim	3,472 0 0	2,314 17 4
Road from Reefton to Big River, *viâ* Devil's Creek	614 0 0	307 0 0
Road up Big River	922 19 0	615 6 0
Continuation of dray-road up Little Boatman's Creek	169 7 6	112 18 4
Road from Capleston to Larry's Creek	640 0 0	426 13 4
Track to connect Capleston with Lone Star	75 0 0	50 0 0
Crushington to Globe Company's workings	403 0 0	201 10 0
Snowy Creek Track	85 15 0	42 17 6
Reefton to Big River	1,792 0 0	1,194 13 4
Glenroy to Horse Terrace	254 0 0	122 10 0
Devil's Creek to Globe Hill	917 6 2	458 13 1
	13,672 6 2	8,610 4 7
Grey County.		
Road from Notown to Deep Creek	1,100 0 0	550 0 0
Road from Langdon's to Moonlight	1,600 0 0	800 0 0
Contribution from goldfields vote towards main road	2,296 6 6	2,296 6 6
Track, Waipuna to Clarke's River	1,200 0 0	800 0 0
Track, Cameron's to Cape Terrace	700 0 0	466 13 4
Road, Limestone to Maori Creek	800 0 0	533 6 8
Red Jack's to Nelson Creek	601 17 6	401 5 0
Barrytown to Deadman's	2,240 0 0	1,493 6 8
German Gully to Arnold's Flat	120 0 0	60 0 0
Baird's Terrace to Lake Brunner	400 0 0	200 0 0
Hatter's Terrace Road	1,000 0 0	500 0 0
Irishman's to Lake Brunner	2,400 0 0	1,200 0 0
Hatter's Terrace	600 0 0	400 0 0
Track, Baird's Terrace to Irishman's	250 0 0	125 0 0
Deep Creek to Bell Hill	1,331 0 0	665 10 0
Track to Blackball Diggings	790 0 0	395 0 0
	17,429 4 0	10,886 8 2
Westland County.		
Improving track, Butchers' Creek to Gentle Annie Terrace	225 10 0	163 13 4
Bridle-track to Kanieri Lake	719 11 0	350 5 6
Bridle-track to Eel Creek	168 9 0	84 4 6
Tunnel-track, Galway Beach to Gillespie's Beach	437 5 0	218 12 6
Road from Duffer's Creek, Greenstone Road, to fifteen-mile peg, Christchurch Road	726 9 0	480 4 6
Continuation of track, Back Creek to Eel Creek	249 4 0	166 3 4
Bridle-track, Duffer's Creek, Bowen and Okarito Road, to sea-beach	333 18 0	222 12 0
Ross Borough boundary to Mount Greenland	1,280 15 0	853 16 8
Track, Kanieri Lake to Humphrey's Gully	279 2 0	186 1 4
Track, Larrikins' to Loop-line Dam	449 11 0	299 14 0
Rough Wainihinihini to Upper Dam	450 0 0	300 0 0
Browning's Pass to Reefs	3,311 6 0	2,207 10 8
Okarito Forks to Teal Creek	600 0 0	400 0 0
Road, Christchurch to Baldhill Range reefs	500 0 0	250 0 0
Extension of Tucker's Flat Road to New Rush	170 19 6	85 9 9
Hokitika Borough boundary (Reefton) to Shotover Rush	120 0 0	60 0 0
Track to New Rush, Back Creek	100 0 0	50 0 0
	10,121 19 6	6,387 8 1
Taieri County.		
Mullocky Gully to Silver Peak	499 15 0	333 3 4
Lake County.		
Track, Skipper's to Phœnix and Scandinavian Reefs	292 2 3	194 14 10
Track to connect scheelite mine with Lake Wakatipu	225 0 0	150 0 0
Arrowtown to Macetown, construction	225 0 0	150 0 0
Arrowtown to Macetown, maintenance	150 0 0	100 0 0
Invincible Quartz-reef Track, Rees River	300 0 0	200 0 0
Rees Valley to company's workings	61 7 6	30 18 9
Pack-track, Criffel Diggings	50 6 6	33 11 0
Left-hand Branch Road, Skipper's	63 9 10	31 14 11
Old Morven Ferry Road	289 0 0	144 10 0
	1,656 6 1	1,035 4 6

LIST of WORKS on GOLDFIELDS, &c.—*continued.*

Locality and Nature of Works.	Total Cost.	Amount of Contribution paid by Mines Department.
Tuapeka County.	£ s. d.	£ s. d.
Making road from top of Terrace to Waipori Bush	300 0 0	200 0 0
Road, Beaumont to Remarkable Bush	300 0 0	200 0 0
Improving road from Waipori Township to antimony-mines, Lammerlaw Ranges	200 0 0	133 6 8
Waipori Township to Waipori Bush	200 0 0	133 6 8
Clutha River to Campbell's	76 9 0	50 19 4
Waitahuna to copper-mine	200 0 0	133 6 8
Road to open up quarry for Waitahuna Bridge	160 9 10	106 19 11
Waipori Road, *vid* Bungtown	566 8 10	283 4 5
	2,003 7 8	1,241 3 8
Wallace County.		
Track, Colac Bay to Round Hill	200 0 0	133 6 8
Pack-track to Round Hill, Colac, and Orepuki	1,050 0 0	500 0 0
	1,250 0 0	633 6 8
Maniototo County.		
Road to Serpentine Diggings	136 10 0	91 0 0
Pig and Whistle to Clarke's Diggings	200 0 0	133 6 8
Shepherd's Hut Flat to Vinegar Hill	100 0 0	66 13 4
Kyeburn Peninsula to main road	82 0 0	41 0 0
	518 10 0	332 0 0
Fiord County.		
Dusky Sound, tracks	300 0 0	200 0 0
Waitaki County.		
Road, Naseby to Livingstone	41 12 0	20 16 0
Southland County.		
Improving tracks from Mataura to Nokomai	75 0 0	50 0 0
Improving road, Waikaka to Leatham	150 0 0	100 0 0
Improving road from Waikaka Township to Leatham Creek	30 0 0	20 0 0
Improving road from Waikaka to Waikaka railway-siding	150 0 0	100 0 0
Widening and improving bush-track to Waikawa	150 0 0	100 0 0
Waikaia to Whitcombe	150 0 0	100 0 0
Waikaka to Switzer's	150 0 0	100 0 0
Road near Waikaka Township	150 0 0	100 0 0
Waikaia to Whitcombe	161 6 8	80 13 4
Waipapa to Six-mile Beach	175 0 0	87 10 0
	1,341 6 8	838 3 4
DIAMOND AND OTHER DRILLS.		
Inangahua County Council (diamond)	2,000 0 0	1,000 0 0
Springfield Colliery Company (diamond)	1,250 0 0	625 0 0
Westland County Council (tiffin)	350 0 0	233 0 0
Diamond drills for prospecting purposes	848 9 11	848 9 11
	4,448 9 11	2,706 9 11
WHARVES.		
Repairs to wharf, Coromandel	300 0 0	150 0 0
Anikiwi Jetty, Marlborough	135 15 9	135 15 9
	435 15 9	285 15 9
AIDS TO PROSPECTING.		
Construction of low-level tunnel, Terawhiti	750 0 0	150 0 0
Queen of Beauty Company, prospecting deep levels	300 0 0	150 0 0
Caledonian Low-level Company, prospecting deep levels	300 0 0	150 0 0
Red Hill Gold-mining Company, prospecting deep levels	600 0 0	300 0 0
Caledonian Low-level Company, low-level tunnel	2,700 0 0	300 0 0
Lyell Creek Extended Company, low-level tunnel	300 0 0	150 0 0
New Cromwell Gold-mining Company	250 0 0	100 0 0
Deep-level Association, Waipori	450 0 0	300 0 0
Little Boatman's deep-level tunnel	600 0 0	300 0 0
Oterongia Prospecting Association	198 17 2	99 8 7
Vincent County	137 9 0	68 14 6
Tapanui Prospecting Association	25 0 0	12 10 0
Tuapeka County	12 0 0	6 0 0
Maniototo County	500 0 0	250 0 0
Pullar, Shelmerdine, and Basan	400 0 0	200 0 0
Royal Oak Association	300 0 0	150 0 0
Star of the East Quartz-mining Company	150 0 0	75 0 0
West Coast Prospecting Association	300 0 0	150 0 0
McBride and party	169 2 2	84 11 1
McLean and party	66 0 0	33 0 0
Deep-level Tunnel, Tokatea	700 0 0	350 0 0
Deep-level Tunnel, Owharoa	300 8 0	200 5 4
Deep-level Tunnel, Tapu	1,200 0 0	600 0 0
Deep-level Tunnel, Cedar Creek	1,207 10 0	603 15 0

LIST of WORKS on GOLDFIELDS, &c.—*continued.*

Locality and Nature of Works.	Total Cost.			Amount of Contribution paid by Mines Department.		
AIDS TO PROSPECTING—*continued.*	£	s.	d.	£	s.	d.
Manuka Flat Prospecting Association	200	0	0	100	0	0
Red Hill Minerals Company	437	19	10	218	19	11
Tuapeka Prospecting Association	277	0	0	138	10	0
Cardrona Prospecting Association	800	0	0	400	0	0
Cromwell Prospecting Association	500	0	0	250	0	0
Coromandel County	550	0	0	275	0	0
Thames County	309	18	0	154	19	0
Thames Borough	200	0	0	100	0	0
Buller County	146	12	6	73	6	3
Inangahua County	488	7	0	244	3	6
Westland County	1,236	19	4	618	9	8
Grey County	871	15	2	435	17	7
Deep-level Prospecting Association, Waipori	432	9	8	216	4	10
Waipu Prospecting Association	180	0	0	90	0	0
Hokianga County	100	0	0	50	0	0
Vulcan Smelting Works, Onehunga	30	0	0	15	0	0
Ohinemuri County	100	0	0	50	0	0
Waitaki County	29	5	0	14	12	6
Waihemo County	85	9	0	42	14	6
William Fox and party	711	1	8	355	10	10
Kirk and party	176	0	10	88	4	11
Hodge and party	98	13	8	49	6	10
Carey and Hyndman	441	9	4	220	14	8
Don, Boyce, and party	107	16	0	53	18	0
Quentin McKinnon	58	10	0	29	5	0
Bullion Mine, Deep-level Tunnel	300	0	0	150	0	0
Sutherland and party	30	0	0	15	0	0
Contingencies	484	15	10	242	7	11
Inangahua Low-level Tunnel	6,966	0	0	3,000	0	0
Deep-level Tunnel, Manaia	451	4	0	225	12	0
Waimea Miners' Association, prospecting at Callaghan's	50	0	0	50	0	0
Deep-level Prospecting Committee, Dillmanstown	120	18	7	120	18	7
Totara Miners' Association, Ross	47	7	6	47	7	6
	28,936	8	3	12,919	8	6
WATER-RACES.						
Water-main, Bull's Battery	350	0	0	100	0	0
Round Hill Water-race	200	19	0	133	19	4
Tomkiss's Water-race	100	0	0	100	0	0
Cardrona Sludge-channel	100	0	0	50	0	0
New water-mains, Thames Water-race	1,479	10	4	739	15	2
Argyle Water-race	7,653	15	1	7,653	15	1
	9,884	4	5	8,777	9	7
DRAINAGE- AND SLUDGE-CHANNELS.						
Drainage-channel, Lawrence (total cost, approximate)	3,000	0	0	2,000	0	0
Subsidy towards purchase of Messrs. Laidlaw and Crawford's freehold in Spotti's Creek, to allow tailings to be deposited (Tinker's Diggings)	500	0	0	400	0	0
Damage by floods, Thames	1,000	0	0	500	0	0
Sludge-channel, Smith's Gully, Bannockburn	1,000	0	0	251	1	0
Round Hill Sludge-channel survey	52	19	7	52	19	7
Compensation to J. Costello, damage done by tailings	788	0	0	788	0	0
Long Gully Sludge-channel	150	0	0	100	0	0
New Pipeclay Gully Sludge-channel	1,547	18	0	773	19	0
Kumara Sludge-channel, No. 2	2,762	17	2	2,762	17	2
Ophir Tail-race	2,300	0	0	1,150	0	0
Lawrence Drainage-channel	1,150	0	0	956	14	0
Muddy Creek Channel	2,000	0	0	1,000	0	0
St. Bathan's Channel	2,000	0	0	1,000	0	0
Tailings-outlet, Maerewhenua	1,595	4	0	1,595	4	0
Ross Sludge- and Storm-water-channel	1,554	10	6	1,554	10	6
	21,401	9	3	14,885	5	3
AID TOWARDS THE TREATMENT OF ORES.						
Testing-plant, School of Mines, Thames	1,200	0	0	600	0	0
Testing minerals, Dunedin Exhibition	142	8	9	142	8	9
	1,342	8	9	742	8	9
ROADS WHOLLY CONSTRUCTED BY MINES DEPARTMENT.						
Construction of road, Arrowtown to Macetown	9,270	6	8	9,270	6	8
Road to open up Woodstock Goldfield	1,000	0	0	1,000	0	0
Ahaura to Amuri	2,504	19	7	2,504	19	7
Waikaia Bush Road	1,000	0	0	1,000	0	0
Waitahuna Bridge	750	0	0	750	0	0
Merrivale, tracks	500	0	0	500	0	0
Mokihinui to Specimen Creek	1,238	7	5	1,238	7	5
Wilberforce Quartz-reef Road	1,830	17	7	1,830	17	7
Opening Mokau River	552	8	0	552	8	0
Lyell to Mokihinui	5,098	8	6	5,098	8	6
Brighton to Seventeen-mile Beach	1,789	7	2	1,789	7	2

LIST of WORKS on GOLDFIELDS, &c.—*continued.*

Locality and Nature of Works.	Total Cost.			Amount of Contribution paid by Mines Department.		
ROADS WHOLLY CONSTRUCTED BY MINES DEPARTMENT—*continued.*	£	s.	d.	£	s.	d.
Whangapeka to Karamea	2,000	0	0	2,000	0	0
Hatter's Terrace to Bell Hill	500	0	0	500	0	0
Cedar Creek Road	3,000	0	0	3,000	0	0
Owen Valley Road	2,208	9	2	2,208	9	2
Cobden to Seventeen-mile Beach	3,036	1	4	3,036	1	4
Cedar Creek Road	1,500	0	0	1,500	0	0
Bridle-track to Upper Anatoki	722	8	0	722	8	0
Whangamata Road	141	10	6	141	10	6
Waikawau to Manaia	1,000	0	0	1,000	0	0
Karangahake through Gorge	1,000	0	0	1,000	0	0
Arthur's Point to Skipper's	12,167	4	1	12,167	4	1
Tracks to Coal Island	54	6	3	54	6	3
Grey Valley to Teremakau	900	0	0	900	0	0
Rimu to New Rush	829	17	9	829	17	9
Kuaotunu–Coromandel Road	500	0	0	500	0	0
Tapu to Waikawau	750	10	0	750	10	0
Puhipuhi Road	1,396	17	9	1,396	17	9
Jackson's Bay to Cascade and Gorge River district	5,310	10	11	5,310	10	11
Improving roads and tracks, Collingwood to Takaka and Motueka	10,905	8	11	10,905	8	11
Contingencies	365	5	4	365	5	4
	73,823	4	11	73,823	4	11
ROADS TO OPEN UP MINES OTHER THAN GOLD.						
Aniseed Valley to Champion Copper-mine	4,963	10	6	4,116	10	6
Richmond Hill to copper-mine	315	16	0	209	4	0
Track, Ohinemuri Coal-seam	267	3	4	133	11	8
Road, Kanieri Coalfield	600	0	0	300	0	0
	6,146	9	10	4,759	6	2
TRACKS TO OPEN UP MINERAL LANDS.						
Glory Harbour to Kopack	50	0	0	50	0	0
Port Pegasus Track	155	7	6	155	7	6
Removing snags and felling timber, Mokau River	40	0	0	40	0	0
	245	7	6	245	7	6

Summary of Works.

	£	s.	d.	£	s.	d.
Roads (subsidised)—						
Bay of Islands County	310	0	0	155	0	0
Coromandel County	8,683	13	9	5,260	15	10
Thames County	11,428	10	11	6,683	10	5
Ohinemuri County	2,039	8	8	1,119	14	4
Piako County	20,339	0	3	13,559	6	10
Hutt County	959	16	6	435	17	0
Tuapeka County	2,003	7	8	1,241	3	8
Southland County	1,341	6	8	838	3	4
Westland County	10,121	19	6	6,387	8	1
Grey County	17,429	4	0	10,886	8	2
Buller County	7,878	1	4	4,561	15	4
Marlborough County	735	4	0	378	18	8
Waimea County	400	0	0	200	0	0
Inangahua County	13,672	6	2	8,610	4	7
Taieri County	499	15	0	333	3	4
Lake County	1,656	6	1	1,035	4	6
Wallace County	1,250	0	0	633	6	8
Maniototo County	518	10	0	332	0	0
Collingwood County	633	14	0	395	16	0
Fiord County	300	0	0	200	0	0
Waitaki County	41	12	0	20	16	0
	102,241	16	6	63,268	12	9
Diamond and other drills	4,448	9	11	2,706	9	11
Wharves	435	15	9	285	15	9
Aids to prospecting	28,936	8	3	12,919	8	6
Water-races	9,884	4	5	8,777	9	7
Drainage- and sludge-channels	21,401	9	3	14,885	5	3
Aid towards treatment of ores	1,342	8	9	742	8	9
Roads wholly constructed by Mines Department	73,823	4	11	73,823	4	11
Roads to open up mines other than gold	6,146	9	10	4,759	6	2
Tracks to open up mineral lands	245	7	6	245	7	6
	248,905	15	1	182,413	9	1

HENRY A. GORDON, M.A.Inst.M.E.,
Inspecting Engineer.

RETURN showing the VALUE of the SALES of WATER, and EXPENDITURE on, and COLLATERAL ADVANTAGES derived from, the Working of the WATER-RACES constructed and maintained by GOVERNMENT, during the Year ending 31st March, 1892.

Name of Water-race.	Value of Sales of Water and Channel-fees.	Expenditure on Maintenance.	Profit or Loss.	Cost of Construction.	Total Cost of Construction.	Percentage on Capital invested.	Average Number of Men employed.	Approximate Amount of Gold obtained.	Value of Gold obtained.	Average Weekly Earnings of Men after deducting Value of Sales of Water and Channel-fees.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.			Oz.	£ s. d.	£ s. d.
Waimea	1,121 16 2	784 13 10	337 2 4*	119,011 6 10		·003	76	2,590	10,100 17 0	2 5 5
Kumara	6,645 11 0	1,584 10 11	5,061 0 1*	39,636 7 11	180,612 12 11	12·8	172	10,239	39,932 2 0	3 14 5
Kumara Sludge-channel	..	404 13 0	404 13 0†	21,964 18 2		..	..	..	..	..
Nelson Creek	213 0 0	292 6 6	79 6 6†	..	90,722 10 8	..	23	245	980 0 0	1 19 2
Argyle	..	..	..	..	..	..	..	..	..	..
Mikonui	50 0 0‡	..	50 0 0*	..	25,927 4 6	..	..	..	..	..
Totals	8,030 7 2	3,066 4 3	4,864 2 11*	180,612 12 11	297,262 8 1	..	271	13,074	51,012 19 0	..

* Profit. † Loss. ‡ Rent.

HENRY A. GORDON, M.A.Inst.M.E., Inspecting Engineer.

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