QUICKSILVER.

By JAMES BUTTERWORTH RANDOL.

EXTRACT FROM REPORT ON MINERAL INDUSTRIES IN THE UNITED STATES AT THE ELEVENTH CENSUS, 1890.

[Wash. 1892.]

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PRESENT STATE OF THE INDUSTRY.

The quicksilver industry during the last decade has remained in the same depressed condition. No new discoveries have been made, and the old mines are becoming exhausted to such a degree as to indicate a rather doubtful future notwithstanding the somewhat improved prices, which should tend to a new stimulus in prospecting as well as in producing.

The New Almaden mine, once the proud rival of the Almaden mine in Spain, has given up its second place to the Idria mine in Austria, and the prospects for regaining its lost rank are not very encouraging. The same may be said of the other California mines. All have had similar experience, as shown by the table below. The New Almaden, with a production of 23,465 flasks in 1880, produced in 1889 only 13,100 flasks. The Sulphur Bank, with 10,706 flasks in 1880, produced only 2,283 in 1889; the Great Western produced 6,442 flasks in 1880 against 556 in 1889, while the Guadalupe, a mine in 1880 producing 6,670 flasks, has produced nothing since 1885.

COMPARATIVE TABLE OF QUICKSILVER PRODUCTION IN 1889 AND 1880.

[Flasks.]

COMPANIES.	1889.	1880.	Increase.	Decrease.
Total	a26,484	59,926	2,114	35,556
New Almaden	13,100	23,465		10,365
Ætna Napa Consolidated	4,590	4,416	174	
Great Western	556	6,442		5,886
Sulphur Bank	2,283	10,706		8,423
New Idria	980	3,209		2,229
Great Eastern	1,345	1,279	66	
Redington	812	2,139		1,327
Guadalupe		6,670		6,670
Bradford	1,874		1,874	
Various companies	a944	1,600		656

a Includes 20 flasks from Oregon.

This table shows improvement only in 3 cases, while in all the others a very serious decrease has taken place, the aggregate of production having decreased 55.84 per cent.

The prices for quicksilver, on the contrary, have shown an improvement, the highest and lowest quotations per flask in 1880 being $34.45 and $27.55, against $50 and $40, respectively, in 1889, a total improvement of 45.16 per cent. This improvement in prices has given some encouragement to prospectors, but with no satisfactory results. The total approximate valuation during the decade from 1870 to 1879, inclusive, was $24,322,500, against $13,480,500 in the last decade—a serious loss, with impoverished mining properties.

The world's production in 1880 was 122,536 flasks, of which the California mines produced nearly one-half, while with a total production of 113,842 flasks in 1889 California only claims 23.25 per cent.

New utilizations for the metal have not been discovered, and the general depression in the Comstock mines has had a very depressing effect on the quicksilver market. The shipments to China and South America ceased altogether in 1889, and shipments to other countries have largely decreased. The total foreign shipments from San Francisco in 1880 were 34,648 flasks, against 5,189 flasks in 1889.

CENSUS STATISTICS.

During the calendar year 1889 there were 26,464 flasks, or 2,024,496 pounds, or 1,012 short tons of quicksilver produced in California. About 20 flasks, less than $1,000 in value, were produced in Oregon. The product is notably less than the usual yield. In 1888, 33,250 flasks were produced.

ESTABLISHMENTS.

In the following table, under the heading of "Productive mines and furnaces", is included every establishment in the United States where cinnabar ore is known to have been mined and quicksilver produced therefrom to the amount of $1,000 or more during the period under review. The nonproductive mines and furnaces include establishments the stoppage of which was caused, among other reasons, by litigation, by low prices for quicksilver and the consequent unprofitable results for the time being, or by lack of sufficient capital and experience to pursue a hazardous industry. It is considered probable that all of those establishments now closed and unproductive will resume work when higher and more remunerative prices for quicksilver can be obtained.

The productive mines and furnaces, with few exceptions, were operated continuously throughout the year, omitting holidays and Sundays.

LOCATION AND NUMBER OF ALL THE QUICKSILVER ESTABLISHMENTS, BY STATES AND COUNTIES.

STATES.	Counties.	PRODUCTIVE.		NONPRODUCTIVE.	
		Mines.	Furnaces.	Mines.	Furnaces.
Total		11	36	6	7
California	Lake	3	12		
Do	Merced	1	(a)		
Do	Napa	4	12		
Do	San Benito	1	3		
Do	Santa Clara	1	7	1	4
Do	Sonoma	1	2		
Do	Siskiyou			1	(a)
Do	Trinity			1	
Oregon	Douglas			3	3

a One retort.

The productive mines and active furnaces employed 937 operatives, of whom 416 were engaged on surface work and 521 were employed underground. The other mines and furnaces employed 24 men, making a total of 961 employés, as shown in the following table:

NUMBER OF EMPLOYÉS.

EMPLOYÉS.	Total.	Productive mines and furnaces.	Nonproductive mines and furnaces.
Total	961	937	24
Men	956	932	24
Women	1	1	
Boys	4	4	
Total on surface	434	416	18
Total underground	527	521	6

PRODUCTION STATISTICS.

Of 95,714 tons (2,000 pounds each) of cinnabar ore mined, 92,964 tons were roasted, producing 26,464 flasks of quicksilver, each containing a standard quantity of 76.5 pounds avoirdupois. Of the 11 establishments working ore, 1 reported only 200 tons produced and worked in retorts, with an average yield of 2.295 per cent, the highest percentage returned. The lowest average yield was 0.286 per cent, and the average percentage yield in quicksilver for all the ore roasted was 1.089. The largest quantities of ore produced and roasted by a single establishment were, respectively, 28,007 and 28,887 tons, and the quantity of quicksilver produced at the several works ranged from 120 to 13,100 flasks.

The following table exhibits the quantity of ore produced and roasted in 1889, the number of flasks of quicksilver produced, and the percentage of yield:

YIELD OF QUICKSILVER FROM ORES ROASTED IN 1889.

NUMBER OF ESTABLISHMENTS.	Ore produced. (Short tons.)	Ore roasted. (Short tons.)	Quicksilver produced. (Flasks.)	Yield. (Per cent.)
1	7,168	7,168	1,874	1.000
1	9,880	9,880	2,283	0.884
1	7,440	7,440	556	0.286
1	200	200	120	2.295
1	4,742	3,992	812	0.778
1	23,500	23,500	4,590	0.747
1	3,400	3,400	804	0.905
1	3,377	3,377	980	1.110
1	28,007	28,887	13,100	1.735
1	7,000	5,120	1,345	1.005
1	1,000	....	....	....
11	95,714	92,964	*a*26,464	1.089

a One mine in Oregon produced 20 flasks, the total product in that state; they are not included, being less than $1,000 in value.

EXPENDITURES.

The following table shows the value of supplies of all kinds consumed during the year 1889, the aggregate of all wages paid, total of all other expenditures for mines and works, including rent, taxes, etc., number of flasks of quicksilver produced, and average cost per flask:

EXPENDITURES IN THE PRODUCTION OF QUICKSILVER IN 1889, NUMBER OF FLASKS PRODUCED, ETC.

NUMBER OF ESTABLISHMENTS.	Value of all supplies.	Aggregate of all wages.	Total of all other expenditures.	Number of flasks of quicksilver produced.	Average cost per flask.
1	$53,567	$104,608	$760	4,590	$34.63
1	5,975	8,060	....	....	(*a*)
1	*b*4,000	20,936	750	804	31.95
1	4,000	12,591	1,000	812	21.66
1	9,564	43,241	1,042	1,874	28.73
1	21,973	47,208	2,507	2,283	31.40
1	9,034	25,352	2,167	556	65.74
1	1,500	2,250	....	120	31.25
1	3,114	27,546	79	980	31.37
1	86,428	204,341	26,826	15,100	31.88
1	20,467	30,156	359	1,345	37.90
11	219,622	626,289	35,490	26,464	33.31

a Ore mined, but none roasted, and therefore omitted in average cost per flask.
b Estimated; correct amount unobtainable.

From the above table it will be seen that at 11 active establishments there were expended $219,622 for supplies, $626,289 for wages, and $35,490 for other expenses, embracing taxes, rent, interest, etc., making a total of $881,401, showing that 71.05 per cent was paid for wages, 24.92 per cent for supplies, and 4.03 per cent for all other expenses. Of the amount paid for wages the office force absorbed $34,966, and there were paid to foremen, mechanics, miners, furnace hands, and laborers $591,323.

PRICES.

The cost per flask of quicksilver produced ranged from $65.74 to $21.66, the average cost for all being $33.31. The following table gives the highest and lowest price monthly for quicksilver:

PRICE OF QUICKSILVER IN SAN FRANCISCO DURING 1889.

MONTHS.	Highest.	Lowest.	MONTHS.	Highest.	Lowest.	MONTHS.	Highest.	Lowest.
January	$43.00	$41.50	May	$45.00	$41.00	September	$47.50	$47.00
February	42.00	41.50	June	50.00	46.50	October	47.00	46.50
March	41.00	40.00	July	47.50	46.50	November	48.00	46.00
April	41.00	40.00	August	47.50	46.00	December	47.50	47.00

For the year the highest price per flask for quicksilver was $50 and the lowest $40. The total valuation of the year's production was $1,190,500. The difference between the cost, $881,401, and value, $1,190,500, is $309,099, which may be regarded as the profit on the year's work, based on the returns collected. The difference between average cost and average sale price was $11.69 per flask.

The establishment producing quicksilver at a cost of $65.74 per flask met with a serious loss on its output, and no establishment made a profit commensurate with the risks attending the mining of cinnabar, its manufacture into quicksilver, and finding for it a market in competition with rich and important establishments carried on by foreign governments.

WAGES.

The wages in the table appended show considerable variations, depending largely upon the locality of the work, its importance, and the degree of skill required for its performance. On work at surface foremen were reported to earn daily wages ranging from $10.33 to $2.66; mechanics, $3.60 to $2.05; laborers, $2 to $1.18, the last-named rate being for Chinamen. Boys under 16 years of age, of whom only 4 were employed, none underground, earned from $1 to 75 cents.

The following table gives the number and classification of employés on surface (excepting the office force), daily wages, and number of days worked during the year:

NUMBER OF EMPLOYÉS ABOVE GROUND, WAGES, ETC., IN QUICKSILVER MINING.

NUMBER OF ESTABLISHMENTS.	FOREMEN.			MECHANICS.		
	Average number employed daily.	Average wages per day.	Average number of days worked.	Average number employed daily.	Average wages per day.	Average number of days worked.
1	1	$2.90	365	a 5	$2.80	301
1	2	10.33	360	5	2.50	360
1	1	2.81	157	3	3.20	90
1	....	....	....	1	3.60	300
1	4	2.86	349	b 42	2.38	306
1	1	2.75	340	5	3.00	340
1	....	....	....	2	2.05	320
1	2	2.66	365	....	....	....
8	11	c 10.33 d 2.66	c 365 d 157	63	c 3.60 d 2.05	c 360 d 90

NUMBER OF ESTABLISHMENTS.	LABORERS.			BOYS UNDER 16 YEARS.		
	Average number employed daily.	Average wages per day.	Average number of days worked.	Average number employed daily.	Average wages per day.	Average number of days worked.
1	e 11	$1.38	300	....	....	....
1	15	1.75	360	....	....	....
1	6	2.00	300	....	....	....
1	17	1.73	265	....	....	....
1	f 87	1.18	284	....	....	....
1	g 98	1.94	281	3	$0.75	187
1	38	2.00	340	1	1.00	310
1	f 12	1.30	300	....	....	....
1	f 2	1.37	308	....	....	....
9	286	c 2.00 d 1.18	c 360 d 265	4	c 1.00 d 0.75	c 310 d 187

a Mechanics comprise engineers, $2.90; blacksmiths, $2.90; and furnace men, $2.65 per day.

b Mechanics comprise carpenters, $3; masons, $5; blacksmiths, $2.10; helpers, $1.03; engine drivers, $2.39; machinists and helpers, $3.67 as their average earnings per day.

c Highest.

d Lowest.

e Laborers embrace men sorting ore, $1.25; teamsters, $1.65 per day.

f Chinese.

g Laborers comprise furnace hands, $2 to $2.25; ordinary laborers, $2; ore cleaners, $1.75 per day.

One establishment reported 42 men employed on surface and underground work without classification or number of days employed, miners at $2.10 and laborers at $1.75 per day. Another establishment reported 11 white men on surface without classification, at $2.80 per day for 352 days. These establishments were not included in the tables.

The tables on the following page exhibit the number and classification of workers underground, their daily wages, and the number of days worked during the year. For foremen at underground work the average wages ranged from $4.68 to $2.75 per day. Miners earned an average of $2.67 to $1.22, the lowest rate being for Chinamen, of whom a few were employed at small establishments.

TOTAL NUMBER OF EMPLOYÉS UNDERGROUND.

Foremen	9
Miners	378
Laborers	*a*134

a 53 unclassified, of which 32 were reported as Chinese, without classification, 362 days, at $1.17 per day.

WAGES OF FOREMEN AND MINERS UNDERGROUND.

NUMBER OF ESTABLISHMENTS.	FOREMEN.			MINERS.		
	Average number employed daily.	Average wages per day.	Average number of days worked.	Average number employed daily.	Average wages per day.	Average number of days worked.
1	1	$2.90	340	*a*6	$2.40	300
1	1	4.00	360	20	2.67	360
1				22	2.45	263
1	1	2.75	110	*b*5	1.22	40
1	2	4.68	306	*c*233	2.66	279
1	3	3.06	340	*b*80	1.25	340
1	1	4.50	316	6	2.05	284
1				6	1.50	336
8	9	*d*4.68	*d*360	378	*d*2.67	*d*360
		*e*2.75	*e*110		*e*1.22	*e*40

a Miners embrace timbermen and machine drill men.
b Chinese.
c Miners comprise tributers, $2.41; drillers per foot on contract, $2.33; drifting on contract, $2.80; timbermen, $3; blasters, $2.75 per day.
d Highest.
e Lowest.

WAGES OF LABORERS UNDERGROUND.

NUMBER OF ESTABLISHMENTS.	LABORERS.		
	Average number employed daily.	Average wages per day.	Average number of days worked.
1	*a*24	$1.90	290
1	5	2.17	360
1	1	2.00	300
1	19	2.09	267
1	*a*25	1.50	340
1	3	1.65	315
1	4	1.35	336
7	81	*b*2.17	*b*360
		*c*1.35	*c*267

a Laborers embrace helpers and hand drillers at $1.90 per day.
b Highest.
c Lowest.

The following table gives the number of office force, total pay of same, total wages of all other employés, and the aggregate wages paid to all employés:

NUMBER OF OFFICE FORCE, TOTAL WAGES, ETC.

NUMBER OF ESTABLISHMENTS.	Number of office force employed.	Total wages paid to all employés.	Total pay of office force.	All other wages.
1		$25,352		$25,352
1		2,250		2,250
1		20,936		20,936
1	1	30,156	$800	29,356
1	3	43,241	2,520	*a*40,721
1	2	27,546	3,900	23,646
1	2	47,208	3,366	43,842
1	7	304,341	17,560	*b*286,781
1	3	104,608	5,200	99,408
1	1	12,591	1,200	*d*11,391
1	1	8,060	420	7,640
11	*c*20	626,289	34,966	591,323

a $300 paid to contractors included.
b $10,606 paid to contractors included.
c Includes 1 female, the only one employed.
d $375 paid to contractors included.

During the census decade, 1880–1889, inclusive, there were no strikes or labor troubles of any kind in any of the mines and works, and fair wages for good work was the rule for employers and employés.

POWER.

The active establishments employed 62 steam motors with a capacity of 2,190 horse power, 1 electric dynamo and motor of 4 horse power, and 1 water wheel of 3 horse power, a total of 2,197 horse power in motors. 54 boilers were employed, with a capacity of 2,438 horse power. 247 animals were also reported as employed, but it is probable a greater number were in use. The details for the respective establishments are shown in the following table:

POWER USED IN QUICKSILVER MINING AND REDUCTION.

NUMBER OF ESTABLISHMENTS.	STEAM MOTORS.		OTHER MOTORS.		BOILERS.		Number of animals.
	Number.	Horse power.	Number.	Horse power.	Number.	Horse power.	
1	2	50	....	....	2	30	4
1	5	230	....	....	5	140	4
1	3	90	....	....	2	125	4
1	2	150	....	....	5	155	12
1	2	50	....	....	4	100	12
1	7	185	....	....	5	400	15
1	29	1,000	2	*a*7	23	1,088	114
1	5	170	....	....	3	200	52
1	7	265	....	....	5	200	20
1	....	....	....	....	....	....	10
10	62	2,190	2	7	54	2,438	247

a One water wheel of 3 horse power, and 1 dynamo and motor of 4 horse power.

The following statement gives an estimated valuation of the active mines and works as nearly as the same could be ascertained:

VALUE OF QUICKSILVER ESTABLISHMENTS.

NUMBER OF ESTABLISHMENTS.	Total capital. (*a*)	Mines and real estate.	Furnaces, houses, and other surface improvements.	Machinery, supplies, tools, and live stock.	Quicksilver unsold.	Bills and accounts receivable.	Other assets.
1	$590,553	$276,530	$50,000	$58,850	$96,660	....	$108,513
1	50,000	30,000	13,300	2,000	4,700	....	....
1	108,460	65,000	25,000	10,000	6,460	....	2,000
1	24,335	6,940	14,000	3,300	95	....	....
1	32,500	20,000	5,000	5,000	2,500	....	....
1	155,000	100,000	25,000	30,000	....	....	....
1	27,000	12,000	5,000	10,000	....	....	....
1	50,466	20,000	10,000	5,000	859	$9,664	4,943
1	122,900	50,000	25,000	10,000	2,900	25,000	10,000
1	59,900	25,000	15,000	10,000	9,900	....	....
b 6	112,000	75,000	35,000	2,000	....	....	....
16	1,333,114	680,470	222,300	146,150	124,074	34,664	125,456

a Estimated. *b* Nonproductive.

Some mine owners placed a higher valuation on their mines and improvements than is given in the foregoing statement, but it is preferred to take what may be considered a conservative opinion of the values as of December 31, 1889. Undoubtedly the original investments in the properties were many times the amounts of present estimates, but it must be remembered that mines are generally decreased in value by the extraction of ore for a long period of continuous work, which has been the case with the quicksilver establishments of the United States.

STATISTICS FOR EARLIER PERIODS.

The earliest records relating to the production of quicksilver in California are for 1850, cinnabar having been first discovered there in 1845. But very little quicksilver was produced prior to 1850, when active work was commenced at New Almaden. Outside of California quicksilver has been produced in 2 localities in the United States: in Oregon, to the extent of 2,000 flasks, and in Utah, where about 200 flasks were reported.

EARLIER CENSUS INFORMATION.

Examination of the United States census reports from 1790 to 1880 in relation to the quicksilver industry shows that no account had been taken of the industry prior to 1860. At that date and in the subsequent reports for 1870 and 1880 the information is quite limited. The following is a summary of the information relating to cinnabar and quicksilver in the census reports prior to 1890, all for the state of California, except the instances noted for 1880:

QUICKSILVER STATISTICS OF THE CENSUS OF 1860. (*a*)

COUNTIES.	Number of establishments.	Capital invested.	Cost of raw material.	Number of hands employed.	Cost of labor.	Value of product.
Total	3	$3,112,000	$166,100	335	$159,000	$382,000
Fresno (*b*)	1	100,000	15,400	110	87,000	152,000
Santa Clara	2	3,012,000	150,700	225	72,000	230,000

a Census report for 1860, "Manufactures of the United States", pages 24, 28, 36, 722. *b* Should be Monterey county.

The census of 1870, in the volume of industry and wealth, contains 3 tabular statements relating to quicksilver and cinnabar, the latter being the ore from which quicksilver is extracted by roasting, and not by smelting, as the table indicates. It will be noted that of the 3 tables the last gives figures largely different from the first 2, although apparently embracing the same subject, and it would appear that all are without real value for want of accuracy.

QUICKSILVER STATISTICS OF THE CENSUS OF 1870. (*a*)

Establishments	4
Steam engines:	
Number	1
Horse power	64
Water wheels:	
Number	1
Horse power	12
Employés	256
Males	248
Youth	8
Capital	$3,500,000
Wages	$181,000
Materials	$837,800
Products	$1,027,680

a Mechanical and manufacturing industries, quicksilver smelted.

SMELTING INDUSTRIES, BY COUNTIES.

COUNTIES.	Establishments.	Employés.	Capital.	Wages.	Materials.	Products.
Total	4	256	$3,500,000	$181,000	$837,800	$1,027,680
Fresno (*a*)	1	87	250,000	70,000	338,600	420,000
Lake	1	75	250,000	50,000	100,500	166,230
Santa Clara	2	94	3,000,000	61,000	398,700	441,450

a Should be Monterey county.

CINNABAR INDUSTRIES.

COUNTIES.	Establishments.	STEAM ENGINES. Number.	STEAM ENGINES. Horse power.	EMPLOYÉS. Total.	EMPLOYÉS. Men above ground.	EMPLOYÉS. Men below ground.	EMPLOYÉS. Boys above ground.	Capital.	Wages.	Materials.	Products.
Total	4	3	71	811	410	382	19	$11,900,000	$599,000	$30,700	$817,700
Fresno (*a*)	1			263	263			150,000	215,000	2,000	330,000
Lake	1			75	75			250,000	50,000	6,500	100,000
Santa Clara	2	3	71	473	72	382	19	11,500,000	334,000	22,200	387,700

a Should be Monterey county.

On page 767 of volume III, Ninth Census reports, the total of the above figures is given as the amount of cinnabar produced in the United States.

In the Tenth Census reports of 1880 all that relates to quicksilver and cinnabar is to be found in volume XIII, "Precious metals". No statements of production, employés, cost, etc., are given, but the localities of important deposits are mentioned, and will be referred to for comparison:

> Cinnabar is the only quicksilver ore of commercial importance, and it is found in numerous localities in California, in the coast range of mountains for 100 or 150 miles north and south of San Francisco, not in well-defined veins, but commonly in irregular bodies distributed through metamorphic rocks of cretaceous age. The usual gangue minerals are quartz, calcite, and magnesite.
>
> In the New Almaden mine, which has been much more extensively worked than any other in the state, these bodies appear, from a model constructed by the owners, to lie on a curved surface, indicating a geometrical relation between the positions of the several ore bodies, though an obscure one. At this mine the masses of ore are usually connected by tiny seams of the same material. There is a strong similarity between this mode of occurrence and that of many lead-ore deposits on the limestone, and it may be that the problem of their true character is the same.
>
> The quicksilver country north of San Francisco is a volcanic region, while to the south volcanic rocks are subordinate in some localities and wanting in others. No general inference as to the genesis or age of the deposits can be drawn without further investigation, while the great similarity in the association of minerals suggests similar origin for most of them. (*a*)

As in the census reports of 1860 and 1870, in 1880 Fresno county is credited with the possession of the New Idria mine, which at the last date properly belongs to and is included in the boundaries of the adjoining county of San Benito. This mine is yet in operation, though no longer of importance. (*b*) The ore is distributed in metamorphic sandstone and shale (*c*). The mines mentioned as in Lake county, the Great Western and Sulphur Bank, are still operated with diminished results (*b*), and in Napa county (*d*) the Redington mine is no longer "one of the most important quicksilver producers in the state"; while the Napa Consolidated mine, also mentioned, is now included with the largest producers (*b*). The occurrence of cinnabar is noted in San Luis Obispo county (*e*), but the mines named, the Oceanic and Polar Star, have ceased to be producers, and no others have replaced them.

The chief mineral resources of Santa Clara county (*f*) are stated to be the cinnabar deposits of New Almaden and Guadalupe, and this still continues to be the case, although the last named has not been an active establishment since 1885. The New Almaden mine is still the largest quicksilver producer in the United States, but its yearly yield is much less than formerly. (*b*)

Santa Barbara county (*g*) is the most southern point where the occurrence of cinnabar is noted, and its single mine, Las Prietas, has long ceased to be active. The Great Eastern is named as the chief mine in Sonoma county (*g*), and it is now the only one in operation there. Reference is made to the Altoona mine, in Trinity county (*g*), now classed with the inactive mines, and that closes the list for California in the Tenth Census.

Douglas county, Oregon (*g*), is credited with the New Idrian mine, which still exists under another name, but was not a producer at the Eleventh Census. In the tables of the present report for the Eleventh Census 2 other mines in the same county are included under the head of "Unproductive mines", but they show fair promise for future production. The occurrence of ore seems to be similar to that of California mines, and it represents the northern end of the series of deposits, the southern extremity of which is in Santa Barbara county, California. "It would be incorrect, however, to characterize the entire series as a 'belt', for toward the north the known occurrences are at long intervals." (*g*) The considerable quantities of float cinnabar mentioned as having been found in Idaho (*h*) are not known to have added to the quicksilver supply, and if there are any quicksilver mines in that state they have not been reported.

Utah is the last on the list, "with several quicksilver claims, the most important of which are the Geyser and Jenny Lind". In 1880 the developments were "very limited, no attempts having been made to reduce the ore" (*i*), and since that date they have made no sign. Mention is also made of cinnabar in Piute county. After the Tenth Census year this claim was worked as the Lucky Boy mine. It is situated about 6 miles south of Marysville, and was idle in 1889. Previously it had produced about 200 flasks of quicksilver. The ore is a selenide of mercury.

In 1889 Colorado and Arizona made claims to recognition as having cinnabar deposits. No quicksilver has been produced within their borders, but specimens of low-grade ores are reported.

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a Compare Tenth Census, volume XIII; United States geological survey, volume XIII, and Professor S. B. Christy, American Journal of Science and Arts, volume XVII, June, 1879.

b See tables of yearly production, page 188.

c Tenth Census report, volume XIII, page 18.

d Tenth Census report, volume XIII, pages 19 and 20.

e Tenth Census report, volume XIII, page 23.

f Tenth Census report, volume XIII, page 24.

g Tenth Census report, volume XIII, pages 24, 25, 26, and 27.

h Tenth Census report, volume XIII, page 55.

i Tenth Census report, volume XIII, pages 455 and 462.

PRODUCT AND PRICE OF QUICKSILVER FROM 1850 TO 1890 BY J. B. RANDOL.

PRODUCTION OF QUICKSILVER IN THE UNITED STATES, BY DECADES.

In the following table is presented the production of quicksilver in California, which includes the whole production of the United States for the census year 1850 to the calendar year 1890, both inclusive. It is given, in addition to the detailed tables which follow, for the purpose of showing at a glance the rise and decline of the industry.

QUICKSILVER PRODUCTION IN CALIFORNIA AT PERIODS OF 10 YEARS FROM 1850 TO 1890.

[Flasks.]

YEARS.	Total.	New Almaden.	New Idria.	Guadalupe.	Redington.	Pope Valley.	Sulphur Bank.	Great Western.	Napa Consolidated.	Great Eastern.	Altoona.	Oakland.	California.	Bradford.	Ætna.	Various mines.
1850	7,723	7,723														
1860	10,000	7,061	1,469	1,470												
1870	30,077	14,423	9,888		4,546	1,220										
1880	59,926	23,465	3,209	6,670	2,139	275	10,706	6,442	*a*4,416	1,279	245	166	422			*b*492
1890	22,926	12,000	977		505		1,608	1,334	2,498	1,046				1,290	931	*c*737

a Including Ætna. *b* From the Saint John mine. *c* Principally from the Manhattan mine.

In the following table the total product of quicksilver for the United States in each year of the industry is associated with its approximate value:

ANNUAL QUICKSILVER PRODUCT IN THE UNITED STATES, WITH ITS VALUE.

YEARS.	Yield in California. (Flasks.)	Approximate valuation.	YEARS.	Yield in California. (Flasks.)	Approximate valuation.
Total 1850–1859	242,994	$13,717,000	Total 1870–1879	491,066	$24,322,500
1850	7,723	768,000	1870	30,077	1,725,500
1851	27,779	1,859,000	1871	31,686	1,999,500
1852	20,000	1,166,500	1872	31,621	2,086,000
1853	22,284	1,235,500	1873	27,642	2,226,500
1854	30,004	1,665,500	1874	27,756	2,919,000
1855	33,000	1,768,000	1875	50,250	2,721,000
1856	30,000	1,549,500	1876	75,074	3,303,000
1857	28,204	1,402,000	1877	79,396	3,041,000
1858	31,000	1,482,500	1878	63,880	2,101,500
1859	13,000	820,500	1879	73,684	2,199,500
Total 1860–1869	403,109	17,738,000	Total 1880–1889	*a*407,675	13,480,500
1860	10,000	535,500	1880	59,926	1,860,000
1861	35,000	1,473,500	1881	60,851	1,810,000
1862	42,000	1,526,500	1882	52,732	1,500,000
1863	40,531	1,705,000	1883	46,725	1,275,000
1864	47,489	1,761,500	1884	31,913	975,000
1865	53,000	2,433,000	1885	32,073	970,000
1866	46,550	2,403,000	1886	29,981	1,060,000
1867	47,000	2,157,000	1887	*a*33,760	1,425,000
1868	47,728	2,191,000	1888	33,250	1,415,000
1869	33,811	1,552,000	1889	*a*26,464	1,190,500

a 65 flasks in 1887 and 20 flasks in 1889 from Oregon not included.

RECAPITULATION.

DECADES.	Flasks.	Value.
Total	*a*1,544,844	$69,258,000
1850–1859	242,994	13,717,000
1860–1869	403,109	17,738,000
1870–1879	491,066	24,322,500
1880–1889	*a*407,675	13,480,500

a 85 flasks from Oregon not included.

The annual contribution which each mine has made to the total product is given below:

TOTAL PRODUCT OF CALIFORNIA QUICKSILVER, BY MINES.

[Flasks.]

YEARS.	Total.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna.	Napa Consolidated.	Great Eastern.	Bradford.
Total	1,544,929	904,359	132,214	99,264	83,475	55,910	57,063	11,557	48,847	14,944	7,093
1850	7,723	7,723	...	...	...	...	...	...	...	...	...
1851	27,779	27,779	...	...	...	...	...	...	...	...	...
1852	20,000	15,901	...	...	...	...	...	...	...	...	...
1853	22,284	22,284	...	...	...	...	...	...	...	...	...
1854	30,004	30,004	...	...	...	...	...	...	...	...	...
1855	33,000	29,142	...	...	...	...	...	...	...	...	...
1856	30,000	27,138	...	...	...	...	...	...	...	...	...
1857	28,204	28,204	...	...	...	...	...	...	...	...	...
1858	31,000	25,761	...	...	...	...	...	...	...	...	...
1859	13,000	1,294	...	...	...	...	...	...	...	...	...
1860	10,000	7,061	...	...	...	...	...	...	...	...	...
1861	35,000	34,429	...	...	...	...	...	...	...	...	...
1862	42,000	39,671	...	444	...	...	...	...	...	...	...
1863	40,531	32,803	...	852	...	...	...	...	...	...	...
1864	47,489	42,489	...	1,914	...	...	...	...	...	...	...
1865	53,000	47,194	...	3,545	...	...	...	...	...	...	...
1866	46,550	35,150	6,525	2,254	...	...	...	...	...	...	...
1867	47,000	24,461	11,493	7,862	...	...	...	...	...	...	...
1868	47,728	25,628	12,180	8,686	...	...	...	...	...	...	...
1869	33,811	16,898	10,315	5,018	...	...	...	...	...	...	...
1870	30,077	14,423	9,888	4,546	...	...	...	...	...	...	...
1871	31,686	18,568	8,180	2,128	...	...	...	...	...	...	...
1872	31,621	18,574	8,171	3,046	...	...	...	...	...	...	...
1873	27,642	11,042	7,735	3,294	...	...	340	...	...	...	...
1874	27,756	9,084	6,911	6,678	573	...	1,122	...	...	...	...
1875	50,250	13,648	8,432	7,513	5,372	3,342	3,384	...	...	412	...
1876	75,074	20,549	7,272	9,183	8,367	7,381	4,322	...	573	387	...
1877	79,396	23,996	6,316	9,399	10,993	6,241	5,856	...	2,229	505	...
1878	63,880	15,852	5,138	6,686	9,465	9,072	4,963	...	3,049	1,366	...
1879	73,684	20,514	4,425	4,516	9,249	15,540	6,333	...	3,605	1,455	...
1880	59,926	23,465	3,209	2,139	10,706	6,670	6,442	...	a4,416	1,279	...
1881	60,851	26,060	2,775	2,194	11,152	5,228	6,241	...	a5,552	1,065	...
1882	52,732	28,070	1,953	2,171	5,014	1,138	5,179	...	a6,842	2,124	...
1883	46,725	29,000	1,606	1,894	2,612	84	3,869	...	a5,890	1,669	...
1884	31,913	20,000	1,025	881	890	1,179	3,292	2,931	1,376	332	...
1885	32,073	21,400	3,469	385	1,296	35	1,144	1,309	2,197	446	...
1886	29,981	18,000	1,406	409	1,449	...	1,949	3,478	1,769	735	...
1887	33,825	20,000	1,490	689	1,890	...	1,446	2,880	2,694	673	1,371
1888	33,250	18,000	1,320	126	2,164	...	625	959	4,065	1,151	3,848
1889	26,484	13,100	980	812	2,283	...	556	...	4,590	1,345	1,874

a Including Ætna.

TOTAL PRODUCT OF CALIFORNIA QUICKSILVER, BY MINES—Continued.

[Flasks.]

YEARS.	Pope Valley.	Saint John.	Altoona.	Oceanic.	Oakland.	California.	Sunderland.	Cloverdale.	Abbott.	Manhattan.	Various mines.
Total	18,097	8,598	7,527	7,391	6,831	5,653	2,777	2,661	2,272	1,415	66,981
1850											
1851											
1852											4,099
1853											
1854											
1855											3,858
1856											2,862
1857											
1858											5,239
1859											11,706
1860											2,939
1861											571
1862											1,885
1863											6,876
1864	800										2,286
1865											2,261
1866											2,621
1867											3,184
1868	1,122										112
1869	1,580										
1870	1,220										
1871	1,970										840
1872	1,830										
1873	1,955										3,276
1874	1,645	1,743									
1875	1,940	1,927	533								3,747
1876	300	1,683	1,979	2,358	2,150	965	1,570	1,028	1,436	976	2,595
1877	1,060	1,463	1,317	2,575	1,395	1,516	735	1,291	836	439	1,234
1878	1,075		1,534	1,679	1,615	1,640	472	116			158
1879	1,325	1,290	1,919	779	1,505	1,110		18			101
1880	275	492	245		166	422					
1881								208			376
1882											241
1883											101
1884											7
1885											392
1886											786
1887											*a*692
1888											992
1889											*b*944

a Including 63 flasks from Oregon. *b* Including 20 flasks from Oregon.

It is possible also from the existing records to present the statistics of production for every mine in each month for the last 10 years, as follows:

PRODUCTION OF QUICKSILVER IN CALIFORNIA FROM 1880 TO 1889, BY MONTHS.

[Flasks.]

1880.

MONTHS.	Total.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna. (*a*)	Napa. (*a*)	Great Eastern.	Bradford.	Various mines.
Total	59,926	23,465	3,209	2,139	10,706	6,670	6,442		4,416	1,279		1,600
January	4,670	1,539	203	142	760	1,000	550		205	39		232
February	4,895	1,809	96	310	965	535	565		375	110		130
March	5,977	2,155	443	239	1,286	730	565		251	210		98
April	4,261	1,667	165	103	611	645	574		161	96		239
May	5,351	1,938	226	356	1,130	560	572		315	164		90
June	5,283	1,985	269	127	819	550	585		420	142		386
July	4,189	1,688	250	135	933		540		455	118		70
August	5,260	2,360	312	189	878	340	525		455	133		68
September	4,708	2,166	245	175	687	300	452		480	122		81
October	5,275	1,858	216	166	865	1,100	557		358	57		98
November	5,748	2,238	539	96	1,209	580	467		591	42		66
December	4,309	2,062	245	101	563	410	490		350	46		42

a Production of Ætna and Napa mines from 1880 to 1883 under heading of Napa mine.

PRODUCTION OF QUICKSILVER IN CALIFORNIA FROM 1880 TO 1889, BY MONTHS—Continued.

[Flasks.]

1881.

Months.	Total.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna. (a)	Napa. (a)	Great Eastern.	Bradford.	Various mines.
Total	60,851	26,060	2,775	2,194	11,152	5,228	6,241	....	5,552	1,065	....	584
January	5,861	2,259	330	140	895	1,300	451	....	430	13	....	43
February	4,261	2,187	171	32	635	600	399	....	233	....	....	4
March	5,560	2,466	206	354	1,100	350	400	....	505	179	....	....
April	5,071	2,507	158	284	706	357	447	....	466	123	....	23
May	4,889	1,346	200	218	1,163	500	681	....	659	97	....	25
June	5,564	1,780	201	196	1,463	340	801	....	621	94	....	68
July	5,188	2,208	110	160	1,057	255	714	....	481	47	....	156
August	5,350	2,260	209	190	1,139	300	585	....	490	57	....	120
September	4,965	2,090	212	187	1,076	201	457	....	592	113	....	37
October	4,965	2,223	140	165	969	400	414	....	485	106	....	63
November	5,232	2,572	577	180	588	375	434	....	310	166	....	30
December	3,945	2,162	261	88	361	250	458	....	280	70	....	15

1882.

Months.	Total.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna. (a)	Napa. (a)	Great Eastern.	Bradford.	Various mines.
Total	52,732	28,070	1,953	2,171	5,014	1,138	5,179	....	6,842	2,124	....	241
January	3,664	1,632	179	178	623	50	395	....	430	144	....	33
February	3,767	1,924	121	145	460	210	348	....	440	98	....	21
March	3,946	2,078	160	70	359	200	505	....	459	91	....	24
April	4,027	2,110	127	174	319	229	486	....	525	57	....	....
May	4,611	2,446	269	211	354	13	521	....	737	55	....	5
June	4,167	2,318	121	131	522	30	456	....	485	76	....	28
July	4,381	2,522	169	195	579	....	410	....	380	111	....	15
August	4,685	2,432	130	184	418	50	490	....	582	388	....	11
September	5,209	2,766	129	225	430	140	513	....	641	348	....	17
October	5,129	2,844	266	251	370	60	516	....	580	229	....	13
November	4,511	2,619	156	96	280	81	200	....	718	306	....	55
December	4,635	2,379	126	311	300	75	339	....	865	221	....	19

1883.

Months.	Total.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna. (a)	Napa. (a)	Great Eastern.	Bradford.	Various mines.
Total	46,725	29,000	1,606	1,894	2,612	84	3,869	....	5,890	1,669	....	101
January	4,582	2,497	112	367	280	77	290	....	590	262	....	7
February	3,600	2,150	133	181	310	7	364	....	295	156	....	4
March	3,875	2,230	142	202	335	....	305	....	485	162	....	14
April	3,354	1,756	76	243	310	....	294	....	530	142	....	3
May	3,768	2,344	144	135	350	....	293	....	325	164	....	13
June	3,561	2,214	137	165	91	....	400	....	360	184	....	10
July	4,024	2,618	85	141	130	....	446	....	452	150	....	2
August	4,431	3,000	139	94	112	....	315	....	695	76	....	....
September	4,642	3,010	164	45	265	....	297	....	750	81	....	30
October	4,129	2,672	272	109	206	....	215	....	521	134	....	....
November	3,488	2,212	115	78	160	....	208	....	613	102	....	....
December	3,271	2,297	87	134	63	....	342	....	274	56	....	18

1884.

Months.	Total.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna. (a)	Napa. (a)	Great Eastern.	Bradford.	Various mines.
Total	31,913	20,000	1,025	881	890	1,179	3,292	2,931	1,376	332	....	7
January	2,805	1,440	103	127	263	....	373	329	135	28	....	7
February	2,321	1,458	59	104	....	....	241	276	174	9	....	....
March	2,459	1,606	36	123	68	....	223	249	152	2	....	....
April	2,709	1,785	75	50	76	....	232	422	69	....	....	....
May	2,470	1,672	125	53	200	....	169	245	6	....	....	....
June	2,694	1,859	44	118	....	200	258	215	....	....	....	....
July	2,628	1,543	29	71	52	200	258	374	101	....	....	....
August	2,912	1,804	63	47	20	306	334	228	110	....	....	....
September	2,377	1,448	67	52	35	58	354	136	169	58	....	....
October	2,668	1,625	115	68	25	160	328	153	90	104	....	....
November	2,985	1,900	157	32	53	150	230	132	240	91	....	....
December	2,885	1,860	152	36	98	105	292	172	130	40	....	....

a Production of Ætna and Napa mines from 1880 to 1883 under heading of Napa mine.

PRODUCTION OF QUICKSILVER IN CALIFORNIA FROM 1880 TO 1889, BY MONTHS—Continued.

[Flasks.]

1885.

MONTHS.	Total.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna.	Napa.	Great Eastern.	Bradford.	Various mines.
Total	32,073	21,400	3,469	385	1,296	35	1,144	1,309	2,197	446	....	392
January	2,483	1,700	172	40	24	....	190	189	131	37	....	....
February	2,316	1,506	245	24	85	35	70	96	180	75	....	....
March	2,262	1,500	314	....	83	....	80	88	145	33	....	19
April	2,816	2,003	340	....	69	....	80	142	145	37	....	....
May	2,793	2,000	269	....	194	....	75	62	190	....	....	3
June	2,713	1,750	330	50	91	....	62	112	250	63	....	5
July	2,694	1,750	321	43	209	....	75	45	191	50	....	10
August	3,047	2,104	324	49	150	....	80	118	175	....	....	47
September	2,978	1,936	347	57	85	....	95	201	180	....	....	77
October	2,468	1,598	236	42	123	....	85	52	185	65	....	82
November	2,468	1,576	292	43	61	....	122	54	190	43	....	87
December	3,035	1,977	279	37	122	....	130	150	235	43	....	62

1886.

Total	29,981	18,000	1,406	409	1,449	....	1,949	3,478	1,769	735	....	786
January	2,398	1,431	70	42	100	....	339	162	147	73	....	34
February	2,103	1,100	175	24	108	....	274	132	192	53	....	45
March	2,425	1,522	20	21	91	....	226	209	218	43	....	75
April	2,293	1,256	90	36	172	....	115	328	172	62	....	62
May	2,381	1,600	101	18	36	....	99	228	128	76	....	95
June	2,722	1,806	110	19	113	....	126	276	123	71	....	78
July	2,601	1,572	95	24	98	....	138	345	138	64	....	127
August	2,202	1,240	105	35	119	....	156	313	74	76	....	84
September	2,108	1,210	179	30	100	....	107	303	82	64	....	83
October	2,390	1,280	106	50	150	....	171	392	124	65	....	52
November	3,232	1,900	180	76	191	....	109	477	209	55	....	35
December	3,126	2,083	175	34	171	....	89	313	162	33	....	66

1887.

Total	33,760	20,000	1,490	689	1,890	....	1,446	2,880	2,694	673	1,371	627
January	3,077	1,904	185	51	162	....	56	450	181	76	....	12
February	2,408	1,700	40	....	149	....	86	240	150	43	....	....
March	2,556	1,584	95	74	110	....	105	125	275	48	....	140
April	2,586	1,671	105	91	157	....	90	200	212	29	....	31
May	2,830	2,040	50	80	126	....	152	100	215	27	....	40
June	2,822	1,700	170	82	127	....	126	200	220	93	....	104
July	2,820	1,567	125	56	175	....	194	200	205	57	201	40
August	2,781	1,517	90	72	160	....	108	200	275	61	220	78
September	2,923	1,535	120	26	297	....	123	400	160	42	195	25
October	2,859	1,405	140	66	171	....	132	300	304	64	228	49
November	2,613	1,225	214	82	113	....	127	165	247	71	295	74
December	3,485	2,152	156	9	143	....	147	300	250	62	232	34

1888.

Total	33,250	18,000	1,320	126	2,164	....	625	959	4,065	1,151	3,848	992
January	3,949	2,650	118	....	292	....	61	246	235	84	179	84
February	2,733	1,730	82	....	156	....	64	105	223	79	243	51
March	2,481	1,400	90	....	150	....	43	95	288	108	270	37
April	2,862	1,579	110	....	138	....	95	143	324	153	292	28
May	3,037	1,610	125	....	155	....	69	226	320	80	357	95
June	2,956	1,500	120	....	189	....	26	94	345	110	454	118
July	2,359	1,100	120	....	167	....	34	50	248	94	463	83
August	2,547	1,109	110	....	215	....	29	....	347	93	527	117
September	2,348	1,178	60	....	195	....	42	....	370	58	357	88
October	2,635	1,269	185	36	180	....	47	....	440	88	294	96
November	2,604	1,400	90	30	176	....	28	....	475	82	220	103
December	2,739	1,475	110	60	151	....	87	....	450	122	192	92

PRODUCTION OF QUICKSILVER IN CALIFORNIA FROM 1880 TO 1889, BY MONTHS—Continued.

[Flasks.]

1889.

MONTHS.	Total.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna.	Napa.	Great Eastern.	Bradford.	Various mines.
Total	26,464	13,100	980	812	2,283	....	556	....	4,590	1,345	1,874	924
January	2,337	1,200	65	....	173	....	81	....	385	94	230	109
February	1,813	820	65	....	173	....	45	....	400	76	182	52
March	2,217	1,290	70	....	175	....	34	....	380	89	116	63
April	2,203	1,249	70	....	215	....	30	....	320	92	119	108
May	2,085	870	70	206	192	....	....	....	445	97	132	73
June	2,218	950	75	117	235	....	....	....	415	211	152	63
July	2,066	966	70	124	211	....	41	....	340	135	110	69
August	2,223	1,000	70	64	216	....	17	....	450	168	170	68
September	2,073	970	75	73	224	....	97	....	360	77	136	61
October	2,453	1,300	80	89	164	....	70	....	385	87	214	64
November	2,492	1,300	130	139	150	....	80	....	380	107	134	72
December	2,284	1,185	140	....	155	....	61	....	330	112	179	122

In collecting the data for the world's production of quicksilver every effort was made to obtain some reliable statistics of the production of quicksilver in Mexico and China, but without success at the time of making this report.

THE WORLD'S PRODUCTION OF QUICKSILVER FOR 10 YEARS. (*a*)

YEARS.	Total supply.	California.	SPAIN.		AUSTRIA-HUNGARY.		Italy.	Russia.	Estimated consumption.	Estimated stock in London, England.
			Almaden.	Various. (*b*)	Idria.	Various. (*c*)				
Total	1,146,741	*d*407,675	485,939	16,273	135,403	8,808	*e*75,704	16,939	1,142,890	....
1880	122,536	59,926	45,322	(*f*)	12,356	712	4,220	....	95,600	68,500
1881	122,678	60,851	44,989	(*f*)	11,333	720	4,785	....	106,300	84,899
1882	119,394	52,732	46,716	2,795	11,663	588	4,900	....	116,200	83,000
1883	118,858	46,725	49,177	2,165	13,152	709	6,930	....	124,800	82,014
1884	105,430	31,913	48,098	2,219	13,967	733	8,500	....	111,300	76,105
1885	101,748	32,073	45,813	2,046	13,503	773	7,540	....	108,300	69,467
1886	107,588	29,981	51,199	2,277	14,496	1,400	8,235	....	123,050	54,000
1887	116,711	33,760	53,276	2,894	14,676	1,030	9,220	1,855	131,700	39,000
1888	117,956	33,250	51,872	1,877	14,962	1,018	10,200	4,777	109,909	47,000
1889	113,842	26,464	49,477	(*f*)	15,295	*g*1,125	11,174	10,307	115,740	45,100

a In the United States the flask contains 76.5 pounds avoirdupois, or 34.7 kilograms; in Spain, Austria-Hungary, Italy, Russia, and elsewhere, only 34.5 kilograms.

b Comprises mines in the provinces of Oviedo, Granada, and Cuidad Real.

c Comprises mines in Carniola and Hungary.

d In 1887 Oregon produced 65 flasks and in 1889 20 flasks, which are not included in this total.

e Figures taken from monograph on the quicksilver mines of Monte Amiata, by Mr. P. de Ferrari, M. E., 1889.

f Quantities unknown.

g Comprises mines in Carniola only, the production of Hungary not being known.

The following table is published simply to show the various statistics which have appeared as to the production of quicksilver in Italy:

VARIOUS STATEMENTS AS TO THE PRODUCTION OF QUICKSILVER IN ITALY.

[Flasks.]

YEARS.	PRODUCTION.		
	Letter from Rome. (*a*)	Dè Ferrari's table. (*b*)	De Ferrari's table. (*c*)
Total	67, 726. 9	66, 689. 4	75, 704
1880	3, 314. 3	3, 343. 1	4, 220
1881	4, 755. 3	3, 689. 0	4, 785
1882	4, 034. 8	4, 034. 8	4, 900
1883	5, 936. 9	5, 936. 9	6, 930
1884	7, 694. 9	7, 694. 9	8, 500
1885	6, 830. 3	6, 830. 3	7, 540
1886	7, 233. 8	7, 233. 8	8, 235
1887	7, 032. 1	7, 032. 1	9, 220
1888	9, 770. 0	9, 770. 0	10, 200
1889	11, 124. 5	11, 124. 5	11, 174

a Letter from D'Amiani; under secretary of state of his majesty's foreign affairs at Rome, dated August 8, 1890.

b From table, page 145, of P. de Ferrari's monograph "Le miniere di mercurio del Monte Amiata".

c From table, page 146, of same, giving production of Monte Amiata in flasks.

PRICES PER FLASK OBTAINED IN NEW YORK FOR CALIFORNIA QUICKSILVER IN 1889.

MONTHS.	Prices obtained in New York.	Netting in San Francisco, freight and drayage $1.30.	Rothschild's quotation and equivalent for quicksilver laid down in New York, duty added.		Laid down in New York, duty added.	London outsiders' price.
			£ s. d.			£ s. d.
January—						
Highest	$44. 00	$42. 70	9 10 0	$50. 50	$46. 60	8 15 0
Lowest	43. 00	41. 70	9 10 0	50. 50	43. 55	8 3 6
February—						
Highest	43. 25	41. 95	8 10 0	45. 25	43. 40	8 3 0
Lowest	40. 00	38. 70	7 10 0	40. 00	39. 30	7 7 6
March—						
Highest	40. 50	39. 20	7 15 0	41. 25	41. 40	7 15 6
Lowest	39. 00	37. 70	7 10 0	40. 00	39. 30	7 7 6
April—						
Highest	42. 00	40. 70	8 0 0	42. 60	42. 60	8 0 0
Lowest	40. 00	38. 70	7 12 6	40. 60	40. 60	7 12 6
May—						
Highest	45. 25	43. 95	8 10 0	45. 25	44. 35	8 6 6
Lowest	42. 75	41. 45	8 5 0	44. 00	41. 85	7 17 0
June—						
Highest	48. 00	46. 70	9 10 0	50. 50	47. 70	8 19 0
Lowest	48. 00	46. 70	8 15 0	46. 60	43. 55	8 3 6
July—						
Highest	49. 00	47. 70	9 15 0	51. 75	50. 20	9 8 6
Lowest	46. 00	44. 70	9 10 0	50. 50	46. 60	8 15 0
August—						
Highest	49. 00	47. 70	9 15 0	51. 75	49. 95	9 7 6
Lowest	48. 00	46. 70	9 15 0	51. 75	48. 90	9 3 6
September—						
Highest	49. 50	48. 20	9 15 0	51. 75	49. 15	9 4 6
Lowest	48. 50	47. 20	9 15 0	51. 75	48. 75	9 3 0
October—						
Highest	49. 00	47. 70	9 5 0	49. 30	49. 30	9 5 0
Lowest	48. 50	47. 20	9 5 0	49. 30	47. 30	8 17 6
November—						
Highest	50. 00	48. 70	9 15 0	51. 75	50. 90	9 11 0
Lowest	49. 00	47. 70	9 10 0	50. 50	49. 95	9 7 6
December—						
Highest	50. 00	48. 70	9 15 0	51. 75	50. 35	9 9 0
Lowest	48. 50	47. 20	9 15 0	51. 75	49. 30	9 5 0

MONTHLY QUOTATIONS PER FLASK FOR QUICKSILVER AT SAN FRANCISCO FROM 1880 TO 1889, INCLUSIVE.

MONTHS.	1880.		1881.		1882.		1883.		1884.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
January	$34.45	$28.30	$28.30	$27.90	$28.50	$28.30	$26.75	$26.00	$26.25	$26.00
February	34.45	28.30	29.85	28.30	28.50	28.10	27.25	26.00	29.00	26.00
March	34.45	29.85	29.05	27.90	28.50	28.10	28.00	26.75	29.00	28.00
April	30.60	29.85	29.85	28.70	29.05	28.50	27.00	26.75	29.00	28.00
May	30.60	29.85	28.90	28.50	29.10	28.70	27.00	26.75	29.00	29.00
June	30.60	27.55	28.70	28.50	28.70	28.50	28.50	26.75	29.00	29.00
July	30.60	27.90	29.05	28.50	28.50	28.30	28.50	27.50	29.00	28.75
August	34.45	29.45	29.05	28.30	28.50	28.30	27.50	26.25	30.00	28.75
September	30.60	30.25	28.50	28.10	28.90	28.30	26.75	26.25	31.00	30.00
October	30.25	29.45	31.75	29.05	28.90	28.30	26.50	26.50	30.50	29.00
November	29.85	29.45	31.75	29.85	28.50	28.10	26.50	26.00	34.00	29.00
December	29.45	27.90	28.90	27.90	27.90	27.35	26.25	26.00	35.00	32.00
Extreme range	34.45	27.55	31.75	27.90	29.10	27.35	28.50	26.00	35.00	26.00

MONTHS.	1885.		1886.		1887.		1888.		1889.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
January	$33.00	$32.50	$32.50	$32.00	$38.75	$38.50	$48.00	$42.00	$43.00	$41.50
February	32.50	32.50	32.50	32.50	38.75	38.50	43.00	39.00	42.00	41.50
March	32.50	31.00	33.00	32.50	38.50	37.00	40.00	38.50	41.50	40.00
April	31.00	30.00	33.00	33.00	40.00	37.50	38.50	38.00	41.50	40.00
May	29.00	28.50	34.00	33.00	38.00	37.50	38.00	37.25	45.00	41.00
June	30.00	29.00	36.00	34.00	39.00	38.00	38.00	37.25	50.00	46.50
July	30.00	29.75	37.00	36.00	38.00	37.50	37.50	37.00	47.50	46.00
August	29.75	29.50	37.00	36.75	37.00	36.50	37.25	37.00	47.50	46.00
September	30.50	29.50	37.00	36.50	38.00	36.50	43.00	37.00	47.50	47.00
October	30.50	30.00	39.00	38.75	39.00	37.00	44.00	43.00	47.00	46.50
November	30.00	29.75	38.75	38.50	40.00	37.00	43.00	42.50	48.00	46.00
December	32.00	30.00	38.75	38.50	48.00	45.00	43.00	41.00	47.50	47.00
Extreme range	33.00	28.50	39.00	32.00	48.00	36.50	48.00	37.00	50.00	40.00

HIGHEST AND LOWEST PRICES PER FLASK OF QUICKSILVER DURING THE PAST 40 YEARS IN SAN FRANCISCO AND LONDON.

YEARS.	SAN FRANCISCO.		LONDON.	
	Highest.	Lowest.	Highest.	Lowest.
			£ s. d.	£ s. d.
1850	$114.75	$84.15	15 0 0	13 2 6
1851	76.50	57.35	13 15 0	12 5 0
1852	61.20	55.45	11 10 0	9 7 6
1853	55.45	55.45	8 15 0	8 2 6
1854	55.45	55.45	7 15 0	7 5 0
1855	55.45	51.65	6 17 6	6 10 0
1856	51.65	51.65	6 10 0	6 10 0
1857	53.55	45.90	6 10 0	6 10 0
1858	49.75	45.90	7 10 0	7 5 0
1859	76.50	49.75	7 5 0	7 0 0
1860	57.35	49.75	7 0 0	7 0 0
1861	49.75	34.45	7 0 0	7 0 0
1862	38.25	34.45	7 0 0	7 0 0
1863	45.90	38.25	7 0 0	7 0 0
1864	45.90	45.90	9 0 0	7 10 0
1865	45.90	45.90	8 0 0	7 17 6
1866	57.35	45.90	8 0 0	6 17 6
1867	45.90	45.90	7 0 0	6 16 0
1868	45.90	45.90	6 17 0	6 16 0
1869	45.90	45.90	6 17 0	6 16 0
1870	68.85	45.90	10 0 0	6 16 0
1871	$68.85	$57.35	12 0 0	9 0 0
1872	66.95	65.00	13 0 0	10 0 0
1873	91.80	68.85	20 0 0	12 0 0
1874	118.55	91.80	26 0 0	19 0 0
1875	118.55	49.75	24 0 0	9 17 6
1876	53.55	34.45	12 0 0	7 17 6
1877	44.00	30.60	9 10 0	7 2 6
1878	35.95	29.85	7 5 0	6 7 6
1879	34.45	25.25	8 15 0	5 17 6
1880	34.45	27.55	7 15 0	6 7 6
1881	31.75	27.90	7 0 0	6 2 6
1882	29.10	27.35	6 5 0	5 15 0
1883	28.50	26.00	5 17 6	5 5 0
1884	35.00	26.00	6 15 0	5 2 6
1885	33.00	28.50	6 15 0	5 2 6
1886	39.00	32.00	7 10 0	5 16 3
1887	48.00	36.50	11 5 0	6 7 6
1888	48.00	37.00	10 0 0	7 0 0
1889	50.00	40.00	9 15 0	7 10 0
Extreme range in 40 years.	118.55	25.25	26 00 0	5 2 6

HIGHEST AND LOWEST PRICES PER FLASK PREVAILING AT HONGKONG FOR QUICKSILVER, BY MONTHS AND YEARS, FOR THE DECADE 1880-1889. (*a*)

MONTHS.	1880.		1881.		1882.		1883.		1884.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
January	$59.75	$59.00	$56.75	$56.25	$58.25	$57.25	$56.50	$55.25	$53.00	$52.00
February	65.00	59.00	58.25	57.75	57.50	57.00	56.25	55.00	53.80	52.00
March	62.50	59.50	57.50	57.00	58.00	57.50	57.00	55.75	55.00	52.50
April	62.25	59.75	59.50	58.00	57.75	56.50	56.25	55.75	56.00	54.75
May	60.50	58.25	58.50	57.75	57.50	56.75	56.00	55.75	56.50	54.75
June	58.75	55.75	59.00	57.50	57.25	56.00	56.50	56.25	55.00	52.25
July	57.50	55.75	58.50	58.00	56.00	55.75	57.25	56.00	53.40	51.75
August	60.50	57.75	58.25	57.50	57.25	56.50	56.50	56.00	52.00	51.00
September	61.75	60.25	57.75	57.00	57.25	57.00	55.75	54.50	52.00	51.50
October	60.50	58.75	58.50	58.00	57.25	57.00	54.00	52.75	54.50	52.00
November	58.75	57.75	58.50	58.00	57.50	57.25	54.50	52.75	62.00	54.00
December	57.50	56.20	58.75	58.00	57.50	56.50	54.00	53.00	69.00	62.50

MONTHS.	1885.		1886.		1887.		1888.		1889.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
January	$68.00	$67.00	$66.00	$64.00	$83.00	$79.00	$115.00	$92.00	$100.00	$93.50
February	67.50	66.50	66.50	65.75	83.50	81.50	95.00	94.00	96.00	94.00
March	67.50	59.00	66.00	65.00	83.50	82.50	90.00	88.00	93.00	90.00
April	61.00	59.00	65.00	64.50	83.00	82.00	88.00	85.50	94.50	93.00
May	59.50	58.00	66.00	65.50	82.50	78.00	85.00	81.00	95.00	93.50
June	61.00	58.00	75.00	67.50	....	78.00	93.00	92.00	100.50	94.00
July	60.00	57.50	81.00	74.00	80.50	80.00	92.50	91.00	116.00	101.00
August	62.50	59.50	82.50	82.00	83.00	79.00	92.00	88.50	115.00	102.00
September	63.00	59.75	82.00	81.00	85.50	85.00	99.50	96.00	111.00	107.00
October	62.50	60.75	84.50	84.00	88.50	87.00	101.00	97.00	106.00	103.00
November	62.00	59.50	82.50	78.50	89.00	87.50	99.50	99.00	107.50	106.00
December	66.50	64.50	78.00	77.00	115.00	103.00	97.00	96.00	108.00	105.00

a During which time the lowest price reached was in August, 1884, $51 to $52, and the highest in July, 1889, $101 to $116.

DISTRIBUTION OF QUICKSILVER.

TOTAL EXPORTS AND SHIPMENTS OF QUICKSILVER IN 1889.

BY SEA.	FLASKS.		
To Mexico	4,593		
To Central America	47		
To Chile and South America	10		
To New Zealand	112		
To Australia	10		
To British Columbia	11		
		4,783	
Shipments to New York		430	
Total by sea			5,213
BY RAILROAD.			
From San Jose, California:			
To New York	5,100		
To Texas	200		
To Montana	1,995		
To Utah	118		
To Idaho	100		
To Arizona	90		
		7,603	
From San Francisco, California:			
To New York	1,500		
To Mexico	819		
To Montana, Idaho, and Utah	2,311		
To Arizona	110		
To Colorado	61		
		4,801	
From San Francisco, via Portland and Northern Pacific railroad, to Montana		350	
Add for shipments to Montana, Idaho, and Arizona not included in above		533	
Total by railroad			13,287
Total shipments by sea and railroad			18,500

SHIPMENTS OF QUICKSILVER IN BOND FROM SAN FRANCISCO. (a)

YEARS.	Spanish, in bond to—	Flasks.	Value.
Total		1,100	$36,619
1886	Mexico	500	13,719
1887	Hongkong	500	18,300
1889	Mexico	100	4,600

a Reported by the San Francisco customhouse.

SHIPMENTS OF QUICKSILVER OVERLAND TO POINTS EAST FOR THE 10 YEARS ENDED DECEMBER 31, 1889, VIA THE CENTRAL PACIFIC RAILROAD. (a)

	FLASKS.
1880	15,553
1881	13,555
1882	7,996
1883	5,211
1884	2,830
1885	9,096
1886	8,039
1887	5,859
1888	3,622
1889	6,889

a Compiled from annual reports of the San Francisco Journal of Commerce.

IMPORTS.

The following table, compiled from the records of the bureau of statistics of the Treasury department, shows the amounts of quicksilver reported by the collectors of customs as imported in each year for 10 years. The original figures are reported in pounds, and sometimes include the weight of the iron flask. The importations in 1890 increased materially, amounting to 10,482 flasks, valued at $445,857.

QUICKSILVER IMPORTED AND ENTERED FOR CONSUMPTION IN THE UNITED STATES, 1880 TO 1889, INCLUSIVE.

YEARS ENDING—	Flasks.	Value.
June 30, 1880	1,296	$48,463
1881	1,539	57,733
1882	6,643	233,057
1883	17,253	593,367
1884	1,518	44,035
1885	2,866	90,416
Dec. 31, 1886	4,468	142,325
1887	7,706	290,380
1888	1,730	56,997
1889	4,464	162,064

IMPORT DUTIES AND EXPORTS.

The following is a comparative statement of the rates of import duty on quicksilver under the several tariff acts from July 30, 1846, to October 1, 1890, both inclusive:

IMPORT DUTIES ON QUICKSILVER.

Act of—		
July 30, 1846	per cent	20
March 3, 1857	do	15
March 2, 1861	do	10
August 5, 1861	do	10
December 24, 1861	do	10
July 14, 1862	do	10
March 3, 1863	do	10
June 30, 1864	do	10 and 15
March 3, 1865	do	10 and 15
March 16, 1866	do	10 and 15
May 16, 1866	do	10 and 15
June 1, 1866	do	10 and 15
July 28, 1866	do	15
March 2, 1867	per cent	15
March 22, 1867	do	15
March 25–26, 1867	do	15
March 29, 1867	do	15
February 3, 1868	do	15
July 20, 1868	do	15
February 19–24, 1869	do	15
July 14, 1870	do	15
December 22, 1870	do	15
May 1, 1872	per cent of existing duties	90
June 6, 1872	do	90
March 3, 1883	per cent	10
October 1, 1890	cents per pound	10

Under the tariff act of October 1, 1890, the flasks, bottles, or other vessels in which quicksilver may be imported are subject to the same rate of duty as they would be if imported empty. Quicksilver flasks or bottles of either domestic or foreign manufacture which have been actually exported from the United States are entitled to free entry.

CUSTOMS DUTIES IMPOSED BY FOREIGN NATIONS UPON AMERICAN QUICKSILVER. (*a*)

Brazil	$5.70 per 100 pounds.
China	$2.60 per 133.3 pounds
Corea	7.5 per cent ad valorem.
Ecuador	$8.52 per 100 pounds.
Greece	73 cents per 100 pounds.
Hawaiian Islands	10 per cent ad valorem.
Haiti	20 per cent ad valorem.
Honduras	$1.66 for 104 pounds.
Italy—Quicksilver	$1.93 for 220.464 pounds.
Oxide of mercury, muriate of mercury, chloride of mercury, precipitate of mercury	$0.77 for 220.464 pounds.
Calomel	$23.16 for 220.464 pounds.
Vermilion	$4.83 for 220.464 pounds.
Japan	$1.58 for 131 pounds.
New South Wales	5 per cent ad valorem.
Peru	10 per cent ad valorem.
Porto Rico	$2.72 for 220.464 pounds.
Russia	$1.20 for 36 pounds.
San Salvador	5 per cent ad valorem.
Spain	31 cents for 220.464 pounds.
Sweden	$4.76 for 100 pounds.
Switzerland	58 cents for 110 pounds.
Turkey	$7.04 for 220 pounds.
United States of Colombia	$9.90 per 100 pounds.
Uruguay	47 per cent ad valorem.
Venezuela	$11.05 for 100 pounds.

a The report is taken from United States consular report No. 73½, Washington, 1887; all in United States weight and currency.

EXPORTS OF DOMESTIC QUICKSILVER FROM THE UNITED STATES FOR THE 10 YEARS ENDED DECEMBER 31, 1889.

[Compiled from the returns sent in by the various collectors of customs.]

PORTS.	TOTAL.		1880.		1881.		1882.		1883.	
	Flasks.	Dollars.	Flasks.	Dollars.	Flasks.	Dollars.	Flasks.	Dollars.	Flasks.	Dollars.
Total	183, 716	5, 617, 685	37, 210	1, 119, 952	35, 107	1, 025, 299	33, 875	988, 454	30, 072	808, 353
Ports from which exported—										
San Francisco	176, 974	5, 378, 118	34, 359	1, 028, 826	33, 035	985, 927	33, 728	983, 977	29, 928	804, 077
New York	6, 066	223, 049	2, 221	76, 244	1, 166	39, 161	143	4, 344	137	4, 037
Philadelphia	630	14, 882	630	14, 882	....	....	....	....	....	....
Boston	40	1, 454	....	....	6	211	4	133	7	239
New Orleans	6	182	....	....	....	....	....	....	....	....
Total	183, 716	5, 617, 685	37, 210	1, 119, 952	35, 107	1, 025, 299	33, 875	988, 454	30, 072	808, 353
Exported to—										
Hongkong	79, 451	2, 371, 108	19, 610	577, 019	17, 031	493, 171	18, 965	560, 353	16, 356	438, 689
Central American States	2, 594	94, 294	41	1, 095	38	1, 086	75	2, 151	150	4, 263
Chile	3, 543	105, 309	754	24, 842	123	3, 700	1, 400	42, 000	1, 150	31, 250
China	87	2, 861	50	1, 475	....	....	....	....	....	....
Germany	....	....	....	....	....	....	....	....	....	....
England	2, 553	96, 082	1, 753	59, 882	....	....	....	....	....	....
British Columbia	205	6, 406	7	211	5	141	16	472	4	110
British possessions in Australasia.	6, 332	190, 638	1, 535	47, 874	1, 330	37, 249	1, 831	52, 997	786	20, 766
Japan	3, 344	88, 705	105	3, 050	314	9, 213	621	17, 601	1, 297	32, 151
Mexico	82, 172	2, 558, 030	12, 413	376, 007	15, 256	450, 448	10, 128	288, 441	10, 157	276, 332
Peru	1, 955	57, 231	440	13, 540	700	20, 161	665	19, 285	100	2, 695
Cuba	377	11, 083	356	10, 270	....	....	1	33	....	....
United States of Colombia	581	19, 118	115	3, 673	208	6, 487	45	1, 280	11	326
Venezuela	333	10, 694	13	497	90	3, 225	98	2, 941	36	1, 028
Dutch Guiana	37	1, 399	1	26	12	418	4	133	5	175
Nova Scotia, New Brunswick, and Prince Edward Island.	23	905	....	....	....	....	....	....	2	64
West Indies	55	1, 629	....	....	....	....	18	552	18	504
All other ports	74	2, 193	17	491	....	....	8	215	....	....

EXPORTS OF DOMESTIC QUICKSILVER FROM THE UNITED STATES, ETC.—Continued.

PORTS.	1884.		1885.		1886.		1887.		1888.		1889.	
	Flasks.	Dollars.	Flasks.	Dollars.	Flasks.	Dollars.	Flasks.	Dollars.	Flasks.	Dollars.	Flasks.	Dollars.
Total	7,370	199,685	6,802	209,758	6,091	204,956	11,394	441,112	10,684	406,399	5,111	213,717
Ports from which exported—												
San Francisco	7,037	189,420	6,547	200,739	5.845	196,384	10,401	396,316	10,145	381,707	5,049	210,745
New York	332	10,233	242	8,578	240	8,340	984	44,448	539	24,692	62	2,972
Philadelphia	....	....	....	....	....	....	....	....	....	....	....	....
Boston	....	....	8	291	6	232	9	348	....	....	....	....
New Orleans	1	32	5	150	....	....	....	....	....	....	....	....
Total	7,370	199,685	6,802	209,758	6,091	204,956	11,394	441,112	10,684	406,399	5,111	213,717
Exported to—												
Hongkong	220	6,750	233	8,990	....	....	3,323	141,237	3,713	144,899	....	....
Central American States	285	8,390	238	8,341	164	5,805	177	6,466	1,333	52,586	93	4,111
Chile	....	....	104	3,042	....	....	....	....	....	....	12	475
China	....	....	....	....	....	....	....	....	37	1,386	....	....
Germany	....	....	....	....	....	....	....	....	....	....	....	....
England	....	....	....	....	....	....	800	36,200	....	....	....	....
British Columbia	15	406	40	1,088	59	1,902	31	1,104	16	548	12	424
British possessions in Australasia	130	3,768	75	2,257	90	3,295	100	3,965	322	12,979	133	5,488
Japan	669	16,032	300	9,100	3	108	....	....	35	1,450	....	....
Mexico	5,830	157,758	5,777	175,828	5,678	190,461	6,920	250,514	5,172	190,013	4,841	202.228
Peru	50	1,550	....	....	....	....	....	....	....	....	....	....
Cuba	11	351	....	....	5	180	....	....	2	127	2	122
United States of Colombia	80	2,376	14	498	22	873	32	1,196	48	2,096	6	313
Venezuela	36	1,057	....	....	60	1,946	....	....	....	....	....	....
Dutch Guiana	....	....	5	176	2	77	3	129	5	265	....	....
Nova Scotia, New Brunswick, and Prince Edward Island.	....	....	2	76	6	232	7	261	....	....	6	272
West Indies	18	529	....	....	1	44	....	....	....	....	....	....
All other ports	26	718	14	362	1	33	1	40	1	50	6	284

ENGLISH QUICKSILVER MOVEMENTS.

The control of the quicksilver market is usually affected by the transactions in London, a résumé of which is given in the following tables, which show a synopsis of the statistical features of each of the past 10 years. The shipments of quicskilver to the United States are also shown.

EXPORTS OF QUICKSILVER FROM ENGLAND.

[Flasks.]

Exported to—	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
Total	16,023	24,889	40,424	49,006	52,548	48,865	66,109	62,606	47,133	57,604
Russia	1,117	1,539	1,451	1,156	769	1,595	1,031	399	45	72
Germany	2,504	2,053	2,974	3,906	2,224	2,916	3,557	3,542	4,098	3,278
Holland	692	708	941	702	819	843	853	1,254	633	1,323
Belgium	285	742	779	868	729	507	816	608	725	
Channel Islands	127	70	131	75	85	142	118	97	40	67
France	3,997	6,143	6,871	5,083	4,492	6,854	4,553	7,718	4,884	8,995
Portugal	465	530	452	444	442 (Portugal and Spain)	609	445	447 (Portugal and Spain)		
Spain	47	51	21	97					475	412
Turkey	24	79	93	123	85	136	97	46	33	42
Roumania and Bulgaria		24								
Roumania and Greece					26					
Morocco			3			9	12		11	
Persia					4					
Gold Coast	5	16	77	131	52		49	33	77	
South Australia	5	11	150			20				
Natal					302	94				
Cape of Good Hope					60					
Natal and Cape of Good Hope							194	971	742	239
United States	200	4,659	13,116	14,382	4,871	5,112	12,311	10,554	4,649	7,967
Dutch West Indies	22	60	64	87	234	76			200	4
Mexico	2,631	5,043	5,562	5,120	5,551	5,680	10,592	6,545	9,967	6,168
Central America	370	230	122	233	217	156	188	124	253	197
United States of Colombia		333	238	202	408	409	63	221	180	620
Canary Islands					1					
Peru	936	970	2,147	2,198	1,767	2,276	3,188	2,025	2,389	4,430
Brazil	67	22	59	216	189	212	173	126	189	
Argentine Republic	1,877	331	2,083	1,591	850	339	114	148	416	434
Norway	4	2								
Denmark	31	46	94 (Norway, Denmark, and Sweden)	88	92	48	49	104	78	42
Sweden	35	32								
Italy	31	79	33	52	40	15	11	27	8	76
Egypt	25	37	19	10	55	1	16	15		154
Bengal		50	392	2,750	920	953	1,498	1,559	1,506	
Java					40					
Java and Ceylon						5				
Victoria	42	162	390	134	75	886	194	826	457	1
New Zealand	37	61	61	80	54	28	34	216	176	69
Chile	314	298	647	1,496	1,308	2,085	2,297	2,625	1,442	
Japan					750	10	810		334	1,006
China		12	10	1,301	10					
Hongkong				4,509	23,924	14,054	21,515	19,208	10,267	16,807
Bombay	75	15	730		868	1,527	869	1,551	1,570	
Madras	11	392	1		12	55	36	63		3,585
Bombay and Madras				1,707						
Canada	1	3	11		41	23	19	332	13	81
Newfoundland							2			
British Burmah		25	31	94	12					
Uruguay	34		8		5	9	10	10	154	
Spanish West Indies			500		1		69			
New South Wales	12	57		112	82	716	29	435	244	1,535
Queensland		4		59	82	465	297	619	878	
Queensland and New South Wales			163							
Philippine Islands								6		
Bolivia								152		

ENGLISH IMPORTS AND EXPORTS OF QUICKSILVER FOR 10 YEARS, BY MONTHS.

IMPORTS.

[Flasks.]

MONTHS.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
Total	49,544	56,259	45,036	54,521	59,969	55,154	58,967	61,114	73,768	67,529
January	6,692	8,680	7,608	362	4,617	4,350	4.496	9,404	11,440	7,250
February	16,380	4,187	4,300	3,270	5,127	4,603	12,488	9,641	10,750	8.546
March	4,117	12,211	7,947	8,300	20,327	8,434	7,179	4,180	13,844	6,591
April	7,778	5,310	10,607	4,082	7,087	329	6,036	11,752	7,960	12,630
May	6,118	5,600	4,546	11,602	9,055	9,545	10,436	4,200	4,237	1,857
June	2,173	9,487	6,490	6,482	4,628	21,328	9,130	11,700	14,902	15,266
July	504	368	....	18,266	3,802	427	4,458	4,754	300	2,479
August	891	600	1,178	529	1,283	1,607	1,289	1,200	26	1,035
September	1,400	....	600	550	500	300	850	510	1,670	3,329
October	2,111	600	960	218	1,340	2,057	1,201	1,298	646	944
November	1,080	527	....	410	800	474	1,004	275	1,273	1,705
December	300	8,689	800	450	1,403	1,700	400	2,200	6,720	5,897

EXPORTS.

MONTHS.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
Total	16,023	24,889	40,424	49,006	52,548	48,865	66,109	62,606	47,133	57,604
January	1,288	2,079	1,947	5,192	4,410	2,524	3,793	5,973	2,181	4,492
February	713	1,165	2,387	4,009	4,912	3,914	4,906	3,232	1,573	4,481
March	1,075	2,136	3,382	3,348	3,412	3,916	10,273	4,866	2,411	7,756
April	1,265	2,126	3,417	4,658	2,035	2,983	8,842	6,375	4,185	8,749
May	985	2,540	2,558	4,407	6,305	3,204	5,556	4,053	11,917	5,295
June	2,252	1,414	4,951	4,604	5,926	4,915	6,655	7,470	5,867	2,238
July	1,367	1,323	2,809	3,718	5,646	3,123	4,371	8,244	3,248	2,483
August	794	2,135	4,187	2,342	3,153	6,488	3,951	6,245	3,367	5,375
September	1,583	2,406	2,772	3,242	3,734	9,642	8,055	3,366	3,714	4,621
October	911	2,042	3,371	4,253	3,071	2.366	2,542	4,320	1,333	4,714
November	1,963	2,576	4,260	6,069	4,335	1,943	3,310	6,117	4,142	2,523
December	1,827	2,947	4,383	3,164	5,609	3,847	3,855	2,345	3,195	4,877

LONDON PRICES PER FLASK OF QUICKSILVER.

1880.

DATE.	Price. £ s. d.	DATE.	Price. £ s. d.	DATE.	Price. £ s. d.	DATE.	Price. £ s. d.	DATE.	Price. £ s. d.
January 3	6 10 0	January 9	7 7 6	February 11	7 0 0	July 13	7 2 6	August 4	7 5 0
January 5	6 17 6	January 14	7 0 0	February 21	7 2 6	July 13	7 5 0	August 16	7 0 0
January 5	7 0 0	January 14	6 17 6	February 23	7 10 0	July 17	7 5 0	September 22	6 17 6
January 6	7 15 0	January 22	7 5 0	March 8	7 0 0	July 17	7 2 6	November 3	6 15 0
January 6	7 7 6	January 22	7 10 0	April 7	6 15 0	July 17	7 0 0	November 23	6 10 0
January 6	7 12 6	January 29	7 7 6	May 25	6 10 0	July 23	6 17 6	December 22	6 7 6
January 9	7 10 0	January 29	7 5 0	June 23	6 15 0	July 23	6 15 0		

1881.

January 7	6 10 0	March 22	6 10 0	May 19	6 5 0	September 26	6 10 0	November 15	6 5 0
January 31	6 15 0	April 4	6 5 0	July 5	6 7 6	October 11	6 15 0	November 22	6 7 0
February 8	7 0 0	April 26	6 7 6	July 7	6 10 0	October 13	7 0 0	November 23	6 10 0
March 3	6 15 0	April 27	6 10 0	August 12	6 5 0	November 7	6 10 0	December 1	6 5 0
March 3	6 13 9	May 7	6 7 6						

1882.

January 1	6 5 0	April 18	6 5 0	June 6	5 18 9	September 9	6 0 0	November 14	5 16 9
January 24	6 0 0	May 15	6 0 0	July 18	5 17 6	October 23	5 17 6	December 29	5 15 0
March 18	5 17 6	June 1	5 17 6						

LONDON PRICES PER FLASK OF QUICKSILVER—Continued.

1883.

DATE.	Price.	DATE.	Price.	DATE.	Price.	DATE.	Price.	DATE.	Price.
	£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.
January 4	5 10 0	February 17	5 17 6	April 3	5 12 6	July 13	5 10 0	October 1	5 5 0
February 14	5 12 6	March 13	5 15 0	April 28	5 10 0	July 20	5 12 6	November 19	5 7 6
February 15	5 15 0	March 20	5 10 0	June 21	5 7 6	August 28	5 7 6	December 20	5 5 0

1884.

February 2	5 2 6	May 27	5 7 6	July 24	5 6 3	November 12	5 17 6	November 20	6 10 0
February 23	5 5 0	June 10	5 3 6	August 18	5 7 6	November 17	6 0 0	November 21	6 15 0
February 29	5 10 0	June 23	5 5 0	August 27	5 10 0	November 18	6 5 0	November 29	6 15 0
March 6	5 12 6	July 3	5 7 6	September 17	5 12 0	November 19	6 7 6	November 29	6 17 6
April 1	5 10 0	July 22	5 5 0	November 10	5 15 0				

1885.

March 13	6 0 0	May 13	5 12 6	August 7	5 15 0	November 9	5 17 6	November 20	6 0 0
March 13	6 15 0	June 1	5 15 0	August 11	5 17 6	November 11	5 16 3	November 23	6 3 6
April 30	5 12 6	June 2	6 0 0	September 14	6 0 0	November 19	5 17 6	November 24	6 5 0
May 5	5 10 0	July 20	5 12 6	September 17	6 2 6				

1886.

January 4	6 0 0	March 8	5 16 3	April 30	6 5 0	July 7	7 0 0	September 21	7 5 0
January 21	5 17 6	March 10	5 17 6	May 14	6 10 0	September 6	6 16 0	September 23	7 10 0
January 22	6 0 0	April 5	5 16 3	June 4	6 15 0	September 13	7 0 0	November 16	7 2 6
February 23	5 17 6	April 7	6 0 0	June 10	6 17 6	September 20	7 2 6	November 18	7 5 0
March 1	5 15 0								

1887.

January 1	7 5 0	May 23	6 10 0	August 9	7 5 0	November 30	9 5 0	December 9	9 10 0
January 6	7 7 6	May 24	6 12 6	August 29	7 10 0	November 30	9 15 0	December 10	9 15 0
March 11	7 2 6	June 17	6 11 0	October 1	7 12 6	December 1	10 5 0	December 10	10 5 0
March 14	7 0 0	June 23	6 12 6	October 10	7 15 0	December 2	10 10 0	December 10	10 10 0
March 26	6 17 6	July 7	6 15 0	November 29	8 0 0	December 6	10 10 0	December 12	11 5 0
March 28	7 0 0	July 11	6 17 6	November 30	9 0 0	December 6	10 5 0	December 12	11 0 0
May 2	6 17 6	August 8	7 0 0						

1888.

January 5	10 0 0	February 21	8 10 0	May 10	6 15 0	July 17	7 7 6	September 15	8 12 6
January 14	9 5 0	March 6	8 2 6	May 23	7 2 6	July 17	7 7 6	September 15	8 15 0
January 17	9 10 0	March 20	8 0 0	May 24	7 0 0	July 20	7 5 0	October 16	9 0 0
January 18	8 15 0	March 23	7 15 0	May 28	7 2 6	July 31	7 7 6	October 17	9 10 0
January 20	9 0 0	April 9	7 15 0	June 4	7 5 0	August 2	7 12 6	October 19	9 1 0
February 14	8 15 0	April 18	7 10 0	June 6	7 10 0	August 10	7 15 0	October 26	8 17 6
February 14	8 12 6	April 18	7 5 0	June 7	7 15 0	August 27	8 0 0	November 16	8 5 0
February 17	8 0 0	April 19	7 0 0	June 11	8 0 0	September 4	8 5 0	November 30	8 10 0
February 21	8 10 0	April 20	7 5 0	June 18	7 12 6	September 5	8 10 0	December 10	8 7 6
February 21	8 7 6	May 8	6 17 6	July 16	7 10 0	September 13	9 0 0	December 19	8 0 0

LONDON PRICES PER FLASK OF QUICKSILVER—Continued.

1889.

Date.	£	s.	d.	Date.	£	s.	d.	Date.	£	s.	d.	Date.	£	s.	d.	Date.	£	s.	d.
January 1	9	10	0	February 6	8	0	0	March 11	7	15	0	May 14	8	4	0	July 30	9	15	0
January 2	8	10	0	February 6	7	15	0	March 11	7	12	0	June 6	8	7	6	September 18	9	3	0
January 2	8	14	0	February 8	8	10	0	March 20	7	7	6	June 6	8	15	0	October 1	9	0	0
January 4	8	15	0	February 8	8	2	6	March 21	7	10	0	June 6	8	12	6	October 5	9	0	0
January 9	8	7	6	February 8	8	0	0	March 25	7	8	0	June 12	9	0	0	October 7	9	5	0
January 9	8	10	0	February 15	7	15	0	March 25	7	10	0	June 15	8	16	0	October 30	8	18	6
January 23	8	4	0	March 4	7	12	6	April 1	7	12	6	June 19	9	5	0	October 30	8	19	0
January 23	8	5	0	March 6	7	10	0	April 4	7	12	6	July 7	8	17	6	December 2	9	10	0
February 5	8	0	0	March 6	7	10	0	April 4	7	15	0	July 9	8	15	0	December 2	9	7	6
February 5	7	17	6	March 6	7	6	6	April 10	8	0	0	July 18	9	0	0	December 11	9	15	0
February 5	7	12	6	March 9	9	7	0	May 9	8	5	0	July 23	9	5	0	December 16	9	10	0
February 6	7	10	0	March 11	7	10	0	May 9	8	10	0	July 23	9	10	0				

ENGLISH SHIPMENTS OF QUICKSILVER TO THE UNITED STATES.

The following table shows the shipments of quicksilver from Great Britain to the United States for the years 1880 to 1889, inclusive, by months:

SHIPMENTS OF QUICKSILVER FROM GREAT BRITAIN TO THE UNITED STATES.

[Flasks.]

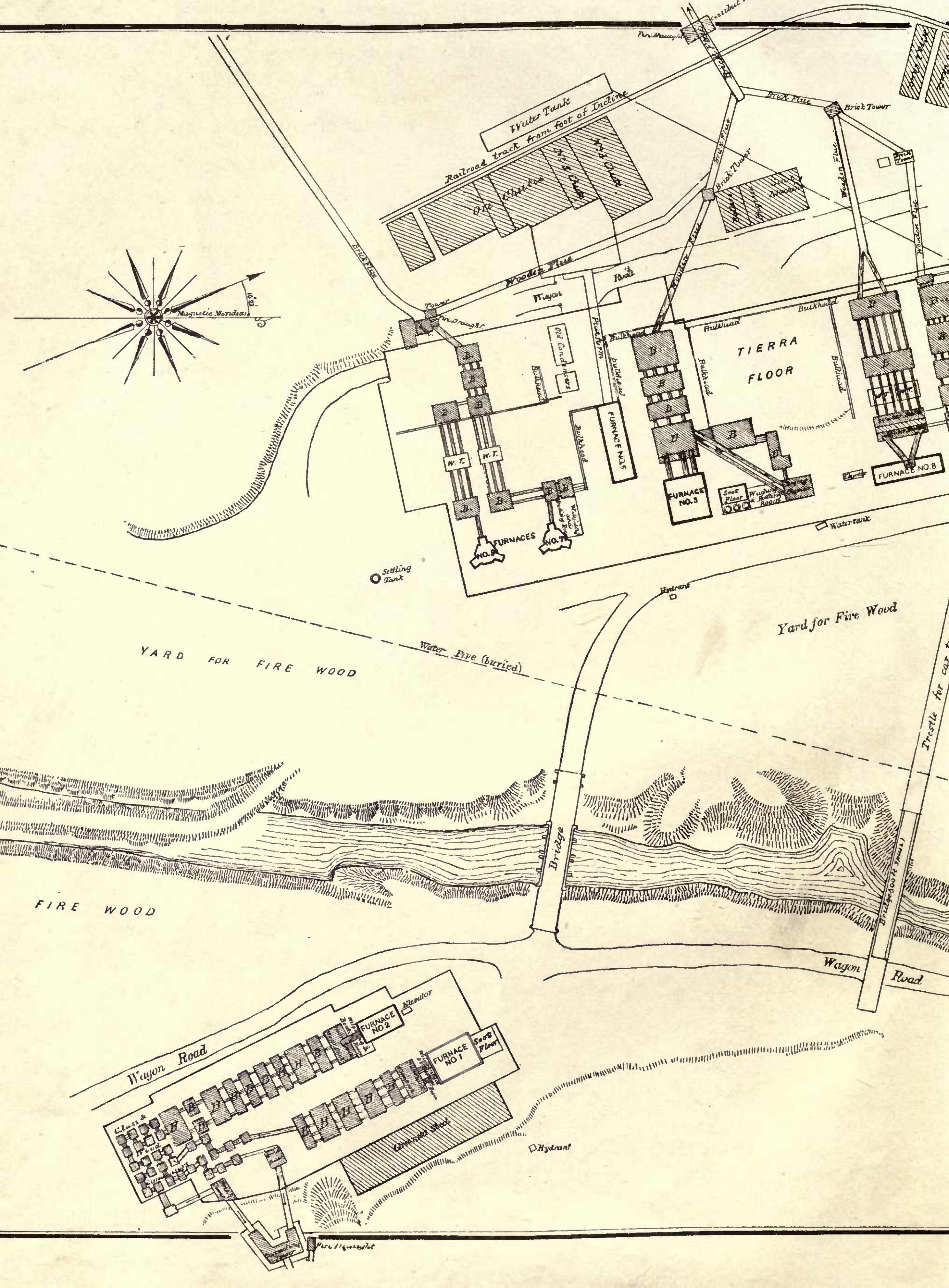
Months.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
Total	200	4,659	13,116	14,382	4,871	5,112	12,311	10,554	4,649	7,967
January	....	....	150	2,207	200	150	300	1,050	100	629
February	....	178	354	1,753	200	350	156	300	600	500
March	....	200	981	2,006	600	300	1,012	100	....	650
April	....	200	984	2,449	196	500	1,338	2,328	300	851
May	....	850	540	2,067	500	100	1,778	650	1,899	1,500
June	100	650	1,772	2,500	1,254	500	700	2,000	400	503
July	....	301	786	....	21	....	1,114	1,800	450	481
August	....	300	1,714	300	450	500	999	910	150	450
September	....	106	763	400	500	1,854	2,607	350	....	100
October	....	220	1,462	200	450	200	701	420	....	1,550
November	....	978	2,074	300	300	....	805	646	....	103
December	100	676	1,536	200	200	658	801	....	750	650

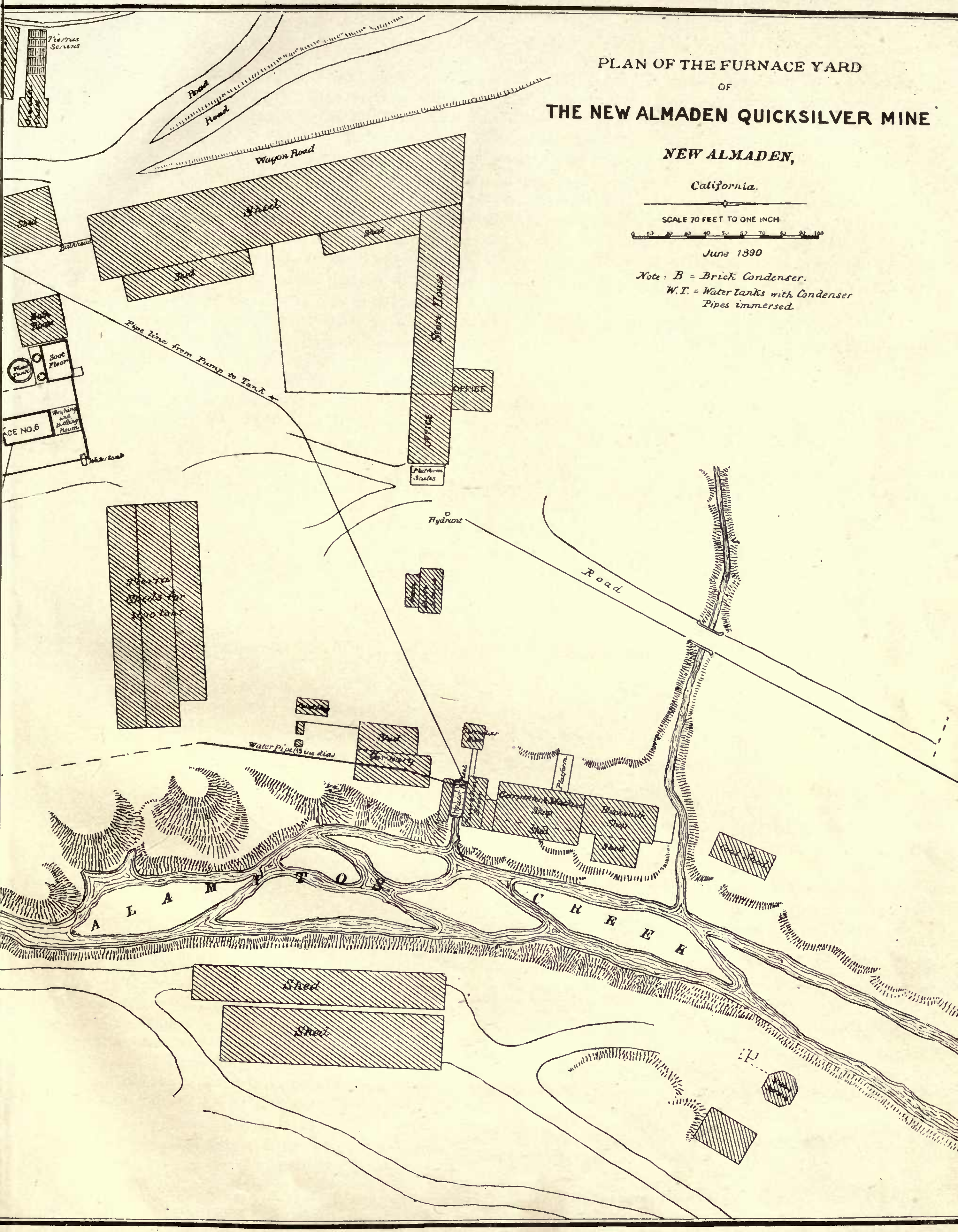
THE NEW ALMADEN QUICKSILVER MINES.

The characteristics of the quicksilver mining industry in the United States can best be understood by the following study of the New Almaden mines:

LOCATION.

The quicksilver deposits exploited by the Quicksilver Mining Company are situated in Santa Clara county, California, in a low range of hills, which has a general northwest and southeast direction, and culminates in Mine Hill at the elevation of 1,755 feet above sea level. This range of hills lies parallel and in front of the main coast range of mountains, separated from it by Capitancillos creek and its affluent in the western and by a branch of Alamitos creek in their eastern position. A low transverse ridge, or so-called "divide", separates Alamitos from Capitancillos creek, and connects the Mine Hill ridge with the main coast range. The highest point of the coast range is Mount Bache, situated about 5 miles south of Mine Hill, with an elevation of 3,790 feet above sea level. Mount Umunhum, 3,430 feet high, in the same range, is about southwest of Mine Hill and 3 miles distant, and Mount Chisnantuck, about 3 miles southeast of Mine Hill, is about 1,790 feet high, being the highest point in the range of hills which extends almost northerly from Mount Bache, and is separated from Mine Hill ridge by Alamitos creek with its source on the northern slope of Mount Bache. The city hall at San José is nearly 12 miles distant in a straight line from summit of Mine Hill, in the direction of north 18° west. The northerly slopes of the Mine Hill range descend gradually into the valley of Santa Clara, of which they form the southern rim. The hills are mostly covered with brush and several species of oak on the northern slope, while the southern slopes are more open. The soil is ill-adapted for cultivation, as it forms only a thin layer on the surface. Water is scarce, the Alamitos and Capitancillos creeks dwindling down in summer time to meager streams that disappear entirely at their entrance in the valley, while during the rainy season they form torrential streams. The railroad station Almaden is 438 feet above sea level, according to the railroad surveys, and the office at the hacienda about 500 feet. The climate is moderate both in winter and summer.


Water Tank
Railroad track from foot of Incline
Old Chutes
Brick Flue
Brick Tower
Wooden Flue
Tower
Magnetic Meridian
Wagon
Road
Platform
Old Condensers
Bulkhead
FURNACE NO.5
TIERRA
FLOOR
FURNACE NO.3
Soot Floor
FURNACE NO.8
Water tank
FURNACES
Settling Tank
Hydrant
Yard for Fire Wood
YARD FOR FIRE WOOD
Water Pipe (buried)
Bridge
FIRE WOOD
Wagon Road
FURNACE NO 2
Elevator
FURNACE NO 1
Soot Floor
Wagon Road
Hydrant


PLAN OF THE FURNACE YARD
OF
THE NEW ALMADEN QUICKSILVER MINE
NEW ALMADEN,
California.
SCALE 70 FEET TO ONE INCH
June 1890
Note: B = Brick Condenser.
W.T. = Water tanks with Condenser Pipes immersed.
Road
Road
Wagon Road
Shed
Shed
Shed
Shed
Store House
OFFICE
OFFICE
Platform Scales
Hydrant
Road
Pipe line from Tump to Tank
Soot Floor
Weighing and Bottling Room
ACE NO.6
Shed
Water Pipe
Shed
Platform
Carpenter & Machine Shop
Shed
Blacksmith Shop
Shed
ALAMITOS CREEK
Shed
Shed

GEOLOGY. (*a*)

The New Almaden, Enriquita, and Guadalupe mines lie nearly south of San José, on spurs of the Santa Cruz mountains. This district has been much more productive in quicksilver than any other in North America, and since 1850 it has yielded four-fifths as much metal as the Almaden mine of Spain. Of special interest in the general geology of the district is the occurrence of a rhyolite dike nearly parallel to the line connecting the New Almaden and the Guadalupe. This is the only known mass of rhyolite in the coast ranges.

The greater part of the surface is occupied by metamorphic rocks, which have been determined as neocomian. They are, for the most part, identical with those so prevalent in the coast ranges. There are also masses of limestone. The general structure of the ridges of the metamorphic rock seems to be synclinal. The underlying rock of the region of New Almaden is undoubtedly granite, although it is at considerable depth.

Pebbles of olivine gabbro are found at various points in the district, but this rock has not been found in place. Upon the metamorphic rocks lie uncomformably areas of miocene sandstones. These are soft, yellowish strata, which were sharply folded by a postmiocene upheaval.

Of special importance in relation to the ore deposits is the rhyolite dike. It not only proves the former existence of volcanic activity, but emphasizes a fundamental structural axis. Parallel to this axis are the directions along which compression and upheaval took place in the early cretaceous, and folding of the tertiary rocks occurred at the close of the miocene. The age of the dike is certainly postmiocene, and probably postpliocene. The fissure system of the mines conforms in general direction with that of the dike, and it is probable that their formation is contemporaneous; also, that ore deposition took place at no great interval after the eruption of rhyolite.

MINE MINERALS AND ROCKS.

The ore is cinnabar, sometimes accompanied by native mercury. The associated minerals are pyrite, marcasite, and chalcopyrite. The gangue minerals are dolomite, calcite, quartz, and bituminous matter, the first being more prevalent here than in most quicksilver districts—a fact probably not unconnected with the unusual quantity of limestone in the sedimentary rocks. A small amount of chalcedony and opal, usually black in color, accompanies the deposits. The rocks associated with cinnabar in this district include every variety of the metamorphic series. Where the rock happens to be a permeable sandstone impregnations have resulted. Elsewhere the ore seems to occur exclusively in crevices in the rock, many of which are only partially filled. In some cases quartz, reddened throughout by cinnabar, occurs in this manner. There is no indication that ore has been deposited by substitution, or that the rock has influenced the deposition of ore by its chemical properties. Ore is found with nearly equal frequency in contact with various rocks, and the existence of fissures appears to have been the necessary and sufficient condition for the deposition of cinnabar and gangue minerals. Where disturbances of the country resulted in the formation of open fissures, or of ground presenting a large amount of interstitial space, ore bodies were formed; but where the rock yielded to a stress as a plastic mass no room was left for ore.

ORE DEPOSITS.

The commonest type of the ore deposits is the reticulated mass or stock work, consisting of irregular bodies of broken rock into which solutions of cinnabar and gangue minerals have filtered, cementing the fragments together with ore; clean cut fissures filled with ore may be seen, and these can only be classed as veins, though they are not persistent.

The ore in the New Almaden mine seems never to occur except close to evidences of faulting. This evidence consists in the presence of layers of attrition products, so-called clays, full of slickensides, and of fragments of rocks more or less rounded by attrition. These layers of clay usually occur on the hanging side of deposits, and are known to the miners as "altas", the Spanish term for "hanging walls". The clays are impermeable to solutions and the ore usually forms on their lower side, as if the cinnabar had ascended and had been arrested by the altas. That the solutions really took this course is clearly shown by the phenomena of other quicksilver districts as well as by the relations observed in the New Almaden mine. The miners very properly follow seams of alta in their search for ore. Sometimes, however, a second mass of ore exists on the hanging side of the clay, and is again limited by a second layer of alta. Such occurrences are to be expected in a country so irregularly disturbed as this. The alta is not a definite substance, though it is usually a dark or black mass readily distinguished even in hand specimens from the country rock. It is simply triturated country rock, and varies in composition with the material from which it has been produced. Its black color is in part due to the presence of manganese. The evidence of moving in the New Almaden mine is not confined to clays. Where the opposing walls were so nearly parallel that no considerable quantity of trituration took place, polishing occurred, and some of the slickensides met with are as brilliantly polished as if the work had been done by a lapidary.

a This article and the following under the headings of "Mine minerals and rocks", "Ore deposits", and "Fissure system" are short abstracts of the article, "Descriptive geology of the New Almaden district", in Mr. George F. Becker's monograph on the geology of the quicksilver deposits of the Pacific slope.

FISSURE SYSTEM.

The various ore bodies of the mines are arranged in subordination to a general fissure which stands in close relation to the general geology of the district. The fissures are the result of a widespread disturbance, and the direction of their strike, southeast and southwest, coincides with the direction of the fundamental axis of the disturbance. The workings in the main portion of the New Almaden mine have developed two principal fissures, dipping north. One of these dips from the surface at a high angle, and in a nearly straight line. The other strikes in nearly the same direction as the first, dips steeply from the surface, then flattens and approaches the first fissure rapidly, and in the lower workings almost coincides with the first. The first fissure contains the ore bodies east of the Randol shaft, which are continuous from the 800-foot to the 1,900-foot level; also the ore bodies west of the shaft in the hanging wall side of the other fissure, which have been worked from the 1,400-foot to the 2,000-foot level. The second fissure contains the continuous ore chute, which extends from the summit of Mine Hill toward the Santa Isabel shaft down to the 2,000-foot level.

The ore deposits of the Cora Blanca and Washington shafts have no connection with those of the main mine. In the former ore has been traced to a depth of 750 feet below the summit of Mine Hill, and in the latter to a depth of 850 feet. The Cora Blanca deposit has a strike of north 18° west, magnetic, and has a dip of 40° to the east. The strike of the Washington deposit is about north 55° west.

The ore-bearing ground of the Enriquita mine was about 500 feet in length, and had an extreme width of about 60 feet, the dip being nearly vertical. The ore was found in rich pockets in limestone, which was inclosed on both sides by serpentine.

Besides the mines mentioned, there are a number of abandoned ones, none of which was ever very productive or very extensively developed.

All the deposits of the district appear to occur along a rather simple fissure system. The main fissure is nearly parallel to the rhyolite dike at the Guadalupe mine. It follows the direction of the hills, the axis of which curves gradually away from the dike for a certain distance. Passing through or near the San Antonio and Enriquita, it seems to break across the ridge at the America and enters the Almaden on the strike of its great fissure. The Washington seems to be on a branch of the main fissure.

HISTORY OF THE MINES AND REDUCTION WORKS.

Andres Castillero, a Mexican captain of cavalry, was sent by his government in October, 1845, to California to confer with General Sutter for the purchase of his fort, established in what is now Sacramento county. Having arrived at Monterey, he began his land journey about the middle of October, 1845. Being informed that a valuable mine existed in the hills some leagues south of Santa Clara, he went there to inspect the mine, which was then known as Chaboya's mine (a). Castillero, having some knowledge of assaying, tested the mineral, which he thought contained some gold and silver and a very small percentage of quicksilver. This last metal he considered then of little importance. On November 22, 1845, he made the "denouncement" of the mine before the alcalde of Santa Clara, naming the mine Santa Clara, in which he claimed to have discovered a vein of silver with an alloy of gold, being situated on the rancho pertaining to José Reyes Bereyessa.

On December 3, 1845, he again appeared before the same alcalde and stated that on opening the mine which he had previously denounced in his court he had, besides silver with an alloy of gold, also taken out liquid quicksilver, and on December 30, 1845, Antonio Maria Pico, the alcalde, gave Castillero judicial possession of the mine, to be known as Santa Clara.

Castillero associated with him in this enterprise Don José Castro, then commanding general of the Mexican forces at Monterey, Secundino and Teodoro Robles, and the father friar José Maria del Refugio Suarez del Real, and went with the last named to the mine to begin operations in December, 1845. Castillero and Padre Real employed William G. Chard, a native of New York, to open the mine. Having no retorts of any kind, Chard put the ore in gun barrels, the mouths of which he placed in water, and, heating the barrels over a fire, distilled some metal. This process, however, was soon abandoned for a better one. A hole or well was dug in the ground and a trough full of water was placed in the bottom. Bars of iron were laid across the top of the well, and a copper still with the upper part coming up through the bars reached down into the water. Ore was then piled on the bars, and a whaler's trying pot was reversed over the heaped ore, wood piled around the pot and over it, and then set on fire. The mercury vapors were forced through the pipe into the water by the heat. In this primitive way from 3 to 4 tons of ore could be reduced with from 6 to 8 cords of wood, the operation lasting from 16 to 18 hours. As the escaping vapors made the work very dangerous, Padre Real conceived the idea of building a new furnace. This was made of adobes, 10 feet high and about 8 feet in diameter on the outside, with 2 chambers inside, one above the other. The top of the lower chamber, which was used as the fireplace, was made full of holes, through which the flames could pass into

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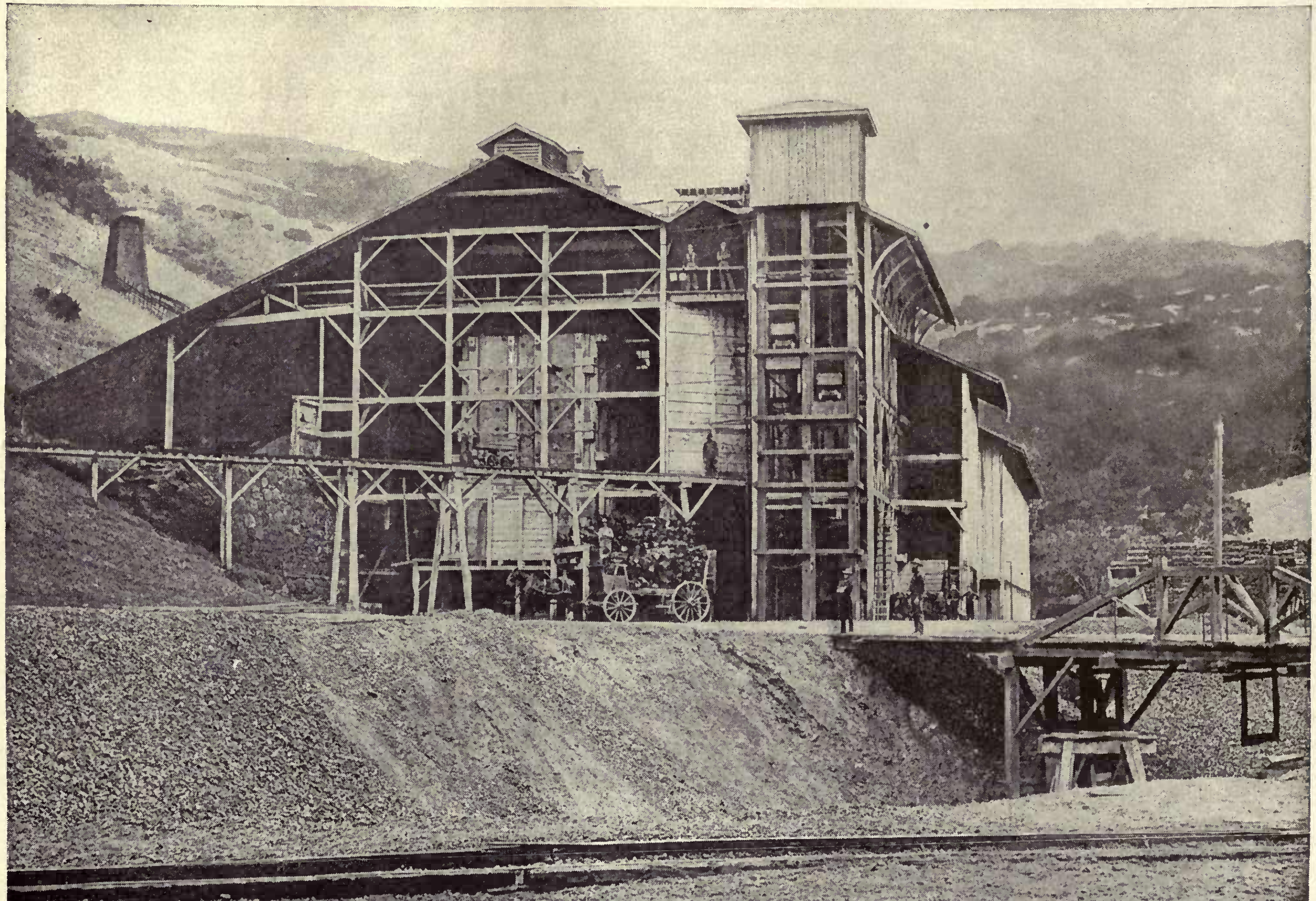
a It is also stated that the mine had been known long before this time, and that Antonio Suñol, Luis Chaboya, and an old man named Robles first discovered and worked the mine as early as 1824, and that to work the ore a mill had been built by Chaboya on the creek now called Alamitos. It is also said that the Indians came to the mine to get paint, which they called "pooyi".



QUICKSILVER FURNACES Nos. 1 AND 2, 1889, NEW ALMADEN, CALIFORNIA.

the upper chamber that was filled with ore. The upper chamber had a large hole on top for charging it with ore. This hole was closed by an iron door during the operation of firing, and cemented, and 6 or 8 iron pipes led the vapors from the upper chamber into a water tank (evidently a copy of the Bustamente furnace without the aludels). This furnace, built only of sun-dried bricks, or adobes, did not succeed very well, as it bursted when the fire became very hot, and badly salivated Chard and the men working at it. It was therefore charged only once.

Castillero had returned to Mexico early in 1846 to report the result of his mission, and while there appealed to the Mexican government for aid in his mining enterprise, in which he succeeded. A contract was made with him in the City of Mexico in May, 1846, by which the government agreed to advance to Castillero and his associates the sum of $5,000 and give other aid for the development of the mine. Unluckily for Castillero, the difficulties just then broke out between the United States and the Mexican government, which ended in the cession of California, and the Mexican government, foreseeing this danger, stopped the payment of the stipulated sum to Castillero. Padre Real had been left at the mine to take care of it. Left to their own resources, and not having the means to carry on the work and make the necessary improvements, Don José Castro, for himself and associates, then made a contract with the banking firm of Barron, Forbes & Co., of San Blas and Tepic, Mexico, by which the latter became lessees of the mine for 16 years, and some time after making the contract became part owners in the mine by the purchase of some of the shares. Mr. J. A. Forbes took charge of the mine for Barron, Forbes & Co. in August, 1846, possession being given by Padre Real. The new firm changed the name of the mine, calling it New Almaden.

When Forbes arrived at the mine the underground workings consisted only of an adit or horizontal entrance 20 or 25 feet in length through the rock. The quicksilver ore was in sight on either side. There was a floor or planilla on the outside of the tunnel, formed of the waste material broken from the mine. Chard, as major-domo, was in charge, assisted by a white man (a blacksmith) and several Indians. One of the Indians remained constantly at the mine to guard it, and slept in the tunnel at night. They were then not actively engaged in extracting ore, but the reduction of the ore took place at the hacienda near the creek every day, sometimes with 2 pots. The ore was brought down from the hill on mules' backs. A log house, as dwelling, and a blacksmith shop were the only buildings constructed. Forbes received from Padre Real 2,000 pounds of quicksilver that had already been distilled. (*a*)

Forbes then erected furnaces with retorts made of 4 potash kettles, built into walls of adobe, with condensers of masonry work immediately adjacent. 400 pounds of ore of average quality, broken into lumps the size of an apple, were put into each kettle or retort, the covers put on and luted with a layer of sand. The fires were then kept up till near night, when the furnaces were allowed to cool gradually. On the next morning the condensers were opened and the metal, which usually amounted to from 300 to 400 pounds from the 4 pots, dipped up. This was a much less percentage than the usual assay indicated, and it was obvious that a large portion of the metal was lost. Forbes wished to devise some way of extracting the metal without mixing lime with the ore in roasting, but was unsuccessful. At length a kiln of lime was burned, and "I am informed", says Rev. Chester S. Lyman, the surveyor, "that the ores yield with this a vastly greater percentage of metal. In the last 3 weeks about 10,000 pounds of metal have been extracted with the same apparatus, being a yield of over 50 per cent". Mr. Lyman stated that in February, 1848, while Alexander Forbes was at the mine as superintendent, there were 4 furnaces in operation for extracting quicksilver, employing from 20 to 30 men. (*b*)

Dr. Tobin arrived from England during the year 1849 to take charge of the reduction works. According to his letter in Ure's Dictionary of Arts, volume II, page 140, the mine resembled then a gigantic rabbit warren. Its greatest depth was about 150 feet, and the weekly extraction of ore varied from 100 to 150 tons. Dr. Tobin got 16 cylinders (retorts) at work, producing from 1,400 to 1,500 pounds of quicksilver daily. This result was satisfactory so far as production was concerned, but not so as regarded expense in fuel and labor. 6 furnaces of the Idria style were built by Mr. Baker, each of 1 ton capacity, and 2 more of a larger size by Dr. Tobin. Very rich ore was burned in these furnaces, but as they were badly constructed so far as the bottoms of the condensers were concerned, very large quantities of quicksilver ran through the foundations into the ground, which in later years was recovered by washings. The small Baker furnaces were built on the south side of Alamitos creek, and Tobin's furnaces on the north side. Tobin's big furnace did not last long; it burst in many places, and salivated all the workmen. It was therefore determined to build the so-called medium furnaces of about 15,000 pounds capacity.

Mr. Russell Bartlett, the United States commissioner on the Mexican and United States boundary question, who visited California in 1853, states that the quantity of quicksilver annually produced at New Almaden exceeded 1,000,000 pounds, and makes mention of 6 furnaces that were kept going night and day. 7 or 8 days were required for 1 furnace operation; that is, charging, firing, and discharging. The men working at the furnaces were so much affected by the escaping vapors that they were kept at the work for 3 or 4 weeks only, when a fresh set of workmen were put in their place.

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a Silliman's Journal: Letter of Rev. C. S. Lyman, Pueblo de San José, March 24, 1848.

b United States *vs.* Andres Castillero, No. 420, 1859, page 12, transcript of record.

Mr. Ruschenberger gives a more detailed account of the distilling apparatus, as follows: (*a*)

A kind of reverberatory furnace 3 feet by 5 feet is arranged at the extremity of a series of chambers of nearly, if not exactly, the same dimensions, namely, 7 feet long, 4 feet wide, and 5 feet high. There are 8 or 10 of these chambers in each series, built of brick, plastered inside, and secured by iron rods, armed at the ends with screws and nuts as a protection against the expansion by heat. The tops are of boiler iron, luted with ashes and salt. The first chamber is for a wood fire, the second is the ore chamber, which is separated from the first by a network partition of brick. The flame of the fire passes through the square holes of this partition, and plays upon the ore in the ore chamber, which when fully charged contains 10,000 pounds (5 tons) of cinnabar. Next to the ore chamber is the first condensing chamber, which communicates with it by a square hole at the left lower corner. An opening at the right upper corner of the partition between the second and third condensing chambers communicates with the latter. The openings between the chambers are at the top and to the right and at the bottom and to the left alternately, so that the vapors from the ore chambers are forced to describe a spiral in their passage through the 8 condensers. The vapor and smoke pass from the last condensing chamber through a square wooden box, 8 or 10 feet long, in which there is a continuous shower of cold water, and finally escape into the open air by tall wooden flues. The floor or bottom of each condensing chamber is about 2 feet above the ground, and is arranged with gutters for collecting the condensed mercury and conveying it into an open conduit, along which it flows into an iron receptacle, from which it is poured into the iron flasks. There are 14 of these furnaces and ranges of condensers, with passages of 8 or 10 feet in width between them. A shed is constructed above the whole at a sufficient elevation to permit free circulation of the air.

The firing was kept up for 60 hours, and the furnaces required 48 hours for cooling before they could be discharged. The fine ores were mixed with clay and water and made into bricks called "adobes", size 10 inches by 4.5 by 4.5 inches, dried in the sun. The larger pieces of ore and adobe were then piled up in the ore chamber, which, when fully charged, contained about 5 tons of ore. This style of furnace remained in operation during the following years, the only modifications made being the size, which was considerably increased.

In 1863, when the Quicksilver Mining Company took possession of the property, there were 5 intermittent furnaces at the hacienda, while a new furnace, No. 6, was completed in December, 1864, with a capacity of 84 tons.

NUMBER OF FURNACE.	When first put in operation.	Capacity. (Short tons.)
1	July, 1861	40
2	May, 1862	40
3	November, 1862	40
4	September, 1863	40
5	May, 1864	40

Furnace No. 1 was the only one built without iron plates in its foundation, while all the other furnaces were so provided.

The subsequent improvements in the furnace plant were as follows:

In 1873 the first shaft furnace continuous in operation was built, after the Page patent, on the site of old furnace No. 2, which was removed for this purpose.

Furnace No. 5 (*b*) received an addition to its condensation plant by the erection of 2 iron condensers of the Fiedler patent.

Furnace No. 6 (*b*) had a wooden condenser added, 26 feet in length, 14 feet in width, and 20 feet high, containing 6 chambers of equal size. The result of this addition was very gratifying, as was found by the examination of the flue, which formerly had yielded from 60 to 100 flasks of quicksilver annually and only 2 flasks after the new condensers went into operation. The flue was also extended a distance of 100 feet and a new smokestack erected.

Furnace No. 7 (*b*), having been unserviceable for 3 years was torn down, with its first 3 condensers.

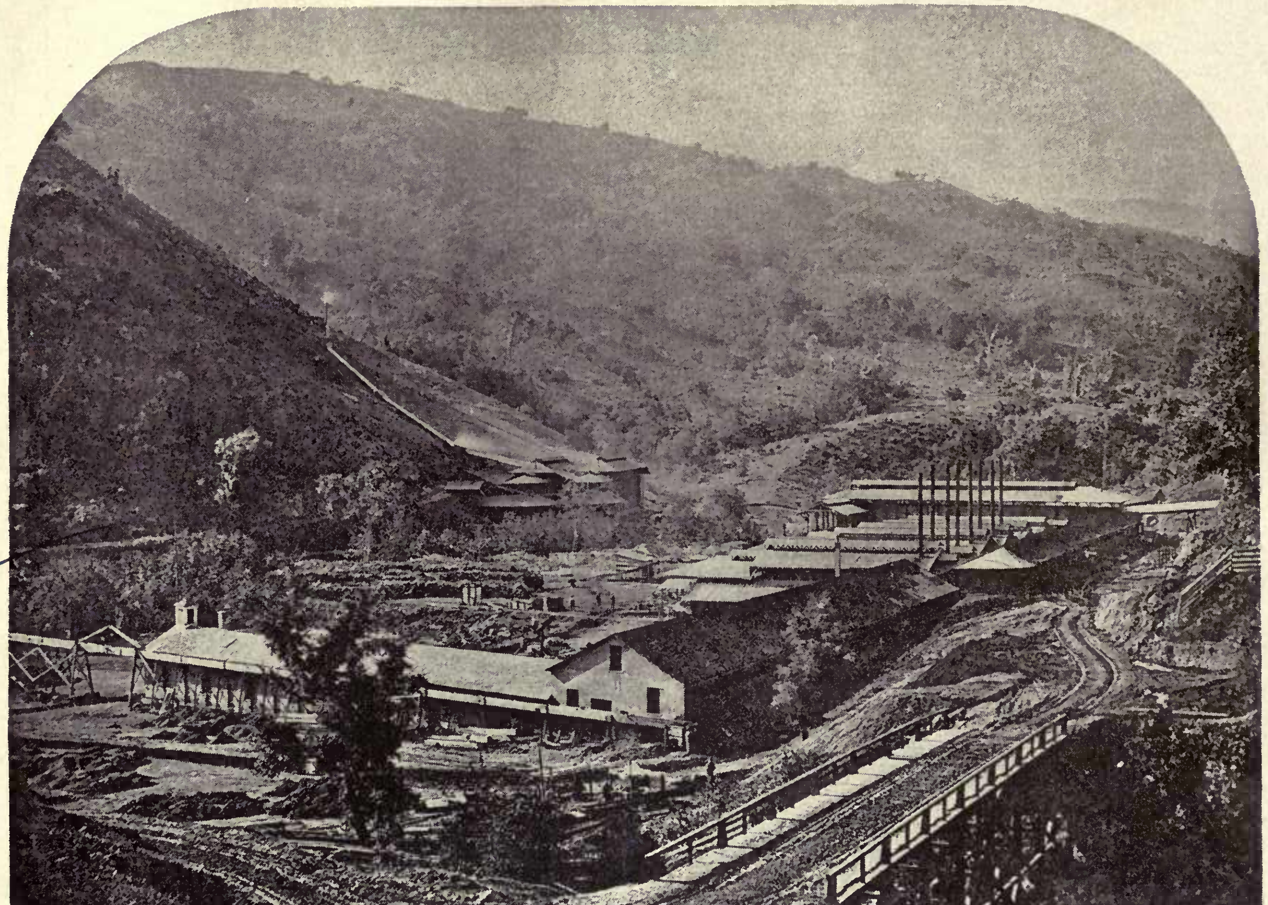
Furnace No. 1 had then 17 condensing chambers; No. 2 18 condensing chambers; Nos. 3 and 4 combined 39 condensing chambers; No. 5 20 condensing chambers, besides 2 Fiedler condensers, and No. 6 20 brick condensing chambers and 6 wooden chambers.

Another improvement with advantageous results was the introduction of openings (covered with glass) into all the upper part of the brick and wooden condensers, allowing the outer and cooler air to come more easily in contact with the hot fumes, as the thickness of a thin pane of glass only intervened, which insured a more rapid and thorough condensation. Trials were also made during 1873 to introduce the combustible with the ore. Coal, coke, and charcoal were first used, but later only coke and charcoal, as the use of coal was not considered beneficial. It was considered that this process would be advantageous in burning and roasting the ore more perfectly and rapidly, especially in places where the flame from the wood fire of the fireplace could not reach freely.

In 1874 the continuous shaft furnace No. 2, built in the previous year according to the Page patent, not proving as beneficial as anticipated, the discharge of ore being irregular, was partially razed and rebuilt into an improved, old style intermittent furnace, and exclusively used for the burning of adobes, with a capacity of 111,000 pounds of adobes per charge, or 444,000 pounds per month. The condensing chambers of this furnace, which were the same as originally used for the old furnace, consisting of a solid block of 18 chambers, were divided into 2 blocks by cutting out one of the chambers and thereby obtaining a better circulation of air, not only on the outside walls but also through the lower arches and passageways on which these condensers are built. The subject of a more economical and improved method of reduction and condensation was the object of constant study and experiment,

a Ure's Dictionary of Art, supplement, page 743.

b Built prior to 1870, and intermittent.



NEW ALMADEN—THE REDUCTION WORKS, OR "HACIENDA", IN 1870.

and the results are evidenced by the introduction of the new iron condensers of the Fiedler patent and those made of wood and glass of the Randol & Fiedler patent, also the introduction of the improved method of extracting quicksilver from the soot by the Randol & Wright process. 4 wood and glass condensers of the new style were built for furnace No. 5, each being 22 feet long, 8 feet wide, and 15 feet high, a cast-iron condenser of the Fiedler type being also added. A wooden tower, with an upcast and downcast shaft, was erected for furnaces Nos. 1 and 2, in the rear of the last condenser, the downcast shaft being supplied from the top with a spray of water which fell through a series of triangular wooden cross-pieces inserted into the sides of the shaft in alternate opposite directions, which divided the water into minute particles, intended to combine with the fumes from the condensers, in order to precipitate all the metallic content reaching this point.

Furnace No. 7, ironclad, of the continuous type, nearly alike to those in operation at the Idria mine in Austria, was also commenced in 1874 and finished in 1875. 2 brick towers and 2 large brick condensers were added to the plant of this furnace. From these the fumes were made to pass through the condensers of furnace No. 5 (not then in operation), and thence into the 4 new wood and glass condensers above mentioned. As this left furnace No. 5 with only 2 iron condensers, a new series of condensers were built for the latter furnace, of which 2 were of brick and 3 of wood and glass, the last ones being each 12 feet long, 12 feet wide, and 20 feet high, with 34 large windows, each condenser being divided into 4 chambers. A new flume 1,000 feet in length, made of Oregon pine and leading to a central chimney, was also built, which received all the fumes from furnaces Nos. 3, 4, and 6. The old brick condensers were provided with new openings, closed in by windows of glass or iron, for better cooling the vapors.

In 1875 the flue began in 1874 was completed and proved of much benefit by carrying the smoke away from the hacienda. Another wood and glass condenser, 12 feet square and 20 feet high, made into 4 compartments and provided with 34 large windows, was added to the plant of furnace No. 5. Furnace No. 7 received the addition of 2 brick towers to its condensation plant, each 7.5 feet wide, 12 feet long, and 26 feet high; also 2 brick condensers, one 27 feet long, 10.5 feet wide, and 27 feet high, and the other 20 feet long, 20 feet wide, and 10 feet high. Furnace No. 1 received the addition of another large wooden condenser built on the same plan as those for furnace No. 5. The wooden tower erected in 1874 for furnaces Nos. 1 and 2 and provided with water spray was removed, as it was found to operate badly. To give additional condensing space to furnaces Nos. 1 and 2 a large brick tower was erected on the adjacent hillside and connected by wooden flues with the last condensers of these furnaces, whence the smoke passes into the main flue that leads up the mountain side to the chimney. The brick chimney serving as outlet to furnaces Nos. 5 and 7 was raised a further height of 32 feet, altogether 62 feet, to increase its draft. 2 Fiedler iron condensers were added to the condensing plant of furnace No. 6 and connected with a Root blower, driven by a small steam engine, to withdraw from the furnace any mercurial vapors remaining after firing had ceased (the furnace being intermittent). Foundation was laid at the end of December, 1875, for another ironclad furnace, No. 9, similar to No. 7 (*a*), in successful operation. Experiments were made with the object of constructing a continuous furnace for the burning of tierras without making them into adobes, and No. 5 furnace was changed into a trial furnace for this purpose, and worked so satisfactorily that plans were made for the double continuous furnace, No. 8 (*b*). The construction of the additional condensers, wherever found necessary, during the past 2 years had given very good results, and scarcely any quicksilver was found in the flues leading away from the last condensers, and in the whole aggregate length of these flues of 1,643 feet (leaving out joint flue of Nos. 5 and 7 furnaces, as both furnaces were in operation and are continuous in action) only 6 flasks of quicksilver were collected after a run of 16 months' operation.

The 2 ironclad continuous furnaces, No. 9, for granza or coarse ore, and No. 8, for tierras or fine ore, were completed and put in operation during the year 1876. It is interesting to show the cost and profit of working the continuous tierras furnace, based on actual work for 39 days and giving 1.40 per cent yield of quicksilver:

Cost of tierras at the mine and dumps, 10 cents per carga, or per ton	$0.67
Cost of transportation	0.35
Total cost of tierras	1.02
One day's supply for No. 8 furnace, 24 tons, at $1.02 per ton	$24.48
Labor of 5 men in 24 hours	12.00
Fuel, 2.57 cords wood, at $6 per cord	15.42
Flasks	9.00
Total cost, $7.766 per flask, or	60.90
Estimated daily yield, 9 flasks of quicksilver, at 50 cents per pound	344.25
Daily profit	283.35

As the furnace is expected to run at least 300 days in the year, the annual profit would be $85,000 from this furnace alone. The dumps and old workings of the mine contained a large amount of tierras that could be profitably worked in this new furnace. Of the old style intermittent furnaces No. 6 was the most favorable exponent, giving the best results for labor and fuel. In 1876 the average cost of working ores in it was $1.97 per ton, of which 63

a Continuous furnace of Exeli type.

b Tierra furnace, Huttner & Scott patent.

cents was for furnace labor and $1.34 for fuel. To roast tierras in the intermittent furnaces it was necessary to first make them into adobes, at a cost of 95 cents per ton for making and handling.

With this data the cost of roasting all the ores handled in 1876 can be arrived at if the work had been done in the old style furnace under the most favorable circumstances:

The coarse ores roasted were 7,392 tons, at $1.97 per ton	$14,562.24
9,266 tons tierras cost $1.97 per ton roasting and 95 cents per ton making into adobes and handling, together $2.92 per ton	27,056.72
Total cost of 16,658 tons for labor and fuel, $2.4985 per ton	41,618.96

Now, the ironclad continuous furnaces Nos. 7 and 9 roasted coarse ore at a cost of $1.1833 per ton, of which there is for furnace labor 52 cents and fuel 66.33 cents; the continuous tierras furnace No. 8 works tierras without making into adobes at a cost of $1.1425 per ton, 50 cents being for labor and 64.25 cents for fuel. The cost would therefore be as follows:

7,392 tons coarse ore roasted in improved furnaces (continuous), at $1.1833 per ton	$8,747.20
9,266 tons tierras not made into adobes but roasted in new continuous furnace, at $1.1425 per ton	10,586.40
Total cost of 16,658 tons for labor and fuel, at $1.1606 per ton	19,333.60
The year's work in old furnaces cost	41,618.96
The year's work in new furnaces cost	19,333.60
In favor of new furnaces, 53.54 per cent	22,285.36
Cost per ton, old furnaces	2.4985
Cost per ton, new furnaces	1.1606
Decrease, 53.54 per cent	1.3379

The first 3 condensing chambers of No. 6 furnace were taken down and in their place a new condenser with drying chamber for moist tierras was erected. The first block of condensers of furnace No. 5 was covered on top with iron plates to form a drying floor for moist tierras. The ironclad furnace No. 9 was completed in April, and was started on May 13. 2 brick condensers and 2 wood and glass condensers were erected for this furnace and connected with the four similar condensers formerly belonging to No. 5.

For a period of 4 months continuous operation of the 2 ironclad shaft furnaces, Nos. 7 and 9, it was found that the amount of ore burned was:

	Pounds.
Granza	3,113,600
Terrero	1,571,200
Total	4,684,800

or 2,342.4 tons.

The expenses were:

For labor	$1,220.00
For 182.75 cords of wood, at $6 per cord	1,096.50
For 70,272 pounds of coke, at $13 per ton	456.76
Total	2,773.26

The furnaces during this time yielded 6,382 flasks of quicksilver, with the following result:

Cost of labor per flask	$0.190
Cost of wood	0.172
Cost of coke	0.072
Total cost per flask	0.434

The new ironclad tierras, furnace No. 8, Huttner & Scott patent, was completed in October and started November 1, 1876. This furnace roasts 24 tons of tierras in 24 hours. It has two brick condensers covered and joined by iron plates, which serve as a drying floor for tierras, 2 iron condensers, and 7 condensers of wood and glass. The furnace itself is 46 feet high, 10 feet wide, and 38 feet long.

In 1877 a large bathhouse was built for the men working at furnaces. A new brick flue was built for furnaces Nos. 3, 4, 6, and 8, and a brick chimney was added 81 feet high. The cornerstone was laid on August 25, 1877, for a new granzita and tierras furnace, No. 3, of the Huttner & Scott type, on the site of old intermittent furnace No. 3, which was torn down.

Comparing the results from No. 8 furnace with assays of samples taken from each car of tierras before charging the furnace, it was found that during the months of November and December, 1876, and January, February, March, and April, 1877, this furnace roasted 5,278,000 pounds of tierras, the actual yield of which amounted to 81,319.5 pounds of quicksilver, while the theoretical amount according to assays indicated 87,862.5 pounds contained in the ore. This shows a loss in reduction of 6,543 pounds, or 7.45 per cent. Allowing, however, 5 per cent of the total weight of the tierras for moisture, there was only a loss of 2.58 per cent.

With the coarse ore furnaces, Nos. 7 and 9, from which assay samples could not be obtained without a great deal of trouble and additional expense, a similar calculation could not be made, but as these furnaces had each a separate system of condensers (No. 7 nearly all of brick and No. 9 of brick and the greater part of wood and glass), it was remarkable that after a continuous campaign with these furnaces for 9 months ended May 31, 1877, during which time each furnace roasted 5,241,600 pounds, the ore for both furnaces having been taken from the same ore bin, the yield of No. 7 furnace was found to have been 7,539 flasks, and that of No. 9 furnace 7,541 flasks, the difference in yield between the 2 furnaces being only 2 flasks.

Large weighing scales had been placed on the track over which the loaded cars passed, so that each charge of 1,600 pounds of ore was accurately weighed.

In February, 1878, the new ironclad furnace No. 3 was completed. On December 30 of the same year the work of furnaces Nos. 7 and 9 ended for the purpose of annual cleaning. The result was for No. 7 furnace, 716 flasks, and for No. 9, 720 flasks, a difference of 4 flasks, both furnaces having been charged with equal amounts of the same grade of ore. In furnace No. 7, however, a trial had been made of adding 240 pounds of lime to each charge, but as the furnace produced less quicksilver with the same grade of ore the addition of lime was not considered beneficial and was discontinued.

The intermittent furnace No. 2 was changed into a Huttner & Scott continuous furnace for granzita, with a daily capacity of 18 tons, and received the first charge of ore on June 20, 1879. Furnace No. 1 was pulled down and rebuilt like No. 2 furnace, with a capacity of 36 tons daily, and finished in January, 1880. The condensation plant of both furnaces was also increased at the same time by adding 14 wood and glass condensers of the latest style, each 4.5 feet square and 25 feet high, to furnace No. 2, and 21 of the same style to furnace No. 1.

During the year 1882 one Idria condenser, consisting of three cast-iron pipes, each 22 inches in diameter, standing in a tank and surrounded by cold water, was added to the condensing system of furnace No. 7. The flue leading from furnaces Nos. 7 and 9 having been also connected with the brick flue leading to the chimney for furnaces Nos. 3, 6, and 8 during the previous year, a Guibal fan, worked by a small tangent wheel driven by water under high pressure, was added to the brick flue to exhaust the smoke by strong draft. The large brick condensers of furnaces Nos. 3 and 6, and later on those of Nos. 1 and 2, were improved by cutting out every third chamber and connecting the different blocks by a system of inclined earthernware pipes. The so-called water back, consisting of a number of 4-inch tubes filled with running water and passing through one of the chambers nearest the furnace, was first tried with furnace No. 2, and gave such good results that this system of cooling the vapors was finally introduced in all the first two condensers of the different furnaces.

In the year 1882 experiments were made to burn coal, in part, with wood. These experiments gave good results with some of the furnaces, but were discontinued immediately in furnaces Nos. 7 and 9, as the small amount of coal used (300 pounds, in place of one-fourth of a cord of wood) did not generate the required heat. A set of wooden screens to aid the condensation of the vapors was introduced in one of the rear condensers of furnace No. 2, and the same arrangement added to condensers of furnace No. 3. Two new brick condensers were built in place of the wood and glass condensers for furnace No. 8, each being 10 feet wide, 29 feet long, and 30 feet high, covered on top with iron plates cooled by flowing water, and each divided into 2 chambers, the last condenser also provided with sloping zigzag screens. A water-tank condenser like that for furnace No. 7 was also added, differing only in having earthenware pipes in place of the costly iron ones. The iron roofing, being soon destroyed by the acid vapors, was replaced by thick boards, and the use of water thereon for cooling was abandoned in consequence.

The introduction in the line of condensers in 1881 and 1882 of water backs and the new style of Idria condensers, consisting of cast-iron pipes standing in a tank of cold water, also the partitioning of the larger condenser chambers, proved very effective, as demonstrated by the small amount of quicksilver obtained in the rear condensers and the proportional amount in the first condensers of the system thus fitted up. The artificial draft by the Guibal fan also worked so well that no further cases of salivation occurred. Furnace No. 9 was supplied, therefore, with a new Idria condenser like No. 7, with iron pipes and water tank, and new brick condensers containing revolving screens were added during the year 1883.

In 1885 a Guibal fan was placed in connection with furnaces Nos. 1 and 2, and the chimney flue of these furnaces was extended 270 feet farther uphill in 1887.

A detailed account of the furnaces and condensers has been published in the transactions of the American Institute of Mining Engineers, volumes XIII and XIV, from papers by Samuel B. Christy, Berkeley, California, entitled "Quicksilver reduction at New Almaden", and "Quicksilver condensation at New Almaden". A few changes have been made in the furnace work at New Almaden since the publication of these papers.

The addition of 1.5 per cent of fuel in the form of coke and charcoal to every charge of 1,600 pounds of coarse ore in furnaces Nos. 7 and 9 has been discontinued since the beginning of the year 1888, with the results that the vapors are not overheated, and, being less expansive, travel a less distance before they are condensed. The same addition of fuel to the granzita ore had been discontinued long before.

During the year 1888 an electric plant was installed at the hacienda to drive the Guibal fan for furnaces Nos. 1 and 2, which are on the east side of the creek. This plant proved so satisfactory that it was enlarged by the installment of a 16-horsepower dynamo at the Buena Vista shaft, with motors at each of the 2 Guibal fans, the connection being made by 7,000 feet of wire. The power is supplied by a small upright engine at Buena Vista shaft, resulting in a saving in fuel and labor and lessening the danger of fire at the furnace yard. Careful measurements have shown that 0.5 horse power is sufficient to drive one of the Guibal fans at a velocity of 60 to 70 revolutions per minute, which is the ordinary speed maintained when condenser cleaning is not being done and all the doors are closed. During condenser cleaning, with usually 1 condenser door open, the speed is increased to 120 revolutions, more or less, depending very much upon the state of the weather.

FURNACE PLANT AT NEW ALMADEN IN 1890.

Number of furnace.	Continuous.	Intermittent.	STYLE.	Daily capacity in tons.	Class of ore roasted.	Number of separate brick condensers.	Total number of brick condensers.	Number of brick towers.	Number of glass and wood-towers.	Number of water-back condensers.	Number of Idria condensers (a).	Remarks.
1	1	....	Huttner & Scott......	36	Granzita......	6	10	1	21	3	....	Connect with one chimney.
2	1	....	....do	18		11	16	2	14	2	....	
3	1	....	....do	36	Tierras	7	20	1	....	....	....	Connect with one chimney (b).
5	1	....	....do	20		4	10	....	....	....	....	
6	....	1	Old	80/100	Granza	7	16	2	....	2	....	
8	1	....	Huttner & Scott......	24	Tierras	4	8	....	....	2	2	
7	1	....	Ironclad	10	Granza	6	9	1	....	2	1	
9	1	....	Exeli	10		2	c5	....	....	2	1	

a This condenser consists of iron pipes or earthen pipes cooled in a water tank.
b A connection exists also by separate brick flues to another brick chimney common only to furnaces Nos. 7 and 9.
c The second brick condenser connects with the fourth brick condenser of No. 7, both furnaces mingling their fumes at this point.

The continuous efforts made to improve the working of the soot and to replace the manual labor of stirring it on inclined planes, which was the process in use during the last few years, finally culminated in 1888 in the invention by Superintendent Von Leicht of a soot machine by which the soot is cleaned by steam power.

The apparatus consists of a cast-iron pot of nearly hemispherical shape, 3 feet 5 inches in diameter and 18 inches in depth. A perpendicular shaft passes down through the center of this vessel, the lower end of which is provided with 4 screw blades that fit exactly the inner surface of the vessel and are made only 12 inches high, the upper edge of each blade being horizontal. The shaft to which the blades are attached passes through a circular opening in the bottom of the vessel just large enough for revolving easily in it, with a play of about one-sixteenth of an inch. The vessel being filled with the soot to be cleaned (each charge contains 3 cubic feet), the shaft is made to revolve by proper overhead gearing between 30 to 50 revolutions per minute. In these revolutions the soot is scraped up by the blades and drops over the upper edge onto the next blade, and so on, keeping constantly in motion, and thus bringing the small globules of quicksilver in contact with each other, uniting them, when they flow to the center of the vessel and pass out through the hole in which the shaft revolves.

Below the soot vessel a short inclined floor is laid, over which the cleaned quicksilver runs down and passes through a gooseneck into a receiver. The soot vessel has the central part of its bottom, about 12 inches in diameter, on hinges. When the soot has been so far cleaned that only a small amount of mercury remains, the shaft is raised, the hinged bottom is opened, and the soot dropped on the inclined floor, from which it is easily taken up by shovels and placed in buckets to be brought back to the furnace from which it originally came. A portion of it is added to every charge of ore, in order to be burned again.

This soot machine requires about 3 horse power, with a speed of from 30 to 50 revolutions. A charge of soot remains about 1.5 hours. The room in which this machine is set up is well ventilated, and the man who attends to all of the work connected with it, that is, keeping up steam, charging and discharging the soot, flasking the quicksilver, etc., is not exposed to any noxious vapors. From June 1, 1888, to September 30, 1889, there were produced in the cleaning of the various condensers 8,191 buckets of soot, to which were added 1,226 buckets of ashes, making a total of 9,417 buckets, or about 4,708.5 cubic feet of soot and ashes worked by the soot machine, from which were obtained 175,969 pounds of quicksilver, or 2,300 flasks and 19 pounds. The total production of quicksilver at the reduction works during these 16 months was 18,346 flasks, from which it will be seen that the percentage of quicksilver cleaned by the soot machine was 12.54 of the total amount of quicksilver produced. The total expenses of condenser cleaning and working of the soot machines during these 16 months was $1,764.15, which gives 1 cent as the average cost per pound of quicksilver obtained from soot. In this estimate the cost of fuel for steam is not included.

Other improvements made include the setting up of a machine for threading flasks and stoppers at the hacienda machine shop in 1886, by which, if necessary, 100 flasks per day can be handled, and old flasks are made serviceable. In 1887 the inclined flue from furnaces Nos. 1 and 2 was extended 270 feet farther up the slope of the adjoining hill, which added much to the general comfort by carrying the smoke to a higher altitude. In 1888 a new water tank of 3,750 cubic feet capacity was erected at an elevation sufficient to provide all the balance hoists with the necessary water, and in 1889 a pump was set up at the water wheel, by which it is worked, pumping water at night, thereby economizing expense for pumping. In 1888 experiments were made with fuel oil as combustible for the furnaces, but the results were unsatisfactory.

The accompanying drawing shows in detail the plan of the present plant at the New Almaden reduction works.

TRANSPORTATION FACILITIES.

A county road leads from the hacienda to San Jose, a distance of 12 miles. The Southern Pacific Company has 2 railroad branches terminating within 2 miles of the hacienda. The Almaden line of the South Pacific Coast Railway division (narrow gauge) branches off at Campbell station, 5 miles out of San Jose. The Almaden line of the coast division (broad gauge) branches off at Hillsdale, also 5 miles out of San Jose. From Hillsdale to Almaden station the distance is 8 miles, and from Campbell 10 miles. The public wagon road does not extend beyond the hacienda. From the hacienda to the mines on the hill leads a wagon road built with a grade of 9 feet to 100 for a distance of 2 miles to the hill office, and thence 0.5 mile more to Spanishtown. Branches from this road lead to all shafts, the planilla, and the ore bins. The whole length of main road and branches combined is 10.8 miles. Another wagon road leads to the company's woodlands, a distance of 5 miles.

WATER SUPPLY.

The water supply on the hill is derived from 3 sources, springs which furnish between 30 and 55 gallons per minute, or from 40,000 to 80,000 gallons per 24 hours, according to season. The main supply comes from the so-called Black Hills, a part of the coast range of mountains, south of the mines, about 2.5 miles distant. The water is carried in pipes and distributed in water tanks, from which the branch pipes lead to the shaft houses and dwellings. The amount of water stored in the tanks on the hill is 157,400 gallons. There are 8 tanks of 15,000 gallons capacity each, 2 of 10,500 gallons, 2 of 2,700 gallons, and 5 of 2,200 gallons. The main Black Hills pipe and branch pipe lines are composed of 2.5-inch pipe, 4,750 feet; 2-inch pipe, 4,500 feet; 1.5-inch pipe, 4,050 feet, or a total of 13,300 feet, and branches of 2, 1.5, 1, and 0.5 inch pipe, together, 14,800 feet. The total length of pipes is 28,100 feet, or 5.32 miles.

As protection against fire there are 12 hydrants, each provided with 50 feet of hose, distributed at the different shaft houses and in front of the office and store.

The water supply to the hacienda and furnace yard comes from 3 springs and from Alamitos creek. A dam across Alamitos creek diverts the water into a wooden flume 14 inches wide and 12 inches high and is carried through the flume a distance of 2,500 feet to a pressure box at the south end of the furnace yard. From this pressure box a sheet-iron pipe, 14 inches in diameter and 845 feet long, brings the water to the penstock of the overshot water wheel, which drives the machinery of the machine shop, the blower for the blacksmith shop, a 28-inch circular saw for sawing wood, a lathe, and a 16-inch circular saw in the carpenter shop. When not used for this purpose it provides power for a pressure pump, which delivers water by a 4-inch and 6-inch pipe, 650 feet long, into the large water tank as supply for the balance hoists. The water wheel has a diameter of 20 feet, is 6 feet wide, and gives, according to the amount of water available, from 3 to 5 horse power. Surplus water from the penstock of the water wheel passes through 300 feet of 6-inch pipe into a 6 by 12 inch wooden flume 2,813 feet long, that runs along the foot of the hill on the west side of the hacienda village and distributes water for domestic purposes. The water escaping from the wheel runs into a ditch, which carries it along the road through the village and is used for irrigating purposes. The total length of pipe lines is over 8,000 feet, consisting of 6, 4, 3, 2, 1.5, 1.25, and 1 inch pipe.

There are 5 large storage tanks; 2 of these, with an aggregate capacity of 6,900 cubic feet, are located 300 feet above the floor of the furnace yard. These tanks are supplied with water by a spring in Deep gulch, carried by a V flume 1,400 feet in length. The water is used for fire plugs, of which there are 11 2-inch hydrants and 10 1.5-inch hydrants distributed throughout the furnace yard. A tank of 4,530 cubic feet capacity is located on the hill slope west of the furnaces, 80 feet above the furnace floor of Nos. 7 and 9, supplied from the overflow of the higher tanks just mentioned.

SURVEYING.

It is estimated that up to the present time the total distance driven in the New Almaden quicksilver mines, in the form of tunnels, drifts, shafts, crosscuts, inclines, and winzes, is over 46 miles. From ore stopes over 1,500,000 tons of material have been extracted. The bulk of this network of excavations is included in an area 6,000 feet square, and has a vertical extent from the summit of Mine Hill to the lowest level of nearly 2,300 feet.

MINING.

The place of the first prospect work was on the southeast slope and 160 feet below the top of Mine Hill, which is the highest summit of the ridge on which the mines are located. The work of exploration consisted of a tunnel driven into the hill that intersected some of the small veins of cinnabar. The work progressed slowly under the supervision of Castillero and Padre Real, one of his partners in the property, with a few Indians to do the work. In December, 1846, the property was transferred under certain conditions to the firm of Barron, Forbes & Co., of

Mexico. Under the new management the mine was brought into better shape, and it may be said that from that date the mining operations at New Almaden began. The early miners were Mexicans, and the first underground work plainly shows their style of working. The ore was mined without any regular system, being in a great measure taken out by tunnels driven into the hillside, with small upraises or downward inclines that followed the indications of cinnabar, or by shallow shafts that were simply circular holes in the ground, provided with notched timbers for climbing up or down to bring the broken ore to the surface in rawhide baskets, called "serones", that were carried by the miners on their backs, as it is seen to-day in many of the Mexican mines, the load being sometimes as much as 250 pounds. This style of mining was sufficient for the time, as the ore bodies were found near the surface of the ground and were of considerable extent. Neither horses nor mules were employed in hoisting, nor were there any tramways or cars. At the surface the ore was cleaned from waste rock and then carried by mules in sacks down to the reduction works, located on the creek at the foot of the mountain, about 1,200 feet below the mine.

In 1851 a large adit was begun to facilitate the extraction. This tunnel, called the "main tunnel", pierces the hill 320 feet below the summit. It started on a course north 45° west (magnetic) from the south side of Mine Hill (*a*). The tunnel for a double track of cars was made 10 feet wide and 10 feet high, with arched roof, supported by timbers of redwood 6 inches square in cross section. The timber sets were 2 feet apart and covered with lagging. The length of this main tunnel was 807 feet. In front of this tunnel a large level place was constructed with the débris from the mine for a planilla or cleaning floor, on which the ores were cleaned from waste rock and sorted. The ground above this tunnel proved to be very rich in mineral, the ore ground reaching to the very summit of the hill. In it were situated many valuable deposits, known as the "labores" (*b*) of San Rosalio, San Pablo, San Antonio, San Ricardo, and San Pedro, somewhat irregular in their course, but all dipping toward the north and west. These labores proved very valuable and yielded large quantities of high-grade ores. This upper ore ground had an extension of 230 feet wide by 400 feet long, dipping in several ore bodies from the surface to the 300 level.

Following the indications in depth, a shaft was sunk at the distance of 769 feet from the mouth of the main tunnel, called the "main shaft", and provided with 2 compartments, 1 for hoisting and 1 for ladder way. A whim round of 38 feet in diameter, worked by mules, supplied the power for hoisting during the first years, and was afterward replaced by a steam engine supplied with steam by a boiler set up at the mouth of the tunnel. The bottom of the shaft finally reached the 600 level at a depth of 573.76 feet below datum point, or 242.25 feet below the floor of the main tunnel.

In November, 1857, another adit, then called New tunnel, and at present known as Day tunnel, was begun from the northeasterly slope of Mine Hill, at a point 459 feet below the mouth of the main tunnel, for the purpose of draining the ground in the 600 level, which the main shaft had reached, and also to provide a tramway for all the ore coming from this part of the mine. Its progress was stopped by the injunction issued by the United States court, after reaching the distance of 508 feet. The injunction having been raised in 1861, the work on the tunnel was again resumed, and continued with various short interruptions until it had reached a total length of 1,887 feet, at which point it connected with an interior shaft, called the Junction shaft, sunk from the upper works on the 600 level (571 feet below datum). This shaft was started in April, 1862, from the northern end of the ore ground on the 600 level and reached the Day tunnel level on August 1, 1864.

The main shaft had opened up the 10-fathom level (377 feet) (*c*), the 27-fathom level (480 feet), Bestor level (507 feet), and Santa Rosa or 600-foot level (573 feet). Thus far the mine had been opened when the Quicksilver Mining Company became the owners of these lands and mines and assumed the entire control of the works, on November 1, 1863.

The deposits of ore had been explored down to the 600-foot or Santa Rosa level, and great ore chambers developed, of which the most prominent were the San Ricardo (194 feet); San Antonio (214 feet); San Ygnazio and San Clemente; La Cruz, on the main tunnel level; Dios te Guia (400 feet); Far West (400 feet); Ardilla (400 to 500 feet); Ventura (530 feet); Buenos Ayres (560 feet); Marysville (585 feet), and North Ardilla (from 550 to 600 feet). These ore chambers formed irregular excavations, often overlying each other in the vein, which varied in width and inclosed deposits of ore from 10 to 30 feet in thickness, the cinnabar showing an intricate network of veins within the great mass of gangue. The cinnabar veins, called "hilos", when small, often assumed a persistent regularity in a north and south direction, the walls of the gangue, or vein matter, generally being soft or of indurated clay schist or serpentine. The upper portions of the mine above the main tunnel level were nearly exhausted; some of the labores had fallen in, were dangerous to work, and had to be abandoned. The Quicksilver Mining Company also took possession of all the outside mines that extend through their property from Mine Hill northwesterly, a distance of 3.75 miles, on a ridge which runs in that direction.

Beginning at the northwest boundary of the company's lands and progressing southeasterly to Mine Hill were

a The summit of Mine Hill is the datum point for all elevations underground or on the surface, the point being marked by a monument set in the ground and covered by an iron cross. The main shaft is almost directly below this monument.

b "Labor", plural "labores", is the Spanish name for "ore stope" or "ore stopes".

c Figures in parentheses are elevations below datum point.


PLAN
OF THE
NEW ALMADEN QUICKSILVER MINE
Scale 290 feet to one inch.
1889.
(Extracted from Monograph XIII, U.S. Geological Survey.)
Santa Isabel Shaft
Water tunnel
2000 Level North
Section Sheet XI.
Section Sheet XII.
Buena Vista Incline
Randol tunnel
Randol Crosscut
West Drift
Theatre Drift
Rattlesnake Drift
Great Eastern tunnel
Day tunnel incline
Clifton
Saint George Shaft
Victoria
Osbuna
O'Brien
Bur Fider
Juan Marquez Drift
Olmedo Drift
Cornish Drift
Burt's Drift

MOUTH (326)
Main Tunnel
300 level
Junction Shaft
San Francisco Shaft (78) Collar
San Cristobal Tunnel
Washington - Santa Isabel Incline (1035)
South Saint George Tunnel
MOUTH (223)
Almaden Shaft (21) Collar
Relief Drift

the following mines or prospects: (1) the Senador, (2) the Purissima, (3) the San Antonio, (4) the Enriquita, (5) the Providencia, (6) the America, (7) the San Pedro and Santa Mariana, (8) the San Francisco, this last one being on the south slope of Mine Hill, but disconnected from the workings of the main tunnel. There were also a great number of tunnels and prospect shafts scattered wherever indications of ore had been found.

The general outlook was not very encouraging. The total length of all the drifts, tunnels, shafts, and winzes opened in the outside mines amounted to 29,919 feet, not including any of the workings in the Almaden mine proper, opened from the main tunnel and Day tunnel. The great ore bodies had already been systematically worked during 14 years. The great Ardilla labor, one of the largest and richest ore deposits, had been worked out to the northwest, and the mine, having produced so largely for many years, was now confined to a small extent of ground. Other ore bodies were still unknown, and the prospects for the future were doubtful.

All excavations in the mine worked as mineral ground, including ground strictly productive of cinnabar, but not including all the mouths of tunnels and adits, were contained in a parallelogram of 450 by 600 feet.

THE DAY TUNNEL had intersected a large area of barren ground, and was connected with the upper workings in 1871, when it gave facilities for ventilation, transportation, and drainage that were much needed. The principal vein that had been followed northward dipped northward, and it was expected that the continuity of the ore would be found in that direction. A small branch of ore observed in the beginning of 1865 extended northward from the Great Ardilla labor, and widened out and improved gradually until 20 men were here employed in breaking ore. When this ore body finally gave out, in August of the same year, another ore deposit was discovered on the 600-foot level. This ore deposit, called Santa Rita labor, opened out into one of the most valuable deposits ever known in the mines. The ore was of the richest quality, and up to the end of 1867 yielded alone 5,149 tons of ore. The labor extended from the north Ardilla, on the 600-foot level, in a northerly direction and almost horizontally, a distance of 375 feet. Here it divided into 2 branches, one called the Santa Rita East the other the Santa Rita West. The Santa Rita East extended a further distance of about 200 feet, the Santa Rita West more than 300 feet. The width of this large ore deposit varied between 30 and 100 feet, with a height or thickness of ore ground from 20 to 40 feet. The Santa Rita proper, discovered in 1865, became exhausted in 1871, having yielded a total of 11,616 tons of rich ore. The Santa Rita West was discovered in 1868 and exhausted in 1870. It yielded a total of 5,937 tons of ore. Altogether the labores named Santa Rita produced a total of 25,294 tons of ore, that averaged not less than 10 per cent quicksilver.

While these discoveries took place in the Santa Rita ground the other parts of the mine were still worked and produced some ore, and the more prominent labores were some above the 300 level, and below this level the Pruyn, La Cruz, Dios te Guia, 10-fathom and 27-fathom levels, the Collegio, Buenos Ayres, Sacramento, Far West, Santa Rosa, the Velasco workings, and some of the outside mines, all adding their quota to the general ore production. As the works progressed still farther north and extended east and west, the ore bodies grew smaller and more scattering, spread out and dipped more steeply north and west. A notable exception in this general downward dip was the connection with the ore body known as the Velasco group that rose upward and was opened by the Velasco tunnel in 1864 (400 level), and another tunnel called Road tunnel. Both tunnels furnished small deposits of high-grade ores, which reached to the 500 level, and descended from what was known as the Theater labor, worked in 1872, steeply to the 600 level. Here the ore disappeared and only barren vein matter remained.

The northwestern explorations opened up the labores known as the Giant Powder (620 feet), the Ponce (624 feet), the New Santa Rita West (640 to 700 feet), discovered in 1871, the Santa Ana, Ossuna and Victoria (637 to 776 feet). These ore bodies apparently formed the northern boundary of the pay chute. The vein, here smaller in size, took a sudden steep plunge down to the 900-foot level with only small detached ore deposits, and in 1873 the mine gave little promise of continuance.

As the bodies of ore discovered during the past years had continued in their northward course with a dip north and west, the only remedy remained to search for the new ore bodies in that direction and at a greater depth, the Day tunnel being too high for these explorations.

On June 10, 1871, ground was broken for a new working shaft. This shaft, called the Randol shaft, named after the manager of the property, was located on a spur of Mine Hill at an elevation of 426 feet below datum point, 359.5 feet above the mouth of Day tunnel, and about 440 feet north of the rich workings in the New Santa Rita West. The Randol shaft reached the vein 1,151 feet below datum, on the twelfth level. The explorations from this shaft were of the greatest importance for the future of the mine, as they disclosed two prominent ore chimneys, one lying east, the other west, of the shaft. In the western ground they continued almost without interruption from the Great Santa Rita labor (700 level) down to the 2,200-foot level of the mine, while in the eastern ground the ore deposits began at the 900 level and extended to the 1,900 level.

These ore bodies have had a width of 100 to 300 feet, and a thickness from 12 to 20 feet and more, and have up to the present time yielded the regular supply of ore. With this same object in view, other shafts were sunk from time to time and connected by underground workings with the general system from the Randol shaft, viz: the Santa Isabel shaft, started in 1877, reaching down to the 2,300-foot level; the Buena Vista shaft, started in 1882, also reaching to the 2,300-foot level, and the Saint George shaft, in 1887, reaching to the 1,200-foot level. South of Mine

Hill the Washington shaft, begun in 1881, reached down to the 1,100-foot level. The Santa Rita shaft was opened in 1884 as a prospect shaft from the ground above the Santa Rita labor, and sunk to the 900-foot level, piercing through the old Santa Rita labor.

HACIENDA TUNNEL.—The mouth of this tunnel is 1,800 feet south 15° west (magnetic) from the hacienda office in the ravine of Alamitos creek, which flows through the furnace yard of the hacienda. Its mouth is 1,202 feet below the summit of Mine Hill. The course is north 70° 25′ west from its mouth for a distance of 1,848 feet, when it takes a more northerly deviation for 492 feet, then returning again to an almost westerly course for 496 feet; total length, 2,836 feet. The tunnel was started in January, 1867. Its object was to serve as a drain tunnel for the mine and for transportation. After having advanced a distance of 486 feet work was stopped. The developments in the Cora Blanca mine, made in 1874, with a rich ore body in sight, and apparently crossing the hacienda tunnel line, have new encouragement, and the tunnel was continued again in December, 1874, this time with machine drills, to insure its speedy completion into the ore ground of the Cora Blanca mine. In October, 1876, it had reached a distance of 2,135 feet without intersecting any vein. Work was then temporarily stopped, while the Gray shaft was sunk to the 1,000-foot level. The tunnel work was again taken up in January, 1878, and, having reached a total distance of 2,340 feet from the mouth, the direction of the tunnel line was changed to a course of almost due west (magnetic) to intercept the productive vein of the Cora Blanca mine, which indicated a pitch in that direction, and a large vein, 30 feet wide, was intersected, on which branch drifts were run north and south for 130 feet. The indications, however, were so unfavorable that all further progress was stopped in August, 1879.

THE CORA BLANCA MINE.—This mine is situated on the east slope of Mine Hill in a direction a little south of east of its summit and from it about 1,300 feet distant. Its vein is entirely disconnected from the vein system of the main mine, running on a true north and south course and dipping east. The ore deposits were discovered in 1864, and produced 1,800 cargas (*a*) of high-grade ore during the first 3 months. The openings then consisted simply of surface works, opened by tunnels. The ore was found in bunches in a vein close to the surface. These upper works were soon exhausted. In 1873 a shaft was sunk, called the Cora Blanca shaft, collar 574 feet below datum, which struck ore at a depth of 53 feet. Steam hoisting works and a pump were erected. A tunnel that had been started in the ravine, 1,000 feet east from the shaft, called the Deep Gulch tunnel, connected with the Cora Blanca shaft in 1874, its elevation being 770 feet below datum (summit of Mine Hill). In 1875 the Cora Blanca mine produced 6,262 cargas of rich ore. The yield lessened in 1876, the vein becoming much harder below the level of the Deep Gulch tunnel (800 level). Another shaft, called Gray shaft, was sunk in 1876, about 660 feet east of the Cora Blanca shaft, and alongside of the Deep Gulch tunnel, 350 feet from its mouth, to prospect the vein at greater depth. The steam hoist and pump were transferred from the Cora Blanca shaft, and the shaft was continued down to the 1,100-foot level. As all efforts to find ore below the 800 level proved futile, the mine was abandoned in 1879. The Cora Blanca shaft has connection with the 600, 700, 800, and 900 levels; the Gray shaft has stations at the Deep Gulch tunnel level (764 feet), the 900, 1,000, and 1,100 levels (846, 944, and 1,045 feet below datum).

THE SAN FRANCISCO MINE was opened in 1864. It is situated on the south slope of Mine Hill, about 650 feet southwest from main shaft. The vein has a northwest and southeast course, and had originally been opened by 2 adits, the upper San Francisco and the lower San Francisco tunnels. As the work progressed downward the vein improved in character, but the yield was irregular. The workings were connected with the main tunnel by the San Francisco branch tunnel in 1869. The ore production of the San Francisco mine in 1866 amounted to 7,238 cargas, reached 13,686 cargas in 1867, and diminished to 8,661 cargas in 1868. In 1868 a shaft, called the San Francisco shaft, was sunk from the 300 level, and in 1869 connected with the Santa Rosa or 600 level. (*b*) It was provided with a steam hoisting engine, set up at the shaft on the 300 level. The labores on the 300 level and above the Manilla and Arcial on the 400 level and the Warren on the 500 level were the most prominent, the last producing nearly 4,000 cargas in 1871. In June, 1874, the New World labor was discovered from the 600 level. This labor extended 220 feet in length, more than 80 feet in width, with a height from 10 to 20 feet, and produced high-grade ore. From the surface down to the 500 level the vein maintained an almost perpendicular position. The vein of the San Francisco mine has an average width of from 50 to 60 feet. It has been prospected over a length of 900 feet, and was found productive over a length of 500 feet. In the New World labor the vein took a pitch of about 45° southwesterly and finally connected with the 800 level, the Santa Clara, which is a continuation of the Day tunnel. This continuance of the ore body led to the establishment of Washington shaft, first called Garfield shaft, which was begun in November, 1881, at a point 470 feet southwesterly from the San Francisco shaft. The Washington shaft starts from the surface, its collar being 176 feet below the summit of Mine Hill. In June, 1882, 416.5 feet of the 3-compartment shaft had been sunk and met with the upraise, 142.5 feet high, from the Santa Clara drift, a total of 559 feet, then continued down to the 1,100 level, which it reached in January, 1885. The 800, 900, 1,000, and 1,100 stations completed, vigorous prospecting was carried on. However, the ore bodies found were limited in extent and reached only to the 850 level. Below this the vein became flatter and spread out in every

a A carga is a Mexican load of 300 pounds.

b The San Francisco shaft has stations at the 300, 400, 500, and 600 levels, at 320, 370, 465, and 560 feet, respectively, below datum.

direction, while the ore showed only in small branches. The regular prospect work from the shaft was discontinued in the winter of 1887.

The San Pedro and Santa Mariana mines have been only superficially developed. Shallow shafts or inclines and prospect drifts of short distances were driven in a very irregular way by prospectors in following the ore indications, and as they were not very encouraging little attention was paid to systematic development. The 2 prospects formed simply an adjunct to the larger mines. In November, 1864, altogether 1,608 feet of tunnels and shafts had been drifted in the San Pedro and 1,547 feet in the Santa Mariana ground. The vein has apparently a connection with the San Francisco vein. The ore production in San Pedro and Santa Mariana virtually stopped in 1868, although small amounts of ore were broken by tributers from time to time in later years.

The America mine, previous to 1864 called "Bull Run", was opened in September, 1863. The mine is situated 1,500 feet northwesterly from the San Pedro workings. The surface of the ground shows much broken vein matter. A tunnel called Upper America, driven 175 feet in length to drain the upper workings, which had started with a small shaft, was completed in July, 1865. Its mouth is on the south slope of the hill, about 100 feet perpendicular below the shaft before mentioned. The ore veins in descending become narrow and almost perpendicular. Another tunnel was started 120 feet lower, called the Lower America tunnel, and driven a distance of 750 feet, as the ore bodies pitched a little to the north. A shaft 216 feet deep was then sunk from the surface. Considerable water was found, and gave much trouble. As the expense of erecting pumping works was not likely to be compensated by the ore in sight, further work was stopped, the engine was removed, and a long tunnel, known as the Great Western, was projected and driven some distance. The ground became very hard, the distance to be driven (1,170 feet) was considerable, and as only 150 feet in depth were gained by it, the work was stopped in 1867. Some metal was broken from the old workings in 1868, 1869, 1873, and 1874 by tributers.

In October, 1885, a new 2-compartment shaft was sunk, with steam hoisting works and pump, about 200 feet southwest from the old shaft. The mouth of this shaft is 147 feet below datum point. It reached the 700 level in March, 1887.

Stations were established at the 500, 600, and 700 levels, at 411, 506, and 601 feet below datum, the 500 level connecting with the lower America tunnel. The developments from these upper levels were unsatisfactory, and the 700 level was very wet. The shaft was sunk 200 feet deeper in the year 1888, with the intention of connecting it with a crosscut from the 1,400 level, Santa Isabel shaft. A large outburst of water injured the shaft in July, 1888, and the unstable character of the ground, combined with the great cost of sinking 400 feet deeper, also the little encouragement which the lower developments had given, resulted in the temporary abandonment of this mine.

The Providencia mine is about 4,800 feet southwesterly from the new America shaft. It consists mainly of surface works that were opened before 1864. Several small drifts were run into the south slope of the main ridge, which is all vein rock. One, called the Providencia tunnel, 711 feet below datum, reached ore at the distance of 120 feet. Another, the Ravine tunnel, 866 feet below datum, was started in 1864, 155 feet below the Providencia tunnel. Its whole length, straight, is 470 feet, with a branch 142 feet. Some prospecting was done in 1867 and 1871, with poor results. This mine has remained idle ever since. It is stated that it produced several thousand cargas of superior ore.

The Enriquita mine is situated 2,000 feet northwest from the Providencia tunnel, on the south slope of the main ridge. The ore body had the shape of a flat arch, its western end with the course north 33° west, the east end south 68° east (magnetic), and a total length of 550 feet, not continuous, but with interruptions in length as well as in depth. This mine was opened in 1859. 3 principal tunnels had been driven—the main tunnel, the Federico tunnel (870 feet below datum), and the Esperanza tunnel, the first one being the lowest. From these tunnels the ore bodies were developed by shafts, winzes, and branch drifts. The upper works being nearly exhausted, the Eldredge tunnel was started in 1863, at the lowest point obtainable in the ravine of Capitancillos creek (1,180 feet below datum), for the purpose of gaining greater depth in the mine and to ventilate and drain the upper works, which had been troubled by foul air and water. In 1865 the Eldredge tunnel had reached a distance of 619 feet; 60 feet were added in 1867. The work was continued in later years from time to time until, in 1874, the tunnel had reached a total length of 875 feet. In 1874 work was again resumed in the upper mine, and prospecting was done in the San Andreas ground, where 282 feet were drifted. Very little ore, however, was found. At the end of March, 1875, all work was discontinued at the Enriquita mine, as the low prices of quicksilver did not encourage prospecting at a point so remote from the general works.

The Purissima mine was worked to a small extent in 1860, and it is said that rich ore was found. In 1864 the whole prospect work aggregated 194 feet of drifting and sinking.

The San Mateo shaft of this mine, which lies about three-quarters of a mile northwesterly from the Enriquita mine, was sunk in 1874 through ore ground a distance of 87.5 feet. The ore, however, appeared only in small branches. Further explorations were stopped for the same reasons which led to the suspension of work at the Enriquita.

The San Antonio adjoins the Purissima ground on the east; development, 588 feet of drifting and sinking.

THE SENADOR MINE is nearly 1 mile northwest from the San Mateo shaft on the north slope of the ridge, and within one-quarter of a mile from the western boundary of the company's lands, adjoining here the lands of the Guadalupe Mining Company. A small shaft and tunnel were driven and sunk, and some 400 cargas of good ore were taken out. A tunnel 40 yards lower in elevation was driven in 1873. No work has been done at this mine since then, when the total length of drifts and shafts amounted to 480 feet.

The illustration of the underground workings shows the present condition of the New Almaden mine. The table following gives the co-ordinates and elevations of the different shafts and tunnels, the datum point for co-ordinates being a point 30 feet distant on the line and outside of the Hacienda tunnel, marked by a monument post. The datum point for the elevations is a monument on the summit of Mine Hill, from which all levels on the surface as well as underground have been determined. This point is 1,755 feet above sea level.

CO-ORDINATES, ELEVATIONS, ETC., OF PRINCIPAL SHAFTS AND TUNNELS.

[Feet.]

No.	SHAFTS AND TUNNELS.	CO-ORDINATES FROM MONUMENT H.		Elevation of collar of shaft below datum point.	Lowest level opened.	Absolute depth from surface.
		North.	West.			
1	Main shaft (a)	1,760	4,945	317	700	345.0
2	Randol shaft (b)	3,535	5,445	426	1,800	1,340.0
3	Santa Isabel shaft (b)	4,105	6,595	728	2,300	1,526.0
4	Buena Vista shaft (b)	5,060	5,990	885	2,300	1,375.0
5	Saint George shaft (a)	3,020	6,240	570	1,200	548.5
6	Almaden shaft (b)	1,990	6,245	275	700	484.5
7	Santa Rita shaft (a)	2,480	5,015	125	900	761.5
8	Washington shaft (b)	830	5,605	176	1,100	880.0
9	San Francisco shaft (b)	1,130	5,245	78	600	485.0
10	Cora Blanca shaft (a)	1,575	3,565	574	900	275.0
11	Grey shaft (a)	1,390	2,925	618	1,100	457.5
12	America shaft (a)	2,240	8,195	147	700	809.5
A	Main tunnel	1,245	4,380	326	(c)	....
B	Day tunnel	3,880	4,000	785	(c)	....
C	Hacienda tunnel	25	70	1,202	(c)	....
D	Deep Gulch tunnel	1,305	2,575	770	(c)	....
E	Randol crosscut	4,245	5,555	760	(c)	....
F	Great Eastern tunnel	3,240	4,190	528	(c)	....

a Closed. b Open. c At mouth.

The Junction shaft goes from the 600 level (Santa Rosa) to Day tunnel, or 800 level; co-ordinates, 2,170 north and 4,810 west.

The shafts of the outside mines are not comprised in this list; neither are the tunnels, as they are of little importance now. The above shafts are those that are or have been provided with steam hoisting works. Those mentioned as opened are in first-class working condition at present date. The tunnels or adits are all open, with the exception of the Hacienda tunnel.

The main horizons or levels are opened from these shafts at distances of 100 feet, more or less, perpendicularly, the absolute elevation being determined by local necessities, as connection with levels from other shafts already opened, or with adit tunnels, etc.

The aggregate length of all shafts, winzes, drifts, tunnels, and crosscuts was 46.35 miles at the end of December, 1889, not including many prospect drifts that were run during the first few years of mining at Almaden and Enriquita, as no record has been kept of these places.

The usual method of prospecting for ore during the first period of mining at Almaden, that is, from 1845 to 1870, nearly, consisted in crosscutting the vein and then following the indications of the small cinnabar veins, called by the Mexican miner "hilos", that usually led to larger deposits. This method was followed in the upper portions of the vein, where the ore bodies occupied all possible positions, sometimes near the middle of the body of vein, sometimes near the hanging wall. Later explorations in depth demonstrated, however, that ore bodies almost persistently followed only the contact of the hanging wall (called "alta" by the Mexican miners) with the vein. The explorations, therefore, were always along the alta wall of vein, no matter how tortuous the direction might be. The ore ground above the 800 level was much more irregular and scattered than that below this depth, where 2 prominent ore chutes were developed, which could be relied on with almost positive assurance within certain limits. One of these chimneys, or ore chutes, is situated on the northeast side of the Randol shaft, the other on the southwest side, and they have been commonly called the north and south veins. The north vein has continued without interruption from the 900 level to the 1,900 level as ore bearing, but has been opened as far as the 2,300 level, the latter distance being barren. The south vein has continued, without any interruption whatever, as an ore-bearing vein from the top of Mine Hill down to the 2,200 level, a total distance, measured on its dip or slope, of nearly 3,800 feet. Below the 2,200 level this vein has proved barren. Branch veins were found in the hanging ground of these main veins, on the north vein as well as on the south vein. Their extension upward or downward, however, is not continuous, and the ore bodies were developed by crosscutting from the main levels. This second vein system is so irregular and uncertain that no reliance can be placed on its being met with by crosscuts. It is only by a very broad and general comprehension of the vagaries of the cinnabar ore bodies that anything like a favorable result might be anticipated. This must explain the enormous amount of underground work done in these mines. The ground explored by the different shafts, including the Washington and Cora Blanca, occupies an area of over 1 square mile.

The early developments of the New Almaden mines were by adits and small shafts, as they are commonly used by the Mexican miners, who were the first laborers employed. The unknown structure of the vein and its apparent irregularity made it difficult during the first period of mining to decide upon a system to be followed throughout. The introduction of English miners (Cornishmen) brought about a decided change in the methods of working, and the use of steam hoisting works and pumping engines obliterated all differences that might have existed in the deep mining employed at New Almaden and elsewhere. Some local customs and arrangements exist, however, and to explain all these a full description of the methods of mining as pursued at New Almaden will be given in the following pages.

At the present day ore is brought to the surface from great depths, and the underground work is entirely done through shafts. From these shafts levels are excavated at regular intervals of about 100 feet. From these levels the prospecting work is prosecuted by drifting, sinking, or upraising, as circumstances may require, along the vein, or crosscutting the hanging wall or foot wall in search of other veins or ore bodies. These explorations are not confined to one level at a time, but include several. The ore bodies when found are usually extracted by stoping out overhead, although underhand stoping is often resorted to.

SHAFTS.—The shafts resemble each other in general features. They are vertical and timbered throughout. The size of their timbers and the distance between sets of timber vary according to the size of the shaft and the nature of the ground through which they have been sunk.

The Randol is the principal working shaft, and has held this place during the past 16 years. It has only 2 compartments, one for hoisting, the other originally for pump work, but at present only used for ladder way. Its size is 4 by 9 feet in the clear, the hoisting compartment being 4 by 4 feet, the pumping compartment 4.5 by 4 feet, and a 6-inch partition between the 2 compartments. It is closely cribbed with 8-inch timbers from top to bottom. The collar of the shaft is 426 feet below datum point. Its actual depth to the bottom of the sump is 1,340 feet. Beginning at the 800-foot station (758 feet below datum), connected with the surface by an adit level, the Randol crosscut, the shaft is provided with stations at every 100 feet of depth, the lowest being the 1,800-foot station, and level, at 1,751 feet below datum.

The Santa Isabel shaft has 3 compartments, 2 for hoisting and 1 for pumping. The shaft is 13 feet 8 inches long by 4 feet 6 inches wide in the clear, each hoisting compartment being 3 feet 8 inches by 4 feet 6 inches; the pump compartment 5 feet by 4 feet 6 inches. The partitions between the compartments are 8 inches thick. The timbering consists of open sets of 10-inch timber with lagging from the collar down for a distance of 60 feet, followed by close cribbing with 8-inch timbers for 240 feet; then again open sets of 10 by 10 inch timbers, and farther down of 10 by 12 inch timbers. The open sets of 10-inch timber are 3 feet between centers; the 10 by 12 inch sets are placed at 3 feet 6 inches between centers. The pump compartment also contains the ladder way. The collar of the shaft is 728 feet below datum; the actual depth to bottom of sump is 1,526 feet. From this shaft stations are established at the 1,400, 1,700, 1,900, 2,000, 2,100, 2,200, and 2,300 levels, represented, respectively, by 1,303, 1,653, 1,856, 1,957, 2,035, 2,134, and 2,234 feet below datum point.

The Buena Vista shaft is 5 by 15 feet clear inside of timbers, and has 2 hoisting and 1 pumping compartments. Each hoisting compartment is 3 feet 8 inches wide. The pump compartment is 6 by 5 feet, and is provided with ladder way. The shaft is closely cribbed from the collar down for 50 feet with 12-inch timbers. Then follow open sets of 12 by 12 inch timbers, 3 feet between centers. The partitions are 10 inches thick. The collar of the shaft is 885 feet below datum point, the bottom 2,260 feet below datum, or 509 feet below sea level, making a clear depth of shaft of 1,375 feet. An adit level connects with the shaft 306 feet below the collar, used as drain level for the water raised by the pumps. Only 2 stations are established in this shaft, 1 at the 2,100-foot level (2,046 feet below datum), and 1 at the 2,300-foot level (2,246 feet below datum). Explorations below the 2,100-foot level having been suspended, the shaft has filled with water to that level.

The Saint George shaft is 4 by 8 feet in the clear, with 1 hoisting and 1 ladder-way compartment. Its total depth is 548.5 feet, including the sump. The collar of the shaft is 570 feet below datum point. The timbering consists of open sets of 10 by 10 inch timber, 3 feet between centers. Stations have been established at the 800 level (750 feet below datum), the 1,000-foot level (930 feet below datum), and the 1,200-foot level (1,105 feet below datum).

The Almaden shaft is 4 by 9.5 feet in the clear, with 1 hoisting and 1 pumping compartment, the latter containing at present only a ladder way. The shaft is timbered with open sets of 10-inch timber, 3 feet 3 inches between centers. The collar is 275 feet below datum point, the bottom at 759 feet; total depth, 484.5 feet. Stations have been established at the 500, 600, and 700 levels. This shaft is not connected with the other parts of the mine.

The Washington shaft, 4 by 14 feet in the clear, has 3 compartments, 2 for hoisting and 1, originally used for pumping, containing now only the ladder way. Its collar is 176 feet below datum point. The levels established are the 400 at 368 feet, the 800 at 741 feet, the 900 at 841 feet, the 1,000 at 941 feet, and the 1,100 at 1,041 feet below datum. There is also the 850-foot level at 795 feet, but without station at the shaft and connected by a short crosscut only. The total depth of the shaft from collar to bottom of sump is 880 feet.

The Santa Rita, America, Cora Blanca, Gray, and Main shafts are 2-compartment shafts.

The San Francisco was originally an underground shaft, and has only lately been driven to the surface, its collar being now at 78 feet below datum point, while originally it only started from the 300-foot level (320 feet).

The Santa Rita shaft was begun in December, 1884, for the purpose of prospecting the ground above and below the old Santa Rita labores. It reached its total depth of 761.5 feet in March, 1886. The greatest depth sunk in 1 month in serpentine was 150.5 feet. Its collar is at 125 feet below datum. The shaft is connected with the Juan Vega tunnel (300 level), the 800 level, 780 feet below datum, and has a station and level at the 900 (880 feet below datum).

The Main shaft starts from the 300 level (main tunnel) and has stations and levels as follows: 10, 20, and 27 fathom levels (at 380, 445, and 482 feet below datum), Bestor's level (at 510 feet), the Santa Rosa or 600 level (at 571 feet), the Little Plat level (at 600 feet), and the Relief or 700 level (at 667 feet below datum).

The America, Cora Blanca, and Gray shafts are timbered with open sets of 10 by 10 inch timbers, 3 feet apart, the partition timbers being 6 by 8 inches in section.

Shaft timbering.—The timbering of the shafts is done from the surface downward as the sinking progresses. Sawed redwood timbers are used for the framework of the sets. These sets are secured horizontally, either close together in very heavy ground (cribbing), or at certain distances from each other (open sets). The open sets are kept apart vertically by posts or studdles at their corners. Between the sets the ground is covered by lagging 3 inches by 6 inches in section, placed upright, and secured tightly against the timbers by wedges driven between the ground and the lagging. Cross-timbers for the partitions form a part of every set.

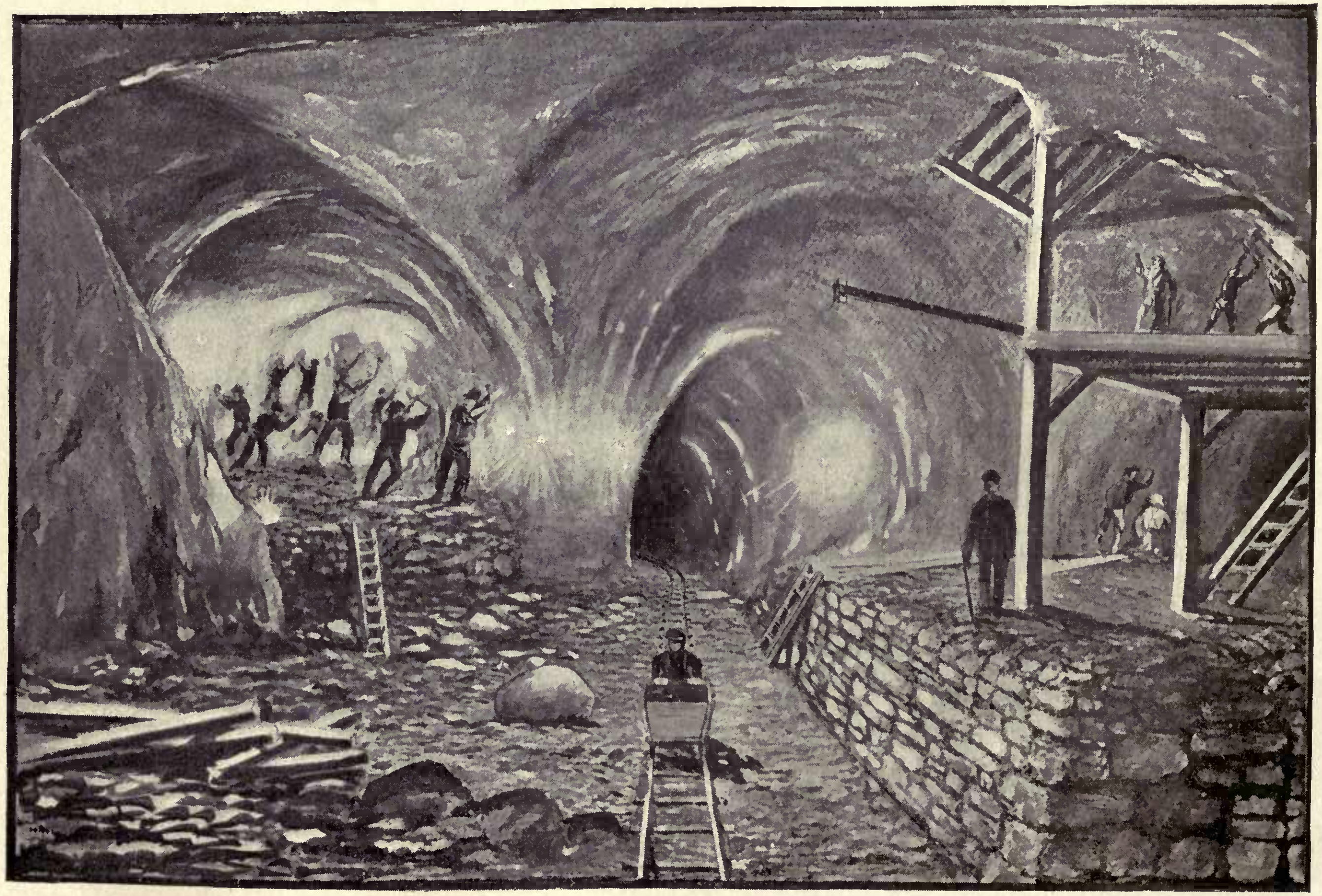
The sizes of the timbers forming the sets are selected according to the size of the shaft and the nature of the ground, which also control the distance between the sets. The posts, or "studdles", as they are called, have simply squared ends, and after being placed in proper position are secured with heavy nails.

In the solid cribbing the end timbers rest against a 1-inch shoulder of the long pieces only. The timber sets for winzes of ordinary size are similarly framed, with shoulder joints at the corners and studdles to keep them apart, and lagging where necessary. This style of framing is changed in winzes that have more than one compartment, and in heavy ground when the timbers are framed like shaft timbers and provided with partitions.

When sufficient ground has been excavated to place a new set, the end timbers are first lowered down and put approximately in place by hanging them from the last set above. Round iron rods, with nuts and washers at one end and a hook at the other end, are passed through holes and secured by nuts in the last set above. Similar rods are passed through the new end pieces and hooked to the rods from above. The long sides of the frame are then lowered in place and the studdles secured in the 4 corners. The iron rods are then screwed up tight, when the new set is firmly held by the one above. The lagging is then put in place and nailed to the timbers, wedges driven firmly between the rock walls and the lagging, and the partitions put in place. When so arranged the new set is held in place by the lateral pressure of the ground, and the iron rods connecting the sets can be withdrawn after a time, although it is usual to keep them in place for 3 or 4 sets above the last one. Every 30 or 40 feet or so the end pieces of the sets rest upon other timbers, called bearers, that are made longer and have their ends for a certain depth supported in holes excavated in the wall rock at the proper distances. This depth depends upon the nature of the ground, being only about 4 inches in hard rock, and sometimes as much as 2 feet in soft ground. When the ground is too soft, or liable to give way, the bearers are omitted until firm ground is reached. Timber sets so adjusted last for many years, and with proper attention require very little repair. Should a set become broken from any cause, pressure of the ground or otherwise, or be forced out of the general alignment, it can be taken out and readjusted without much difficulty. In very heavy ground this method of timbering is replaced by solid cribwork, in which one set rests upon the other. Here the iron rods are dispensed with, and the sets are built up from below, precaution being taken to have sufficient space for the sets between the one first secured in the bottom and the others that are to follow on top to inclose the sides, the last remaining space being filled in by a piece of board, wedge-shaped to the required size and driven firmly between the sets.

Small prospect shafts have their sides timbered with 2-inch planking, no other timbers being used, except a few open sets near the surface of the ground. In this case the planks are sawed to proper lengths and placed horizontally with their faces against the sides of the shafts, the end planks being secured by pieces of 1 by 6 inch boards, nailed against the long sides to prevent the ends from being forced in. Wedges hold these planks firmly in place. The partitions are also made of 2-inch plank secured by 1 by 6 inch pieces. The planking is done from time to time as the depth of the shaft increases, and then from the bottom upward, as in cribwork.

The stations in the shafts from which the different levels start are chambers excavated, and timbered if necessary, extending the whole length of the shaft, usually 16 feet deep, and consist of 2 floors, called the upper and lower plats. The upper plat has its floor on a level with the car track of the drift starting from the plat, while the



FRANCISCO VELASQUEZ CHAMBER; A RICH ORE BODY IN 1865, AT NEW ALMADEN.

From a drawing by J. Ross Browne.

lower plat furnishes dumping room for the material to be hoisted to the surface. The upper plat is 7 or 8 feet high in the clear between the timbers. The dump plat has a capacity for about 30 tons of rock, which is dumped by the cars through an opening between the rails over the whole length of the plat. The upper plat is used for landing timbers and supplies or tools sent into the mine.

In opening a station for a new level, one of the long sides of the shaft sets adjoining the station with its lagging is taken out for the entire height of the 2 plats, and heavy upright timbers are inserted at the 2 corners of the shaft timbers and one opposite each partition, to take up the pressure of the other side. These timbers are called "brow pieces". The roof of the stations is either left unsecured (when in solid rock) or is timbered with horizontal or arched timbers, as the case may require, and is covered by lagging. The upper and lower plats have floors of 3-inch fir planking, that of the upper plat resting on 12-inch timbers or joists.

All the shafts and winzes are provided with ladder ways. The ladders have 2 by 4 inch redwood scantlings for sides, each piece 15 feet 7 inches long. The distances between the sides is 10 inches in the clear. The rounds of the ladders are 11 inches apart, made of five-eighth-inch round bar iron. The third round from each end of the ladder is made of three-quarter-inch round bar iron, with shoulders or bosses that abut against the inner side of the spars, and nuts screwed on the ends of these bars to prevent the spreading of the sides. In putting ladder ways in perpendicular shafts or winzes, 2 ladders are joined together at the sides by a piece of scantling, and, having the upper end secured to the shaft timbers by iron clamps, stand with their lower end upon small platforms built across the shaft, which gives them sufficient slope for greater ease in climbing. The next pair of ladders starts either from the same side of the shaft or from the opposite side, the head of the second ladders projecting sufficiently above the platform to afford a hold while the next step is taken. Inclined winzes have platforms at every second ladder when the winze is not used for other purposes, or have a continuous line of ladders if space should be required for hoisting or lowering.

TUNNELS OR DRIFTS.—The usual size of all drifts or tunnels is 7 feet high by 5 feet wide in the clear. In hard rock, which requires no supports to hold it in place, this cross section is of course irregular, but whenever the nature of the ground makes timbering necessary the cross section is obtained by the clear length of the timbers. The top or cap piece which supports the roof is 4 feet long in the clear, and the posts or legs are each 7.5 feet long in the clear, spreading to a width of 6 feet at the bottom. 2 posts or legs and a cap form a set of timbers. These are set from 3 to 5 feet apart, according to the nature of the ground, and covered with lagging on the roof and sides when the ground requires this precaution. The lagging is 3 by 6 inches in cross section, and of suitable length to cover the space between the sets. In drifts where a good solid vein is followed it is usual to dispense with 1 leg of the set, as the vein is hard enough to stand without breaking, and only the hanging-wall side and the roof have to be supported. The timber used is redwood, hewed to different sizes. The dimensions are selected according to the nature of the ground. The largest size timbers are 16 by 16 inches square, the smallest 8 by 8 inches. Round timber has of late years been used, as it is somewhat cheaper, and the round sticks are often split in two in making sets for drifts. The lower ends of the posts are simply placed on the floor without sills. A piece of lagging of proper length is usually wedged and nailed between the upper ends of the 2 adjoining sets to keep the sets apart and transfer the pressure of the ground against one set to the neighboring sets. The lower ends of the posts do not require this precaution, as they are set in the ground a few inches and so are firmly held.

The grade or inclination of the floor of the drifts or tunnels is about 1 foot in the hundred in all drifts following the vein, where they are usually very tortuous. Straight tunnels, adits, or crosscuts of greater length have an inclination of only 3 or 4 inches to 100 feet. All drifts or levels are provided with tracks of steel rails, joined by fish plates and resting on crossties of redwood 4 by 6 inches in section, 4 feet long. 90 per cent of all drifts and tunnels require timbering to prevent the caving in of the sides and roof.

The excavating of drifts and shafts is usually done by hand drills. The Santa Isabel and the Buena Vista shafts have been sunk largely by machine drills; so also all the long crosscuts underground.

ORE EXTRACTION.

The ore deposits having been reached by the drifts or crosscuts, their removal is accomplished in the following manner: The face of the vein rock is blasted out as far as the ore deposit reaches back into the vein, the floor being kept level with the drift. The deposits of cinnabar generally follow the hanging wall or alta, and vary in thickness from a few to many feet. As all the rock that contains cinnabar is broken out there is a large cavity left of irregular form, with sloping bottom and sloping, overhanging roof. The roof being formed of the hanging wall, which is mostly a shaly formation, is sometimes hard, but often very soft and clayey, and timbers have to be inserted for its support. The regular plan followed in stoping and timbering these ore excavations is by breaking the vein upward (overhead stoping) from the bottom of the level where the stope commences for a horizontal distance of about 4 feet, when, after squaring the face of the stope, the timbering, consisting of posts, caps, and lagging, is put in to secure the roof. In this way the ore is followed up as far as it reaches, and the timbering is continued as the excavation proceeds. The ore deposits being very irregular in form, it follows that the timbering is also very irregular in arrangement. A set of timbers usually consists of 2 legs or posts, a cap, and lagging, or, in very heavy ground, split timber, to support the roof. 2 auxiliary uprights or posts are put in place first, reaching from the bottom of the excavation to its roof and placed in a position normal to the pressure of the roof. Small channels from 4 to 6 inches deep, called "hitches", are cut in the foot wall for these auxiliary posts to secure them against the force of blasting. These posts are of different sizes, according to the nature of the roof, and usually 12 by 12, 14 by 14, or 16 by 16 inches thick. They are sawed off at proper lengths to reach the roof of the labor, against which they are tightly wedged. Parallel with the face of the labor they are usually 12 feet apart and 3.5 feet in the other direction. Against the inward side of these timbers, toward the face of the labor, the regular sets are placed, long enough to admit on the top the caps, which are also of heavy timbers from 12 by 12 to 16 by 16 inches thick, and on top of these caps, reaching from one set to the other, is placed the lagging or split timber to support the roof. In some cases 2 or 3 caps are laid on top of each other to support the heavy pressure of the roof, and the uprights sometimes consist of 4 posts, each 16 by 16 inches thick, bolted together with three-quarter-inch round iron bolts, forming a solid column of timber 32 inches square. Even this method is sometimes insufficient to withstand the great pressure, and solid cribwork of heavy timber has to be substituted to support the roof. Whenever possible waste rock is piled up in the form of pillars or walls, which, when well laid, is the best protection against pressure, although the steep slope of the ore bodies makes this method impossible in most cases.

The character of the vein is such that the ore can not be extracted without the aid of powder, and for this purpose, if possible, black powder is used, in order to prevent too much fracturing of the ore into very fine stuff. In very hard siliceous veins, however, dynamite powder is used; also when large fragments of rock have to be blasted, or in making room for timbers and in wet holes. The faces of the labores advance upward with a breadth of 20 to 50 feet, and if any ore remains at the sides it is taken up after the first stope upward has reached the level above, or it is taken up in steps all around as the work progresses. The main object is to keep a central place for the delivery of the broken ore into the cars, which would be more difficult if the whole face of the ore body were advanced upward at once. Pillars are not left in the ground, although with a very extended ore body (they are from 100 to 300 feet in length at times) it is usual to start the stopes from 2 or more places at once. The sorting of the ore is not done underground, excepting that large fragments of barren rock are left behind and piled up in places where they are out of the way. The filling in or stowing of the exhausted labores with waste rock is seldom resorted to on account of the irregularity of the stopes and the great expense incurred in tramming the rock to the required places. Old exhausted labores, however, are used as dumps for the waste rock from prospect drifts. The caving together of old labores, should it happen, does not cause any inconvenience, and most of the ground has been accessible after 10 years and over.

Two systems are employed in extracting the ore, (1) the footage system, and (2) the tribute system. The footage system is usually employed in new labores; that is, in such as have been recently discovered. The miners are paid by the depth of the bore holes drilled, the contract for each labor being awarded to the lowest bidder per foot. The number of men forming a company for 1 labor ranges, according to the size of the labor, from 4 to 20 or more. The men work in 2 shifts of 10 hours each, commencing work at 7 o'clock in the morning and 7 o'clock in the evening, respectively. These shifts are under the control of a foreman employed by the Quicksilver Mining Company. He is called the "blaster", and receives his orders from the mining captain. The blaster determines where the holes shall be drilled, in what direction, and to what depth. Beginning at the commencement of the shift and continuing for about 4.5 hours, each party of 2 miners will probably drill 6 to 8 feet of holes of 1.25 inches in diameter, or during the whole shift of 10 hours probably from 6 to 12 holes. The first part of the work is finished at about 25 minutes to midnight or midday, as the case may be, when a rest is taken for lunch. The blaster measures then the depth of all the drill holes and keeps a record of these figures, which constitute the earnings of the men. He hands to the men the powder can, and directs how much powder is to be used for each hole. After all the holes have been properly charged and tamped he gives the order to fire. The candle snuffs under each fuse are then lighted, and the men retire to a safe place. The number of blasts are carefully counted as they go off, so as to be sure that all charges have been exploded. In case a hole misses fire it becomes the duty of the blaster, after a delay of 30 minutes, to return to the drill holes and to find the unexploded charge. The hole is refired if it is found that the fault has been in the candle going out before setting fire to the fuse; but should the fuse have been burned without communicating the fire to the charge, then the hole is left untouched for 24 hours, and the men in the vicinity are warned to be careful. After 24 hours' time the charge is carefully picked out, and the hole is recharged and fired if necessary.

In the tribute system a company of miners, having selected some part of the mine to extract ore from, usually one of the abandoned stopes of former years, apply for a private contract to work it. They attend to all the different operations of mining, that is, stoping, drifting, blasting, and timbering, at an agreed price per ton of ore extracted. These contracts are given only for 1 month at a time and are renewed from month to month. The superintendent of the mine reserves the right to state the number of men that shall be employed in the work. The detail work is generally under the supervision of the mining captain, in order that the ground may be explored to the best advantage. The transportation is done by the Quicksilver Mining Company. Tools and timber are also furnished, the tributers supplying only powder and light.

STOPE OR "LABORE," NEW ALMADEN QUICKSILVER MINE.

TRAMMING.

The waste rock from prospect drifts and winzes, crosscuts or upraises, if not used in filling up abandoned stopes, is brought in cars to the shafts where it is hoisted to the surface. The ore from the labores is transported in the same way. Care is taken to keep the ore separated from waste rock, and to keep separate the ores coming from the company's labores as well as those coming from the different tributers' labores, as the account of each tributer company must be kept distinct.

In the Randol mine, where many shifts of miners are working in prospecting or tribute work, and where many labores are being stoped, tramming is continued day and night. This work is awarded by contract to the lowest bidder per ton. A company of 4 or 6, sometimes 8, men takes the contract for tramming on several levels that can be worked together conveniently. In those parts of the mine where only 2 or 3 drifts or labores are being worked and the distances to be trammed are short the miners do their own tramming. In tramming, 2 men usually attend to a car that holds 1 ton of rock or ore. They fill the car at the ore stopes or at the pile of waste rock that has been thrown back by the miners.

On the 1,400-foot crosscut south from Santa Isabel shaft, which is over 2,600 feet in length, and in the Day tunnel, which is also of great length, the tramming is done by mules. The mules that work on the 1,400 crosscut from Santa Isabel shaft are stabled underground. The tramming from the Randol shaft on the 800-foot crosscut (adit) is done by mules to bring the hoisted material, ore, or waste rock from the shaft to the surface. 1 mule pulls a train of 2 cars, and is attended by a driver.

Cars.—Those used in the Randol mine are 5 feet 6 inches long inside the box, 2 feet 3 inches wide, and 1 foot 10 inches deep, holding from 1,600 to 2,000 pounds of rock or ore. The box is made of pine planks, the sides 1.5 inches thick, the bottom 2 inches thick, lined with quarter-inch sheet-iron plate on the inside. The upper edge is also protected by strap iron screwed on. The box has a hinged door in front hung on a 1-inch round bar of iron. This door is kept closed by a hook at the end of an iron bar which runs along the bottom of the car, and is opened or closed by turning the handle at the rear end of the car box. The trucks are made of 4 by 10 inch pine lumber, and provided with cast-iron wheels 14 inches in diameter. These cars dump only in front.

In the Day tunnel and the Randol adit (800 crosscut) cars of the largest size are used, as they are trammed by mules. These car boxes are also of wood, but measure inside 6 feet 2 inches in length, 2 feet 6 inches in width, and 2 feet deep. They have a capacity of 3,000 pounds. In construction they resemble the cars used in the Randol mine, except that they are provided with brakes worked by foot power from the rear end of the car.

At the Buena Vista shaft, where the cars are hoisted to the surface, they are made of three-sixteenth-inch sheet-iron boxes, 3 feet 8 inches long, 26 inches wide, and 2 feet deep. They dump in front or at the sides, as required. The truck is framed of timber and rests on 12-inch cast-iron wheels. One wheel of each pair is keyed to the axle, while the other revolves freely. The axles are of 1.25-inch round steel, revolving in cast-iron boxes. The cars weigh 600 pounds empty, and hold about 1,200 to 1,500 pounds.

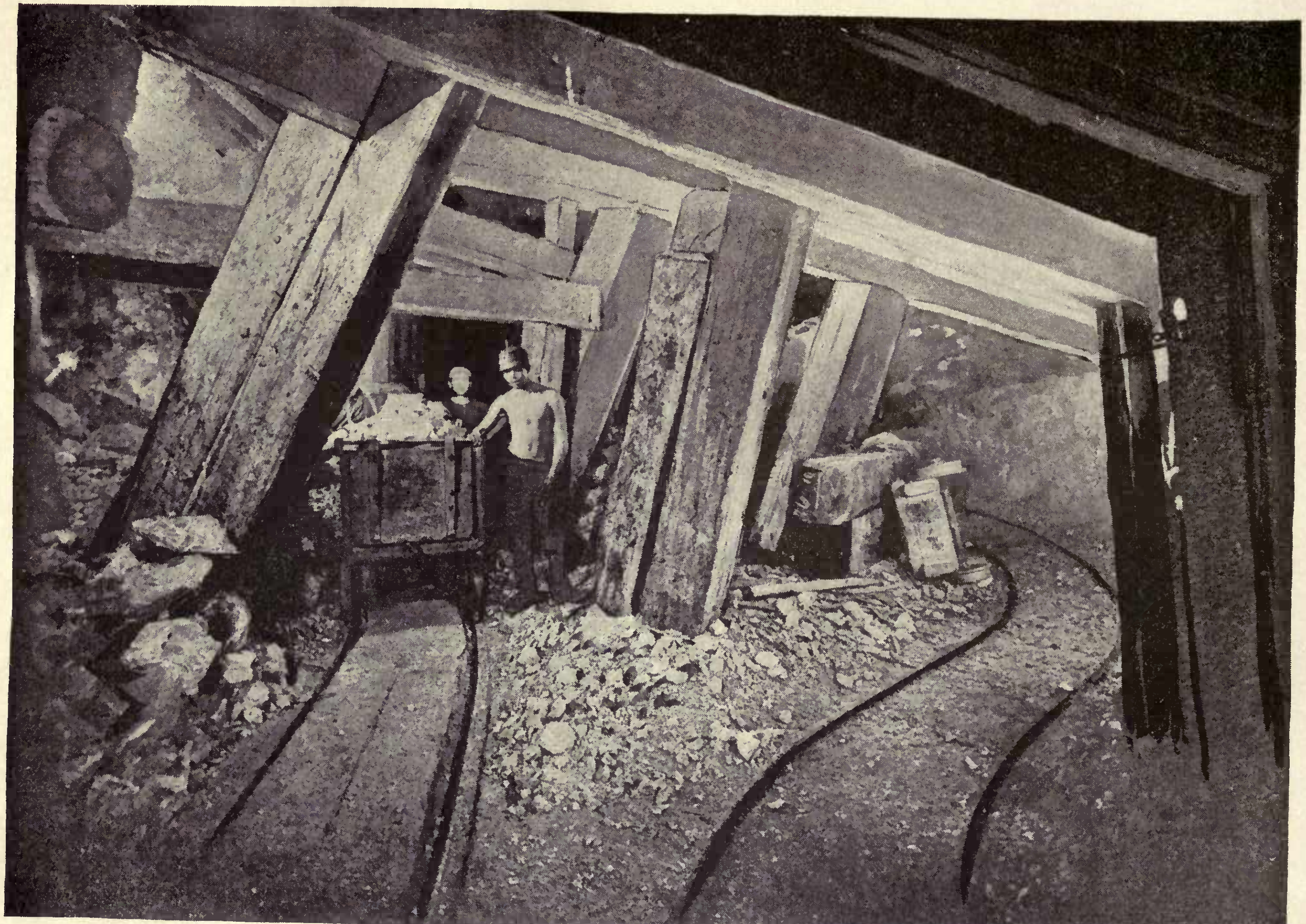
The gauge of the tracks is 24 inches in the Randol mine, 30 inches in the Day tunnel and Randol adit, and 20 inches in the Buena Vista, Almaden, Saint George, and San Francisco. One man, called the track layer, with an assistant, attends to all the laying and repairing of the tracks. The rails now used in the mine are of steel, weighing 12 pounds to the yard. The total length of all underground railroads, including the tracks leading from shafts to ore and waste dumps, is 35,000 feet, in round numbers.

Hoisting.—The ore and waste rock from the Buena Vista shaft is hoisted to the surface in cars on double-deck cages, provided with tracks for this purpose. There are consequently no dump plats in the Buena Vista stations. The cars while on the cage are held in place by hooks, which are dropped into staples riveted to each side of the car. All the other shafts are provided with skips for hoisting the ore and waste rock. The skips are rectangular boxes made of quarter-inch steel plates, stiffened at the corners by 2-inch angle iron, to which the sides are riveted by half-inch rivets driven from the inside. The inside dimensions of the horizontal section of the skip are 2 feet 8.5 inches by 2 feet 7 inches. The front side is 6 feet 3 inches long on the outside, while the rear side is only 3 feet 7 inches long, which gives the skip a sloping bottom. The lower end of the front has a hinged door 2 feet 4 inches high, covering the whole width of the skip. This door is closed by a latch bar 3 inches by five-eighths inch extending across the front and dropping into catches projecting from each side of the box, and is kept locked by a movable key or pawl which hangs above it. A piece of angle iron riveted to the bottom of the box, on the outside near its front edge, serves for a shoulder to rest against the apron or door of the shaft while unloading. The guide frame or bale of the skip is made of three-quarter-inch iron, 4 inches wide, riveted to the sides of the skip by rivets driven from the inside of the box. The transverse bar on the upper end of the frame or bale is of wrought iron 1 inch thick and 3.5 inches deep, with flanges at each end and bolted to the guide frame. From the transverse bar down along each side of the frame to the lower end of the skip box extends a guide strap 4 inches wide, one-fourth inch thick, fastened to the frame and skip box 1.25 inches from the face of the box, which brings the outside faces of these guide straps 2 feet 11.5 inches apart and leaves one-half inch for play between the guide rods. Near the upper and lower ends of each guide strap shoes are fastened to the frame and skip box, made of iron three-eighths inch thick, 6 inches high, the 2 flanges or checks of each shoe extending 2.75 inches beyond the face of the guide strap. The inner faces of the flanges are protected by false plates riveted to the shoes. The inner surfaces of each pair of plates when worn down are easily replaced. A drawbar 2.25 inches in diameter passes through the upper end of the bale or frame. It has a vertical play of 9 inches, and is prevented from turning by a key. To the lower end of the drawbar double nuts are screwed to hold it within the frame, while 2 nuts on the upper end hold the clevis to which the shackle is attached. The top of the guide frame is covered by a bonnet or hood of three-sixteenths-inch sheet iron, fastened to the frame by bolts. The bonnet has hinges at the distance of 6 inches from its ridge, to allow its being opened if necessary. The skips are provided with a safety arrangement, alike on all skips and cages except the timber cages, which are without it. The arrangement referred to consists of 2 round steel bars, 1.5 inches in diameter, extending across and beyond the frame of the cage far enough to embrace within their ends the guide rods, also called "skip rods", which are sticks of timber 3.75 inches square, planed, and fastened to each side of the shaft, extending from top to bottom. On the ends of the round steel bars are placed and keyed fast cast-iron eccentrics having a serrated surface on a part of their circumference. The bars are supported by and revolve freely in eyes forged on each side of the upright members of the frame of the skip or cage. A chain pulley is keyed to each bar at the center, to which a three-eighths-inch chain is made fast, passed around it, and attached to the drawbar or lifting bolt. The length of this chain is such that when the drawbar takes the weight of the cage it causes the shafts carrying the eccentrics to partly revolve, bringing the smaller radii of the eccentrics opposite each other. As there are no teeth on this part of the circumference of the eccentrics, there is sufficient space left between to clear the wooden guide rods. The bars while turning into this position act on 2 strong steel spiral springs, 1 on each side of the corresponding eccentric, drawing their coils closer together and exerting a force of several hundred pounds. The moment the strain is removed from the drawbar or lifting bolt, in the event of resting the cage or skip on some support, or in case of the suspending rope parting or breaking, the springs uncoil with sudden force, turn the shafts or cam bars, and bring the greater radii of the 2 opposing eccentrics closer together, their teeth grasping the wooden guide rods with stronger force the heavier the attached weight, and preventing the skip or cage from further descent. The weight of these skips complete is 1,700 pounds. Their capacity is 3,000 pounds of rock. Skips of the same size are used at the Santa Isabel shaft. Shafts with small hoisting engines have skips of proportionate size, holding 2,000 or 1,000 pounds only, but the construction is similar to those of the largest size, and all are provided with safety attachments. For hoisting water, self-dumping skips, working automatically, have been used at the Santa Isabel and Buena Vista shafts.

For hoisting and lowering men at the Randol and Santa Isabel shafts double-deck cages are employed. They contain 2 platforms or floors 2 feet 7 inches square, made of quarter-inch sheet iron, 6 feet apart, hanging by 4 round iron bars, 1 inch in diameter, from 2 bars that are fastened to the guide frame with three-quarter-inch bolts. These cages are provided with bonnets and safety clutches. Each deck holds 6 men. To send timbers into the Randol mine a cage with a single platform and without bonnet or safety apparatus is used. The guide frame is 8 feet long and 2 feet 8 inches square. The cage at the Buena Vista shaft is similar to the one used for men at the Randol shaft. It has in addition track irons on each deck for the cars. This double-deck cage weighs 1,800 pounds.

The Buena Vista shaft is provided at the top and at the 2,100-foot station with landing chairs to support the cage while the cars are run off or on the platform of the cage. They consist of 4 wrought-iron knees, 2 on each side of the shaft, into which they project, and are situated just below the floor of the station. They are withdrawn from projecting in the shaft by a lever keyed to the shafts, which are connected with the knees by iron rods. By moving the lever backward the shafts partly revolve, withdrawing the knees and leaving the way clear for the descending cage. The "lander" or station tender operates this lever, a catch being also provided to keep the lever in position when withdrawn, if required. Automatic covers close the top of the Buena Vista shaft when the cages are down.

The rock and ore from the mine are hoisted at the Randol shaft to the 800-foot adit level, and thence run out in cars drawn by mules, as already mentioned. This adit level, or 800 crosscut from the Randol shaft, is 700 feet long. From the mouth of the crosscut begins an elevated car track, which leads to the planilla or ore-cleaning shed and to the waste dump. At the 800-foot station a sheet-iron door or apron, movable on hinges, is secured against the open side of the shaft in such a way that by the movement of a lever the upper edge of the apron will project about 4 inches inside of the shaft, while the lower edge will project outside and over the top of a car that stands in place on the track alongside of the shaft. The loaded skip having been hoisted a couple of feet above this 800-foot station, the apron is brought into position by the lever, and the skip is lowered down until it rests with the angle iron on its bottom against the upper edge of the apron. The skip door is then opened by throwing aside the key or pawl and swinging the latch bar from the catches, when the whole charge drops into the ready car. 1 man at the station attends to this work. 2 cars make a train, which is drawn by a mule, attended by a driver. A loaded train is taken out and the empty cars returned while another train is filled by the man at the station. A switch track at the station gives room for the management of the trains. The loaded train, having arrived at the mouth of the adit, is taken in charge by a man called the "car dumper". He pushes the cars to their destination and dumps the loads at the different screens when loaded with ore, or discharges them over the waste dump if they contain waste rock, called "tepetate". In this way the work goes on without interruption day and night.



TRAMMING, 1,500-FOOT LEVEL, RANDOL SHAFT, NEW ALMADEN QUICKSILVER MINE.

At the other shafts, where the ore or waste rock is brought to the top of the shaft and where the cleaning floors for ore and the waste dump are near at hand, the discharging of the skips and the tramming of the loaded cars, etc., is done by 1 man, called the "lander", using only 1 car, which can be discharged while another skip load is being hoisted to the surface.

The arrangement for loading skips at the different stations of the Randol and the Santa Isabel shafts is as follows: Filling the skips with the material to be hoisted from the Randol shaft is done by contract. The prices for skip filling range from 8.5 to 10 cents per ton. 6 men at the Randol shaft form a company, who attend to all skip filling at the different stations of that shaft. At other shafts, where less rock is hoisted, skip filling is done by day's labor. The stations at all the shafts excepting the Buena Vista are of 2 stories. In the Randol and Santa Isabel shafts a dump car is used for filling the skip. This car stands on the lower platform, on a short track facing the shaft. It is made entirely of iron and holds exactly 1 full charge for the skip, or 3,000 pounds. The dump car is of the same size as the skip. The car is open in front, a short board being placed in the forward end to keep the rock in place while the car is being filled. The forward end of the rails that form the track are bent upward, so that the car can be pushed only a short distance ahead, just sufficient to overhang the skip ready for the load. The advantage of this dump car is that the skip fillers can prepare the load while the skip is being hoisted and lowered again, and a charge is ready by the time the skip returns to the station. The dump car is then run forward on its short track and its charge dumped into the skip. To hold the skip in place while being filled and to relieve the hoisting rope from the sudden shock of the falling load a bar is placed in the shaft, which is held at one end by a bolt run through an eye in the bar at one end, and through 2 stationary ring bolts fixed to the side of the shaft nearest the station, while the other end of the bar is allowed to drop against the rear side of the shaft, the bar being of such length as to lay at an angle to suit the sloping bottom of the skip. In shafts that are not provided with dump cars skips are filled by shoveling.

Lighting the mines.—For lights candles are used. The trammers often prefer to use small lamps burning fish oil, as they better withstand the draft. The shaft houses are lighted up at night by large headlights that throw a strong light against the gallows frame and upon the hoisting rope.

Ventilation.—All the different levels of the mine are connected by the shafts and winzes, which insures the free circulation of air through all its workings. In long crosscuts and drifts remote from the main air currents the air at times becomes hot and vitiated and artificial ventilation is necessary. This is usually accomplished by doors, which force the air current to take a certain desired direction, or by wooden boxes or sheet-iron pipes so arranged that the air is compelled to pass through these conduits toward the face of the drift. Where these means fail, blowers or fans, in connection with wooden boxes or sheet-iron pipes, are used. Blowers for small drifts, upraises, or winzes are driven by hand power. When a greater or more constant volume of air is needed, these fans or blowers are driven by engines, worked by steam only when the power is applied on the surface. For underground power compressed air only is used. As nearly all the underground workings are connected by the different shafts, the natural ventilation takes place by upcast or downcast currents, aided by the different adit levels.

The main tunnel (300 level) of the old mine connects by winzes with all the upper workings above that level, and by an interior shaft, the Main shaft, with all levels down to the 600-foot level, and thence by the Junction shaft, also an interior shaft, with the 800 level, or Day tunnel. The Day tunnel connects with the Washington shaft, and by a branch drift with the Randol shaft. The Washington shaft connects on the 1,100 level by an incline with the 1,400-foot level of the Santa Isabel shaft. The Santa Isabel shaft connects on the 1,400 level with the Randol mine, and through upraises with the Saint George shaft. The 1,700-foot level of the Santa Isabel connects by a long crosscut with the Randol shaft, and by an incline shaft the 1,900-foot level of the Santa Isabel is also connected with this crosscut (1,700). The Randol shaft connects through a winze from the 1,900 level with the 2,100 level, Buena Vista. The 2,100-foot level of the Buena Vista and Santa Isabel are also connected. The adit to the Randol shaft, or 800 crosscut, aids also in the ventilation, so also does the adit or water tunnel on the 1,200 level, Buena Vista. The levels from the different shafts are also connected by numerous winzes, and partly also by passages through some of the old ore stopes.

The Santa Isabel shaft is a downcast shaft (collar 728 feet below datum), and acts so at all times. The Buena Vista shaft is always upcast (collar 885 feet below datum), taking the current of air from the Santa Isabel. Part of this current comes through the Buena Vista shaft to the surface; another part ascends through the 2,100-foot incline into the Randol workings.

The Randol shaft, 426 feet below datum, acts at all times as an upcast shaft from the bottom level (1,800-foot level) to the 800 adit or crosscut. The air current through the 800 adit, or crosscut, of the Randol shaft changes its direction according to the state of the weather on the surface. On cold days the current rises in the shaft and the air comes in through the crosscut, while on warm days the current is reversed.

The Randol shaft takes the air current from the 2,100 level, Buena Vista, as already mentioned, from the Santa Isabel through the 1,700 crosscut mainly, and also from the incline shaft connecting the 1,700 crosscut with the 1,900 level, Santa Isabel. The Saint George shaft, 570 feet below datum, is an upcast shaft, taking the current from the Randol shaft and partly from the Santa Isabel shaft. The Washington shaft, 176 feet below datum, is an upcast shaft in cold weather and downcast on warm days. The air current passes out of the Day tunnel on warm days, and reverses on cold days. So also acts the current of air in the incline connecting the 1,100 level of the Washington shaft with the 1,400 level, Santa Isabel, being downcast on warm days and upcast on cold days. These shafts and tunnels form the main arteries for the ventilation of the whole mine.

TEMPERATURE.

The temperature at different points in the mine is naturally much influenced by the air currents. The 1,700 crosscut which connects the Santa Isabel shaft with the Randol shaft is the coolest part of the deep underground passages. It averages 60° fahrenheit in summer and 50° in winter. The highest temperature observed in any part of the mine was 88.5° fahrenheit. Some observations gave the following data (the degrees are fahrenheit):

SANTA ISABEL SHAFT.—On December 14, 1888, the temperature at the surface was 55°. At the 1,400 station, near shaft, 575 feet below surface, it was 58°. In the 1,400 crosscut from this shaft, at a point 800 feet distant from the shaft, it was 78°. At the face of the 1,400 drift south from the crosscut, at a distance of 2,600 feet from the shaft, with ventilation through air boxes 10 by 20 inches in section, the observed temperature was 85°. It must be noticed that this observation was taken while the drift was being worked, as the temperature is much less after only 12 hours interruption of the work. In the 1,400 level west (a branch of the 1,400 crosscut) and about 550 feet distant from a winze coming up from the 1,500 level of the Randol shaft, the drift being supplied with air by an 11-inch pipe, the observed temperature was 84°.

SAINT GEORGE SHAFT.—On December 14, 1888, the temperature at the surface was 55°. At the 1,000 level, near station (386 feet below surface), it was 76°. The Saint George shaft acts as an upcast shaft. At the 1,200 level, in an upraise 20 feet above the drift, it was 82°. This observation was taken while the upraise was being worked. The point was remote from shaft or winze and had no artificial ventilation.

RANDOL SHAFT.—On December 13, 1888, the temperature at the surface was 51°, the weather rainy. At the 1,300 station, near shaft (826 feet below collar), the temperature was 72°. At the 1,300 level, in an upraise 20 feet above the level and 1,200 feet distant from the shaft, the temperature was 77° while the upraise was worked. At the 1,400 station, near shaft (925 feet below collar), it was 75°; at the 1,400 level, at a point 500 feet north from the shaft, 76.5°; at the 1,400 level, at a point 800 feet north from the shaft, 78°, and near the same place, standing in the air current, coming up from a winze, the temperature was 76°. At the face of an upraise from the last observation point, and at about 30 feet above the level, the observed temperature reached 86°. This upraise was then being worked. At the 1,500 level, in an upraise about 1,500 feet distant from the shaft and about 40 feet above the level, the temperature reached 88.5° while the miners were at work. On the 1,600 level, west of the shaft about 1,000 feet and in good air current, the temperature was 73°. At the 1,600 station, at shaft, it was 74° (1,125 feet below surface), while the temperature on surface was 54°.

For ventilating purposes there are on hand 1 No. 2 and 1 No. 3 Baker rotary pressure blower, 1 Root blower, and 1 Blackmann power ventilator and exhaust wheel of 5 feet diameter. For special purposes exhaust fans are constructed similar to the Guibal fans of old construction. One of these fans, 12 feet in diameter, had been erected at one time over the Washington shaft for the purpose of regulating the ventilation on the 1,400 crosscut from the Santa Isabel shaft, while much carbonic-acid gas was present, and very satisfactory results were obtained with small cost. The fan was driven by a small steam engine of 6 horse power. All the communications with the Washington shaft were closed except the one with the 1,400 crosscut, Santa Isabel.

The length of drifts, winze, and shaft which this current had to pass through was: 1,400 crosscut to foot of incline, 2,490 feet; length of incline (235 feet perpendicular elevation), 300 feet; 1,100 level, Washington, 950 feet; shaft to the surface, 865 feet; or a total of 4,605 feet. The air in the 1,400 crosscut was mixed with carbonic-acid gas to such an extent that a lighted candle would go out almost instantly, and the natural draft was insufficient to set the column of heavy air in motion. The 12-foot exhaust fan was started on May 23, 1888, at noon, the fan making 40 revolutions per minute, and at 2 o'clock the same afternoon the air in the crosscut was found pure. The exhaust flue had an area of 19.125 square feet (perimeter 17.5 feet); the velocity of the exhausted air, measured by Cassell's anemometer, was 682 feet per minute.

For ventilating short drifts or crosscuts small ventilating fans of 18 inches diameter and 8-inch face are used, driven by a 6-foot wheel moved by hand power. Boys are employed for this purpose. The air is carried to the face of the drift by 8-inch sheet-iron pipes.

DRAINAGE.

The water from all underground workings below the 800 level is conducted to the Buena Vista shaft, where it is pumped to the adit or drain tunnel, and through this tunnel reaches the surface. The amount of water raised is small when the large area of the underground workings is taken into consideration. The part of the mine controlled by the Randol shaft, from the 800 level down to the 1,800 level, is almost dry, and the small quantity of water which collects in the sump is pumped out once a week by a hand pump and the water conducted in a pipe through the 1,800-foot level toward a winze which connects with the Buena Vista shaft. The workings above the 800 level are drained by the Day tunnel and the Randol crosscut. From the Washington shaft the water is drained by a siphon down the incline from the 1,100-foot level into the 1,400 crosscut of the Santa Isabel shaft. From the 1,400 station of the Santa Isabel shaft the water is carried by an inverted siphon, made of a 4-inch pipe, down the shaft to the 2,100-foot level, and along that level to the Buena Vista shaft, and up to a tank 193 feet below the adit tunnel, and thence raised by the pump. The water from the lower workings of the Santa Isabel shaft drains into the Buena Vista shaft, and with the water from other parts of the Buena Vista workings is pumped to the surface. The Saint George shaft drains into the Santa Isabel workings. The Almaden shaft is drained by hoisting the water in buckets.

Buena Vista pumping engine.—The pumping engine at the Buena Vista shaft is of the compound direct-acting rotative type. The cylinders are placed directly over the main beam or bob, and in line with it. The initial cylinder piston is connected by means of rods, and slides to the pin nearest the fly wheel, the expansion cylinder piston being connected to the beam in the same manner, between the initial cylinder and the beam trunnions. The total lift is 890 feet, including the sump. The pump work in the shaft is on the Cornish system, and consists of 8 plunger pumps, 2 of which are placed at each of the 4 stations, with a single spear passing between them. In addition to these pumps is the one stationed 193 feet below the adit tunnel. The water comes to this pump from the 1,400 level of the Santa Isabel shaft through a 4-inch pipe 3,000 feet long and discharges 75 gallons per minute into the supply tank.

The pump stations are 10 by 18 feet in size, and situated at distances varying from 205 to 237 feet perpendicularly above each other. The tanks on these stations have each a capacity of 2,400 gallons. The pump stations are at 499 (193 below adit), 543, 743, 971, and 1,171 feet below collar of shaft. The bob stations are 384, 634, and 1,062 feet below collar. Each pump discharges through an 8-inch column into station above. The column is made of 8-inch lap-welded wrought-iron tube, joined at the ends by cast-iron flanges fitted on the tube and secured by expanding it to fill the bore of the flange tightly and in a manner to prevent telescoping. The spear, or pump rod, is of Oregon pine, 1,160 feet long, in sections of 50 feet. The first 600 feet of this rod are 12 by 12 inches in section, the remainder being 10 by 10 inches. The joining of the sections is effected by butting the ends evenly and closely together and securing them in position by placing wrought-iron strapping plates 20 feet long, 8 inches wide, and 1 inch thick on each of the 4 sides of the rod, the joint being in the middle of their length, and bolting through rods and straps with 40 1-inch bolts, one-half passing the other at right angles. The pump plungers are connected to pump rod by cast-iron brackets securely bolted to 2 opposite sides of the rod and engaging with flanges on the ends of the plungers. To provide against lateral motion of the rods they are stayed at each 50 feet of their length by inclosing them in wooden guides, the rod at such places being lined with oak boards secured by iron clamps. The balance bobs are 3 in number, made of cast iron, with wrought-iron tension straps. They are each connected to the pump rod by wrought-iron links or connecting rods 15 feet in length, with brass journal boxes and straps on each end. They are hung from 2 wrought-iron pins in nose of the bob, the lower end engaging with pins in 2 cast-iron brackets bolted to 2 opposite sides of the pump rod. The bob stations are 30 feet long, 12 feet wide, and 18 feet high, secured by 14 by 14 inch timbers; so also are the pump stations. The first is 383 feet from the surface, the second 250 below the first, and the third 428 feet below the second. A 9-inch lift pump is used to raise water from the sump to the plunger pumps on the 2,100-foot level, the difference in capacity between the 2 8-inch pumps and the lift pump being supplied by the flow of water in the 2,100 level, which also receives any excess over 75 gallons per minute from 1,400 level at Santa Isabel shaft.

The pumps described raise 315 gallons per minute, making 8 double strokes in that time. It would be 360 gallons per minute if the supply pipe to pump taking water from 1,400 Santa Isabel shaft was large enough to admit of a supply of 120 gallons per minute, which is the amount required to supply that pump at 8 strokes per minute. The stroke of the pump is 6 feet.

The pump rod is actuated, as already mentioned, by an under-beam compound condensing steam engine with Scott & O'Neil balanced puppet valve and cut-off motion. The cylinders are placed side by side on a heavy bed plate, and to the bottom of this are bolted the guide plates for the crossheads. The cylinder of the high-pressure engine is 21 inches in diameter and has a stroke of 96 inches. The expansion cylinder is 47 inches in diameter, stroke 70 inches. The connecting rods of each engine are connected directly to one end of the beam and pump rod to the other end. The initial engine, being on the outside, has a longer stroke and greater piston speed than the expansion engine, which is placed nearer the center of the beam. The beam is made of cast iron, the arms of which are securely tied by wrought-iron straps 10 by 2 inches in section. The main connecting rod connects an angle arm of the beam to a wrought-iron crank and shaft, on which is placed a fly wheel 24 feet in diameter, weighing 50,000 pounds. The valve motion is derived from a shaft running at right angles to the crank shaft and operated by a miter wheel.

The air pump and condenser are of a special kind on account of the small quantity of water available. The condensation water falls from the condenser through an 8-inch pipe to a tank placed 35 feet below it. The end of the pipe is 3 feet below the water surface in the tank, sealing it against the atmosphere. A small independent bucket-and-plunger pump maintains the vacuum in condenser. The condensation water flows from the tank receiving it through a flume 1,850 feet long and 2 feet wide, passing in its circuit through a pond 25 by 50 feet, and discharging into a tank a few feet from and about 6 feet lower than the first tank. A pump placed in the shaft at this point raises the water, discharging it into a tank on the surface, when it again passes through the condenser, it having been sufficiently cooled in its circuit through flume and pond, the cooling surface of which is nearly 5,000 square feet. The engine is also provided with an automatic stop, which throws the valves out of connection and instantly stops its motion if through any accident it should be relieved of all or any considerable part of its load.

The foundation is built of hewn sandstone, with cap stones of granite. The pump work is handled, when necessary, by a double-cylinder horizontal geared hoist, set on stone and granite foundation.

The cylinders are 12 inches in diameter, with stroke of 24 inches. The reel and spur wheel are bolted together and keyed on same shaft. The spur wheel is 12 feet 1 inch in diameter, with V-shaped teeth, 3.25-inch pitch, and 12-inch face and gears, with a pinion 2 feet in diameter on crank shaft of engine. The reel is 3 feet in diameter, and constructed for winding flat rope. The engine is fitted with a closed link and reversing lever, Corliss throttle valves, and a powerful Eckhardt stand brake, applied on engine fly wheel. The rope used is flat crucible steel wire rope 4.5 by 0.5 inch, 2,000 feet of which can be wound on the reel if desired. The rope in use is about 1,600 feet long.

Santa Isabel pumping works.—The pumping plant at Santa Isabel shaft consists of 6 6.5-inch plunger pumps and 4 6-inch pumps, all having a stroke of 5 feet.

Of the 6.5-inch pumps 2 are placed at the 1,700, 1,400, and 1,000 foot levels; of the 6-inch pumps 2 are placed at the 1,900 and 2,000 foot levels. They are actuated by 2 pine rods 6 by 8 inches in section, 1,230 feet long, in 50-foot sections, and connected in the same manner as those at Buena Vista shaft. They are connected to 2 right-angle bobs on the surface, arranged so that one rod is ascending while the other is descending. In this way one rod balances the other, and as the water flows through the column on both up and down stroke, 1 discharge column only for the 2 pumps is required. There is 1 balance bob attached to each rod to relieve the surface bobs of some of the weight of the pump rods. The column is made of 6-inch lap-welded wrought-iron tube, connected by threaded ends and screwed into connecting sleeves. Part of the column, however, is connected by cast-iron flanges.

This pump work is operated by a compound condensing engine, the high-pressure cylinder being within and concentric with the low-pressure cylinder, the piston of which is an annular ring 42 inches in diameter outside and 26 inches inside. The high-pressure cylinder is steam jacketed, 19 inches in diameter, with stroke of 5 feet. The steam distribution is effected by a double-ported slide valve controlled by Davey differential valve gear. The air pump is driven by an extension of the high-pressure piston rod. It is 9 inches in diameter, 5-foot stroke, and is situated directly behind the steam cylinders. The engine frame is extended to connect with sole plates carrying the bobs operating the pump rods. They are of cast iron, with tension straps of wrought iron. The pit work is handled, when required, by a capstan situated near the shaft house.

A third pumping plant, not now erected, consists of a horizontal noncondensing engine, having on the crank shaft a pinion gearing with a spur wheel, on the shaft of which is keyed a disk with wrist pin. The disk has in its face 4 holes at varying distances from its center, into any one of which the wrist pin may be put, giving a stroke varying from 2.5 to 4.5 feet. This wrist pin is connected by a wooden connecting rod strapped with iron to an angle bob to which pump rod is attached. The bob is constructed of wood, with iron straps, and fitted with a balance box, wherein weights may be placed to equalize load on the engine. The gear wheels are 2.375-inch pitch and 9-inch face; ratio between pinion and spur wheel as 1 to 7.

The pumps in the shaft are to have 6-inch plungers, the stroke varying with the position of the wrist pin in the disk or crank plate operating the angle bob. The spear rod is 6 inches square, to which the plungers are secured in a different manner from those described at the Buena Vista shaft.

The plunger is of iron, cast hollow, and about 1 inch in thickness. A suitable piece of timber, considerably longer than the plunger, is made to fit tightly inside of the hollow tube, and after being driven in is tightly wedged in place. The timber projecting beyond the plunger is square in section and clamped to the pump rod, a distance piece being introduced between them to bring the plunger to the desired distance from the rod. There are 2 plunger pumps and 1 lift pump still remaining as part of the pit work, operated by the machinery just described, the capacity of which is 50 to 60 gallons per minute from a depth of 1,000 feet; speed in shaft, from 3 to 12 strokes per minute.

The Santa Isabel pumps will discharge 170 gallons per minute from a depth of 1,500 feet; speed in the shaft, from 1 to 10 strokes per minute.

The Buena Vista pumps will discharge 315 gallons per minute from a depth of 1,800 feet; speed, from 2.5 to 8 strokes per minute. The average speed at Buena Vista pump works at present is about 4 strokes per minute.

In addition to the regular pumping machinery there are available for mine drainage 4 steam pumps, 2 of which are of a capacity of 80 gallons per minute, 1 of 40 gallons, and 1 of 50 gallons capacity; also 2 bailing tanks, holding 500 gallons each, and 2 other tanks, each carrying 120 gallons.

HOISTING WORKS.

Buena Vista shaft.—The hoisting machinery at the Buena Vista shaft consists of 2 horizontal noncondensing engines, with balanced puppet valves with O'Neil cut-off motion, reversing link, and Corliss throttle valves.

The engines are connected by and act on the same crank shaft. 2 reels, to which brake wheels, 10 feet in diameter and 8-inch face, are attached, are placed on the crank shaft, and are free to revolve in either direction and independent of each other. They may be made to revolve with the shaft by throwing into gear 2 clutches sliding on the shaft (it being square in section at these places) and revolving with it. The reels may be used singly or together, and by winding the ropes on the reels in opposite directions one may be made to hoist while the other lowers, using the descending cage and rope as a counterweight. Flat steel wire rope is used, 3.5 inches wide and three-eighths of an inch thick. The length is 1,600 feet. Each reel is provided with a powerful Eckhardt brake, operated by the foot. An iron brake strap lined with wood is also employed, acting on the crank disks, which are 8 feet 10 inches in diameter and 6-inch face. This brake acts on the engine, or either reel or both, if the clutches on the shaft are engaged with them.

A Behr spiral indicator shows position of cages in the shaft. This indicator consists of a drum 39 inches in diameter, 4 feet 6 inches long, revolving with its axis vertical behind a pointer, to which a vertical motion of 2.375 inches for each revolution of the drum is communicated by an upright screw, revolving by the side of the drum. The vertical motion of the pointer, combined with the circular motion of the drum, traces a spiral line on its surface, the length of which is about one-tenth of the depth of the shaft. On this line are placed brass plates showing the different stations and the number of bells constituting the signals for the stations.

A second pointer, moving against a stationary index board, is also provided. This is always in the engineer's sight and lessens the liability of his confusion by reason of the revolving drum carrying the station marks out of his sight during the greater part of its revolution.

These indicators are driven by gear wheels, one on each reel and in permanent connection with it. The 2 reels are set opposite the 2 hoisting compartments in the shaft and are situated 50 feet 6 inches from it. On the platform from which the engine is handled there are 5 levers, 1 for throttle valves, 1 for reversing the engine, 1 for adjusting the cut-off, and 2 for operating clutches. The 3 pedals for operating the brakes are side by side, and they, with the first 3 levers, are within reach of the engineer without changing his position. The foundation is built of sandstone, with granite cap stones. The gallows frame consists of 2 perpendicular frames of 18-inch timbers, 1 at each end of the shaft, 45 feet high, standing on sills 55 feet long. The frame is 18 feet wide, from outside to outside, and stiffened by horizontal beams and braces. Each frame is secured against the thrust by inclined beams 16 by 20 inches thick, and 50 feet 9 inches long. The 2 frames stand 32 feet 6 inches apart, from outside to outside, and are connected by bridged trusses of 18-inch square timbers, supported by struts 12 by 18 inches. The horizontal beams on top and crossing from one frame to the other are 18 by 24 inches. The sheaves are carried on 14-inch timbers, 2 on top of each other at each side of the sheaves.

The overhead pulleys or sheaves are 9 feet in diameter (center 48 feet above floor), with rims of cast iron and wrought-iron arms. The speed of hoisting is from 1,000 to 1,200 feet per minute in the shaft. The load, including 1,000 feet of rope, is 9,000 pounds.

Each compartment of the shaft has a separate bell for signaling. The bell cord is of three-eighths inch galvanized twisted iron-wire rope, and can be reached from the cage in any position in the shaft.

The boilers at this shaft are 6 in number, set in pairs over 1 furnace. They are each 54 inches in diameter and 16 feet long, with 46 3.5-inch tubes. Each pair is connected by 1 mud drum and 2 steam drums. A 6-inch safety valve is placed on each steam drum, 2 of which are also fitted with Crosby adjustable safety pop valves. The main steam pipe is 10 inches in diameter, with 6-inch branches to the hoisting engine and pumping engine.

SANTA ISABEL SHAFT.—The hoisting machinery at Santa Isabel shaft is a single horizontal high-pressure engine, cylinder 16 inches in diameter, stroke 36 inches, with balanced slide valve and reversing link.

On the crank shaft are 2 pinions, free to revolve on it, and 2 clutches revolving with it, the latter sliding on 2 feathers to engage with either or both of the pinions. There are 2 reels, 1 for each hoisting compartment in the shaft, each 10 feet in diameter and 20 inches wide, having a spur wheel and brake rim cast on one side, the spur wheels gearing with pinions on the shaft. The wheels are 11 feet in diameter, pitch of teeth 3 inches, and 8-inch face. Ratio of wheel to pinion is as 4.5 to 1. Round steel-wire ropes 1.125 inches in diameter are wound on the 2 reels, and in opposite directions to admit of hoisting with balanced load. 2 dial indicators show position of cage in the shaft, the index pointer traveling about 10 inches for every 100 feet traveled by the cage in the shaft. Each reel is provided with a stand brake, the shoes of which are lined with sugar pine. A powerful iron band brake is also applied on the engine fly wheel. The 3 brakes are operated by the foot and one of them is so arranged that hydraulic power can be applied to it. The one last referred to is on the reel working opposite the middle compartment in the shaft, it being the one used when sinking is done in the shaft. The gallows frame is 32 feet in height, built of 14 by 14 inch timber in the form of a truncated pyramid 30 feet square at the base and 18 by 15 feet at the top. Overhead pulleys are 9.5 feet in diameter, the rim grooved for rope of 3.5 inches in circumference.

The machinery is set in a massive foundation of artificial stone, the center of reels being 48 feet from the shaft. The boilers are 4 in number, set in pairs, 2 having separate furnaces and 2 being set over one furnace. The latter are connected by 1 mud drum and 1 steam drum, the former by 1 mud drum, but having separate steam drums. Of this pair, each is 56 inches in diameter and 16 feet long, with 48 3.5-inch tubes. The other pair is built of steel, each 54 inches in diameter, 16 feet long, and having 46 3.5-inch tubes. A 4-inch safety valve is fitted to each steam drum. The boiler feed water is heated by exhaust steam to the boiling point before entering the boiler.

The hoisting speed at this shaft is from 600 to 800 feet per minute. The load, including 1,000 feet of rope, is about 6,700 pounds.

RANDOL SHAFT.—The hoisting gear at the Randol shaft consists of a high-pressure horizontal engine, cylinder 16.5 inches in diameter, the stroke being 30 inches.

1 reel, 9 feet in diameter, 25-inch face, is keyed on the spur-wheel shaft, the spur wheel being driven by a pinion on the crank shaft. These wheels have V-shaped teeth, 3-inch pitch and 10-inch face, ratio about 4.5 to 1.

The pointer on the indicator has a vertical motion of 3.25 inches to 100 feet in the shaft, the direction of its motion being the same as that of the cage in the shaft. It is operated by a vertical screw driven by bevel gears, which derive their motion from reel shaft. The reel is fitted with a stand brake, which is applied by releasing a weight acting on a lever, drawing the brake block together and against the reel. A foot brake is also applied to the fly wheel of the engine.

The speed of hoisting is from 500 to 600 feet per minute. The load is the same as at the Santa Isabel shaft. A round steel-wire rope is used, 3.5 inches in circumference (1.125 inches in diameter). The gallows frame is 28 feet high, built of 12 by 12 inch timber, of the truncated pyramid style, 24 feet square at the base and 11 feet at the top. The overhead pulley is 8.5 feet in diameter.

3 boilers set singly furnish steam for this engine, 2 of which are used at one time: 1 56 inches by 16 feet, with 48 3.5-inch tubes; 1 52 inches by 16 feet, with 54 3-inch tubes; 1 54 inches by 16 feet, with 46 3.5-inch tubes. Each boiler has 1 steam drum, 2 have 4-inch safety valves and 1 a 5-inch safety valve. The feed water for boilers passes through a heater, through which exhaust steam passes, and is raised to a temperature of over 200°.

The record of hoisting at the Randol shaft gives the number of skip loads of rock and ore during the last 4 years as follows:

1886	37,371
1887	40,862
1888	41,791
1889	45,934

In 1889 the average number of skip loads hoisted each working day was 184, or 276 tons, exclusive of the number of trips made with men, timber, etc.

WASHINGTON SHAFT.—The hoisting machinery at the Washington shaft has 2 reels, 6 feet 6 inches in diameter, 24-inch face, one opposite each of the 2 hoisting compartments in the shaft. They are both placed on the same shaft, one being free to revolve and the other keyed. The latter is in permanent connection with the engine, connecting spur wheel and pinion being in a ratio of about 5.5 to 1, the teeth 2.375-inch pitch, 6-inch face. The former is made to revolve with the reel shaft by throwing into gear a clutch sliding upon 2 feathers and revolving with it. Round steel-wire rope 3.5 inches in circumference is used and wound on the reels, 1 passing over and 1 passing under. The reels are driven by a pinion on the crank shaft of a horizontal slide-valve engine, 12-inch cylinder with 24-inch stroke. A speed of 400 feet per minute in the shaft is attained. The load, when skip is at the bottom of the shaft, is 4,500 pounds. The indicator is the same as that at the Randol shaft. This machinery is situated 60 feet from the shaft and set on a foundation of timber. There are 2 boilers, each 56 inches in diameter, 16 feet long, with 48 3.5-inch tubes.

The gallows frame consists of 2 perpendicular upright beams 16 by 20 inches in section, 43 feet 4 inches high, standing on 16 by 18 inch sills 56 feet long, and braced in the line of thrust by inclined beams 16 by 18 inches, 56 feet long. The 2 uprights, 1 at each side of the shaft, stand 20 feet apart and are trussed at the height of 28 feet by a horizontal timber 18 by 20 inches, supported by short braces or struts of 9 by 20 inches. Across the tops of the uprights and connecting both is another horizontal beam 18 by 20 inches. Perpendicular posts 12 by 20 inches are framed between the 2 horizontal beams and carry the sheaves, the shafts of which are 35 feet 6 inches above the floor of the shaft house. The sheaves are 8.5 feet in diameter.

The 2 hoisting machines for prospect shafts as used at the Almaden and Saint George (now at San Francisco) have each 2 steam cylinders 6 inches in diameter, with a stroke of 12 inches. A reel, supported by brackets cast on engine frames, is fitted to each. They are 20 inches in diameter, 10.5-inch face. A spur gear is cast on the side and is driven by a pinion on crank shaft of the engine. The ratio is 4 to 1; pitch of teeth, 1.5 inches, 3.5-inch face. The load, including 500 feet of wire rope five-eighths of an inch in diameter, is 2,000 pounds, and is raised at a speed of 300 feet per minute. A foot brake is applied on the reel.

The upright boilers supplying steam to these engines are 42 inches in diameter and 8 feet high, each having 99 2-inch tubes. They stand on cast-iron base plates 10 inches high, forming the ash pit, and have brackets carrying the boiler feed pumps. Each boiler has a steam drum and a 2-inch safety valve.

The gallows frames are of the truncated pyramid style, overhead pulleys 36 inches in diameter.

THE ENGINEERS.

The engineers at the several shafts work in 2 shifts of 12 hours each. The cages or skips are put in motion in answer to the signals given by gongs that are connected with the different stations of the shafts by wire rope made of galvanized coarse iron wire, twisted, three-eighths inch diameter, and attached at each station to an iron lever. The general signals are: 1 bell for "hoist" or "stop"; 2 bells for "lower down". Other signals are agreed upon as circumstances require. The engineers attend to the brakes. Where 2 reels are employed, hoisting with balanced cages or skips is invariably the rule, and with single reels when lowering the skip the engine is reversed and the speed of the descent is regulated partly by means of the fly-wheel brake and partly by putting the reversing link in position for hoisting, the throttle valve of course being closed.

When raising or lowering men 1 cage only is used, the other reel, if there are 2, being then held by the reel brake. The speed of the cage in the shaft is then from 300 to 400 feet per minute, and its descent is regulated in the same manner as in the single-reel hoist, by fly-wheel brake and reverse bar, the operating reel being invariably in connection with engine when men are in the shaft.

The boilers are cleaned regularly at intervals of from 2 to 4 weeks, according to the amount and kind of water used. The water is supplied from 3 sources, one of which supplies a limited amount of very pure water, that forms little or no scale in the boilers in which it is used. The water obtained from the other sources forms a very hard scale, which necessitates the use of boiler-cleaning compounds, besides a liberal use of the scaling hammer, to keep the boilers in good condition. Every boiler has a manhole in front, below the tubes, through which access is gained to the sheets immediately over the furnace, which are thus kept thoroughly clean. The vertical tubular boilers, being inaccessible on the inside, require to have the tubes removed about every 2 years, when they are thoroughly cleaned and the tubes replaced.

HORSE WHIMS AND WINDLASSES.

For prospect shafts there are also, for hoisting, 2 horse whims. The reel is 7 feet diameter, 10-inch face, and revolves on a 3-inch shaft with vertical axis. The sweep rod can be thrown in or out of gear at will, as the bucket is required to ascend or descend. An iron strap brake is applied to regulate the descent of the bucket, the sweep rod being then out of gear. A half-inch steel wire rope is used. The load is about 300 pounds, and moves through the shaft at about 70 feet per minute.

The windlasses used for prospect work have a wooden reel 6 inches in diameter and 4 feet long, with wrought-iron crank handles inserted in the ends, which are strengthened by iron rings being driven on them, the axles being formed by a part of the crank handles projecting from the ends of the reel in a direction parallel with its axis. 2 upright pieces, generally of 1.5 by 12 inch pine board set in a mortise cut in a 6 by 6 inch cross-timber, support the reel, and are connected by a plank, the ends of which rest upon and are spiked to the upright pieces. On the top of this board is a wooden bar, sliding in guides, which is drawn out far enough to catch the handles and prevent the reel from revolving when it is required to hold the bucket and keep it in position desired. When lowering the bucket a brake is applied on the reel, and consists of a rope, one end of which is made fast to the crosspiece and a turn taken around the reel in the direction of its motion when lowering. The loose end is then drawn tight, as may be required to command the descent of the bucket. 2 buckets are sometimes used, the rope having a number of turns on the reel, with 2 free ends. To these ends the buckets are attached and assist in balancing each other. As the depth of the shaft increases a turn is taken off the reel, adding to the length of the free ends. The load is about 100 pounds. 3-inch hemp rope is used. 100 feet can be sunk in this way.

AIR COMPRESSORS.

To supply compressed air for operating machine drills, pumps, and other machinery in the mine there are 2 air compressors erected in the Santa Isabel shaft house: 1 Burleigh air compressor, with steam cylinder of 18 inches diameter and 24-inch stroke, the air cylinder of 24 inches diameter and 20-inch stroke, discharging into receiver 54 inches in diameter, 12 feet 6 inches high; 1 Clayton air compressor, with 2 steam cylinders, each 14 inches in diameter, and 2 air cylinders of 12 inches diameter, all of 9 inches stroke. The air cylinders are double acting. The receiver is 36 inches in diameter and 9 feet long. Another Burleigh air compressor, with steam cylinder of 15 inches diameter and 18 inches stroke, and air cylinder of 15 inches diameter and 15 inches stroke, discharging into an air receiver 48 inches in diameter, 10 feet 6 inches high, is on hand, having been in use at the Washington and Buena Vista shafts.

MACHINE DRILLS.

The rock drills, 11 in number, are as follows: 2 3.5-inch Ingersoll Eclipse drills, 1 3.5-inch Ingersoll tappet drill, 4 3-inch Ingersoll Eclipse drills, 1 3-inch Ingersoll tappet drill, 2 3-inch National drills, and 1 2.5-inch Ingersoll tappet drill.

VENTILATION.

For ventilation there is 1 Baker blower of a capacity of 1,500 cubic feet per minute, and 1 Baker of a capacity of 1,000 cubic feet; 1 Root blower, capacity 800 cubic feet per minute, and 1 48-inch Blackmann exhaust ventilator.

SHAFT HOUSES.

Buena Vista shaft.—The shaft house at Buena Vista contains hoisting-engine room, 45 feet wide and 100 feet long; pump-engine room, 45 by 45 feet; boiler room, 45 by 55 feet, the whole forming a rectangular frame building 90 feet wide and 100 feet in length. Fire protection is afforded by 4 hydrants (2-inch), fed by a supply tank containing 15,000 gallons. The pressure of water is 70 pounds per square inch. Adjoining the boiler room there is an excavation in which 700 tons of coal can be stored. Situated near the shaft house is the blacksmith shop, 46 by 26 feet, a part of which, 18 by 12 feet, is inclosed and used as a drying and changing room for the miners.

Santa Isabel shaft.—The Santa Isabel engine house is 90 by 40 feet. Connecting with it at right angles is the boiler room, 60 by 40 feet. Adjoining the main building is the miners' changing room, 21 by 12 feet in extent. The blacksmith shop, about 100 feet from shaft house, is 40 by 20 feet in dimensions. 4 2-inch hydrants are placed around the building, having a water pressure of 50 pounds per square inch. Supply tank contains 15,000 gallons. The shed provided for coal storage will hold 400 tons.

Randol shaft.—The works at the Randol shaft are contained in an irregular building, whose greatest length is 80 feet and greatest width 50 feet, the boiler room being 40 by 32 feet. The changing and drying room for the use of the miners, 19 by 18 feet, is provided with 2 steam heaters. Placed adjacent to the shaft house are the carpenter, blacksmith, and machine shops. The carpenter shop is 24 by 40 feet in size. The blacksmith shop is 25 by 50 feet, and has 4 forges. Blast is supplied by a No. 3 Anderton blower. All of the forges are worked by day, and 1 by night. The drills dressed average about 1,000 every day at this shop. The kind of steel used for drills is 1-inch octagon black diamond. The machine shop adjoins the blacksmith shop, and is 16 by 35 feet in size. It contains 1 Putnam lathe, 12-inch centers; 1 power drilling machine, 1 Wiley & Russell bolt-cutting machine, 1 milling machine, and 1 hand-power drilling machine. These machine tools are driven by a 6 by 16 inch steam engine, and are used in making and repairing cages, skips, cars, tanks, etc., and in repairing the machinery at the different shafts. 2 2-inch hydrants, with 35 pounds water pressure, supply protection against fire. 600 tons of coal can be stored at this shaft.

Washington shaft.—The engine house at the Washington shaft is 99 by 32 feet, the adjoining boiler room being 40 by 32 feet. 300 tons of coal can be stored at this shaft. The blacksmith shop and carpenter shop are near the main building, the former being 25 by 40 feet in extent, having 2 forges. The carpenter shop is 32 by 60 feet. 1 2-inch hydrant is provided for fire protection. To the hydrant is attached 50 feet of 2-inch hose, and all other hydrants at the shaft houses are similarly provided. The changing room is 12 by 20 feet.

The Almaden engine house is 34 by 78 feet, the boiler room 24 by 36 feet, which also contains the blacksmith shop.

The San Francisco shaft house is 20 by 54 feet; height of gallows frame is 16 feet, 14 feet spread at the bottom and 8.5 feet at the top.

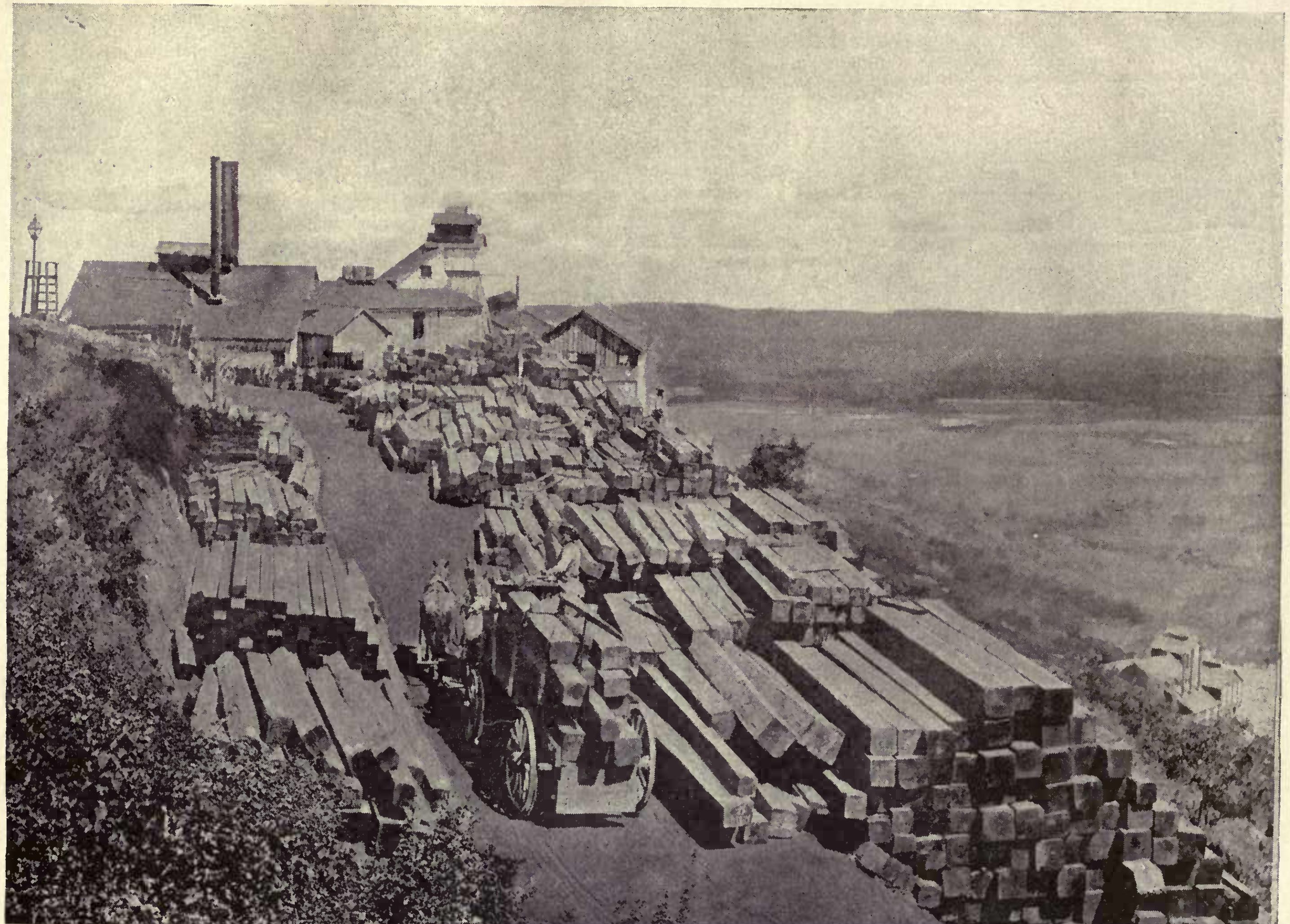
LIST OF ENGINES, ETC., AT NEW ALMADEN.

HOISTING ENGINES.

LOCATION.	GEARED.				DIRECT ACTING—2 CYLINDERS.		
	Single cylinder.	Double cylinder.	Diameter of cylinder. (Inches.)	Stroke. (Inches.)	Number of engines.	Diameter of cylinder. (Inches.)	Stroke. (Inches.)
Randol shaft	1		16.5	30			
Santa Isabel shaft	1		16.0	36			
Buena Vista shaft		1	12.0	24	1	16	60
Washington shaft	1		12.0	24			
Saint George shaft		1	6.0	12			
Almaden shaft		1	6.0	12			

STEAM PUMPS.

LOCATION.	DOW.		KNOWLES.		WORTHINGTON.		CAMERON.		STODDARD.
	No. 4.	No. 6.	No. 5.	No. 0.	No. 1.	No. 2.	No. 0.	No. 5.	No. 5.
Randol shaft	1					1			
Santa Isabel shaft				1					1
Buena Vista shaft				2					
Washington shaft					1			1	
Saint George shaft							1		
Hacienda				1			1		
In storeroom	1	2						1	



RANDOL SHAFT, NEW ALMADEN, CALIFORNIA, IN 1889.

LIST OF ENGINES, ETC., AT NEW ALMADEN—Continued.

ENGINES FOR GENERAL SERVICE.

LOCATION.	HORIZONTAL.			VERTICAL.		
	Number of engines.	Diameter of cylinder. (Inches.)	Stroke. (Inches.)	Number of engines.	Diameter of cylinder. (Inches.)	Stroke. (Inches.)
Randol shaft	1	6	16			
Buena Vista shaft				1	6	8
Almaden shaft				1	6	7
Hacienda	1	8	16	2	6	7
In storeroom	1	6	12	1	6	7

AIR COMPRESSORS.

LOCATION.	BURLEIGH.		CLAYTON DUPLEX.
	No. 3.	No. 7.	No. 3.
Santa Isabel shaft		1	1
Washington shaft	1		

PUMPING ENGINES.

LOCATION.	GEARED.			COMPOUND CONDENSING, DIRECT ACTING.				
	Number of engines.	Diameter of cylinder. (Inches.)	Stroke. (Inches.)	Number of engines.	High-pressure cylinder.		Low-pressure cylinder.	
					Diameter (Inches.)	Stroke. (Inches.)	Diameter (Inches.)	Stroke. (Inches.)
Santa Isabel shaft				1	19	60	{ 26 42 }	60
Buena Vista shaft				1	21	96	47	70
Washington shaft	1	10	20					

MACHINERY AT HACIENDA.

The machine shop at the hacienda contains 1 screw-cutting lathe with 9.5-inch centers, 1 flask-tapping and threading machine, 1 Wiley & Russell bolt cutter, and 1 power drilling machine.

The engine house contains 2 horizontal tubular boilers: 1 of 50 inches diameter, 15 feet long, with 40 3.5-inch tubes, and 1 of 30 inches diameter, 11.5 feet long, with 19 3-inch tubes; 1 Knowles steam pump, No. 7; and 1 horizontal steam engine, with 1 cylinder of 8 inches diameter and 16-inch stroke, driving soot machine, also set up in the engine house.

DESCRIPTION OF TOOLS.

The hammer is a piece of steel, weighing from 7 to 8 pounds. It has 2 striking faces or polls, the eye in the center being 1.25 inches in diameter, into which the helve or handle, about 2.5 feet long, made of ash or hickory, is fastened.

The drills are octagonal bars of cast steel, about 1 inch thick, cut in lengths of 1.5 to 4 feet. One end is flattened out wedge-shaped and drawn to 1.125 or 1.25 inches in width.

The scraper is a three-eighths-inch bar of round iron, 3.5 to 4 feet long, on one end of which a hemispherical spoon is hammered out at right angles to the axis of the bar, while the other end has a half-cylindrical spoon about 6 inches long, which is used in charging drill holes with black powder when their direction is horizontal or slightly upcast.

The swab stick is a piece of round wood three-fourths of an inch in diameter and 3 or 4 feet long. One end is bruised into the shape of a brush, to which the sludge from the drilling adheres and is drawn from the drill hole.

The "gad" is a piece of drill steel 6 inches long made into the form of a wedge. It is used to wedge off fragments of rock, or for breaking ground which does not require blasting.

The "moyle" is a bar of drill steel from 1 to 2 feet long with 4-sided point. It is used like the gad, and is especially employed in cutting the so-called "hitches" for timbers.

The pick is made of a square bar of iron 1.5 inches thick and slightly curved in the plane of the handle. It has a 4-sided pyramidal steel point at the curved end, and a poll 3 inches long at the other end. It has an eye like the hammer 3 inches from the face of the poll, into which the ash or hickory handle, about 2.5 feet long, is inserted and secured.

The shovel is the ordinary long or short handled square or round-pointed shovel. They are bought with the helves fitted to them.

These constitute the regular kit of tools with which the miners are provided by the mining company. Broken pick handles or hammer handles are replaced by the miner who uses the tool.

The wheelbarrow is used in some of the prospect drifts, where a regular track for tramming has not been laid. The wheelbarrow used in mining is made of wood, and is of the old Cornish type called the "Jack" wheelbarrow.

The timbermen use axes, crosscut saws, handsaws, augers, chisels, sledges, block and tackle, and ropes, furnished them when needed.

EXPLOSIVES.

Black and dynamite powders are stored in the company's powder magazine, a solid brick building, well protected and standing isolated at a safe distance from the Randol shaft. The percussion caps and fuse are kept apart in the company's storehouse. The black powder used is the size F from the Santa Cruz powder mills, and the other powder is dynamite No. 2. The explosives used in the footage labores are under the charge of the blaster, who receives at one time from 25 to 30 kegs (of 25 pounds each) of black powder and about 100 pounds of dynamite powder from the magazine and stores them in an underground magazine built in an abandoned labor or situated at a safe distance from the workings. About 100 to 200 feet of fuse only are taken into the mine at one time, so as to prevent its getting damp from exposure to the atmosphere underground. The blaster keeps in his magazine, which is under lock and key, also all the tools used by the timbermen working in the labor. The contractors working under the tribute system for ore, or having contracts for drifting or sinking or other prospect work, store their explosives in a safe place at a distance from their work. The dynamite powder for ordinary drill holes is bought in sticks about 8 inches long and 1 inch in diameter. For machine drills the sticks are 8 inches long and 1.5 inches in diameter.

To charge a hole with dynamite powder a fuse of the required length is first prepared, one end of which is shaped to go into the cavity of the cap. The cartridge is then put into the drill hole and pressed tightly in place with the swab stick. It is often found convenient to break the stick of powder into halves before placing it in the hole, for the reason that it will more readily expand when pressed down by the swab stick and more completely fill the drill hole without leaving voids. Sometimes in very hard ground a half or a whole stick more of powder is placed on top of the first one. The fuse with the cap then being placed down on the cartridge, the hole is filled with fine dirt loosely thrown in and slightly tamped, while a wet hole is simply filled with water in place of tamping.

The charging with black powder is done as follows: If the hole is downcast, half of the charge of powder, from 4 to 7 inches of the drill hole, is poured in, the fuse with the cap is inserted, and the other half of the powder charge is poured on top. The hole is then tamped, which consists in packing from 12 to 18 inches of fine dirt on top of the powder by the use of the tamping bar or swab stick. After the hole has been properly tamped a small piece of candle (or snuff) is placed under the outhanging end of the fuse, to be lighted when all holes have been charged and are to be fired. An upcast hole is charged with a cartridge made of powder. These are cylinders made of soaped paper, 1 inch in diameter and from 12 to 18 inches long, filled with powder. The fuse is inserted in the middle, as in charging with loose powder. The object of the paper cylinder is simply to retain the powder, and the paper is soaped so as to keep the powder together. These cartridges are tamped and fired in the same way as with loose powder.

In drilling, the place selected for the hole is started, if possible, with a pick. A man then takes a short drill, and, holding it steadily in both hands in the direction the drill hole is wanted, lets his partner strike the other end in successive strokes with the hammer. After each blow he raises the drill slightly and gives it about one-tenth of a turn. In this way the rock is chipped and a cylindrical hole is formed. Water is poured in the hole if possible, as it is found to expedite the drilling, converting the dust into a wet sludge, in which state it is easily removed from the hole. A rag or washer is put around the drill to prevent the splashing of the water. As the depth of the hole increases a longer drill is used, and by continuing in this way a hole from 4 to 6 feet deep may be drilled. The ordinary drill holes are usually from 1 to 4 feet deep, according to circumstances.

METHOD OF WORK.

Men employed in prospect work labor in gangs as follows: For shaft sinking, usually 9 men, in 3 shifts of 8 hours each, one shift going to work at 7 o'clock in the morning, the next at 3 o'clock in the afternoon, and the third shift at 11 o'clock at night. No time is allowed for regular lunch. For sinking winzes, 6 men, in 2 shifts of 10 hours each, are employed; for raising a winze, 4 men, in 2 shifts of 10 hours each; for drifting, 4 men, in 2 shifts of 10 hours each. These rules are sometimes altered to suit circumstances.

Drifting with machine drills is done by 9 men in 3 shifts of 8 hours each. Most of the drifting and sinking is done by hand drills. Machine drills are only employed in straight tunnels or crosscuts and in the larger shafts when a rapid progress of the work is desirable.

In prospect drifts miners follow the contact of the vein or the footwall with the hanging wall (alta). To do this requires some experience, as the variable nature of the rock makes this distinction at times very difficult. For

TUNNELING AT THE NEW ALMADEN QUICKSILVER MINE.

this purpose the shift bosses and the mining captain visit daily the different parts of the mine where explorations are going on to make sure that no errors are made by the contractors in following the vein.

It is the rule of the company that in drifting, sinking, or raising the contractor has to follow the line of contact between the alta and vein or footwall, one-half of the drift being in either ground, and that should the contact be lost and the breast of the prospect show a decided change to either, running all in alta or all in vein, the contract is considered finished, and new arrangements have to be made as to price before work is continued as directed under the new circumstances.

In crosscuts and inclines or upraises where a certain direction is to be maintained in order to reach a certain point, lines are hung by the surveyor from the roof of the drift to indicate the required course.

The timbering of drifts, shafts, winzes, or crosscuts is done by the contractors in pursuance of their work, and is included in the contract price. The detail part of the work is left entirely to the company of miners (contractors), under the supervision of the shift bosses and the mining captain, and the timber is sent into the mine once a week for this purpose, usually Saturdays. Miners working on footage are paid for the loss of time in transporting the timbers to the labores and in assisting the timbermen, while men working on tribute or by contract do this work without compensation, as it forms a part of their contract. For the underground transportation small 4-wheeled trucks are used. The timbers are stored underground partly in the upper plats of the stations, partly in side drifts that are unused, or at other places on the line and out of the way of the tramming cars.

The system used in the prosecution of the prospect work is called the "yardage system", because the work is paid for by the linear yard in depth or distance excavated. The yardage work is almost entirely done by contract. The several drifts, shafts, winzes, or crosscuts selected by the management of the mine as the future month's work are publicly posted at the company's office on the hill 1 or 2 days previous to the acceptance of the bids, in order to give the miners sufficient time to view the ground and satisfy themselves as to the difficulties and the hazard of the undertaking. The bids are received on raya day (pay day), which falls usually on the last Saturday of every month, and when all bids are received they are compared and, the lowest or most advantageous ones being selected, the awards are made public on the same day. Bids for footage work, tramming, and skip filling are received at the same time.

TIMBERS.

All the timbers used underground are of squared hewn redwood. The thickness varies from 8 to 16 inches, the length from 8 feet to 16 and 20 feet. The lagging is 3, 4, or 6 feet long, and has a thickness of 3 by 6 inches in cross section. Ties for car tracks are 4 by 6 inches in cross section and 4 feet long. Timbers are stored on the surface near each shaft, a year's supply being always kept on hand. Here the timbers are framed for the required work, including timbers for shafts, winzes, and drifts, which are of known sizes, while the timbers for use in the labores are sent into the mine in whole lengths and cut to proper shape underground. The required sizes and numbers are selected and marked with their destination, the shaftman keeping an account of every size and length of timber sent into the mine.

Every Saturday, as already mentioned, is set apart for sending down into the mine timbers that will be required during the coming week. At the Randol and the Santa Isabel shafts cages especially built for the transportation of timbers are employed. The timbers are made to stand up on the platform of the cage, while the upper ends are securely lashed to its frame. The timbers are lifted into this cage by a hand winch, using a 1-inch manilla rope, to which 2 chains are fastened with dogs at their ends, that are driven into the timber. They are brought to the shaft on small trucks, and when at the proper station in the shaft are received there by the men, who unload them from the cage by the dexterous use of rollers, aided by the engineer on the surface by slowly hoisting at the given signal. A regular force of timbermen, from 15 to 20, attend to the general timbering in the mine, as repairing and replacing old or wornout or broken timbers in drifts and labores or winzes, and framing timbers for these purposes on the surface. These timbermen are paid by the month, and have their light furnished.

The timbering of the footage labores is done under the supervision of the blaster (who is in charge of the labor) by the timbermen, assisted by the miners working on footage contract if necessary, for which work they receive day's pay.

The yardage work is measured at the end of the contract, which usually extends to the end of every month, by the mining captain, aided by the surveyor, and in presence of the mining superintendent. The footage work is measured daily before blasting the holes by the blaster or foreman of each labor.

Contracts with tributers are renewed every month by the mining captain and superintendent, who then inspect every tributer's pitch or labor, and agree with the company of tributers on the price to be paid per ton of cleaned ore.

The laborers in the mine are paid by the day and provide their own light. Their work consists in shoveling ore in the footage labores down to the platform, where it is handy for the cars; assisting the timbermen, shaftmen, and pumpmen; filling skips in shafts, and tramming cars where this work is not given out by contract; dumping the cars at the planilla during nighttime, and other services. About 20 men are employed in these occupations, in 2 shifts of 10 men each.

One man, an experienced miner, is employed at each shaft to attend to all work that pertains to it, looking after the pumps, skip roads, station plats, ladder ways, shaft timbers, and general repairs. He is assisted by laborers or timbermen as required. The shaftmen are paid by the month and are furnished with light.

The mining captain is the superintendent of all underground work, which he directs with the aid of the shift bosses. All matters relating to mining are reported to him.

There are 2 shift bosses, alternating, or day and night shifts. They inspect during their shift all work done in the mine by prospectors or tributers, also the laborers, timbermen, trammers, etc., marking down labor shifts and footage work, and reporting the same at the office. They see that the proper force of men is at work everywhere, and in cases of absence that substitutes are provided to insure the regular working at all places.

SURFACE WORK.

The surface foreman supervises all surface work not directly connected with mining. He makes the requisitions for all necessary supplies and materials, which he keeps in store, and accounts for them as they have been received and distributed. All improvements on the surface, dwellings, boarding houses, storehouses, offices, shaft houses, roads, water works, telephone lines, etc., are under his direct supervision, so also the working of the old surface ore dumps, the planilla work, stables, and transportation. He collects the rents for dwellings and ground lease, is the manager of the Helping Hand hall, and looks after the sanitary and general police regulations.

The surveyor attends to all surveying on the surface and in the mine and the mapping thereof. He makes monthly a report on the progress of the prospect work, the condition of the labores, the quantities of ore and waste rock hoisted at the different shafts, and ores sent to the hacienda reduction works.

The clerk in the hill office keeps the monthly and daily account of all labor performed and ore produced, and the pay rolls.

The chief engineer has charge of all machinery, boilers, and the blacksmith and machine shops on the hill and at the hacienda. His monthly report contains: skip loads of ore and waste rock hoisted at each shaft; trips with men and timbers; average steam pressure in pounds; average vacuum in inches; temperatures of feed water, of hot-water well, and injection water; revolutions of pumping engines; number of gallons of water raised; amount of coal used at boilers, in blacksmith shop, and for steam pumps; amount of coal and firewood on hand; quantities of different lubricants used, and other notations of interest.

Transportation is done by contract. The contractor keeps his horses and wagons at the hacienda. He provides teams at fixed contract prices, and hauls the ore from the planillas or the old surface dumps to the ore chutes at a certain price per ton. The hauling of timber, coal, wood, and other supplies is also by contract. Between 70 and 80 draft horses and mules are employed in this work.

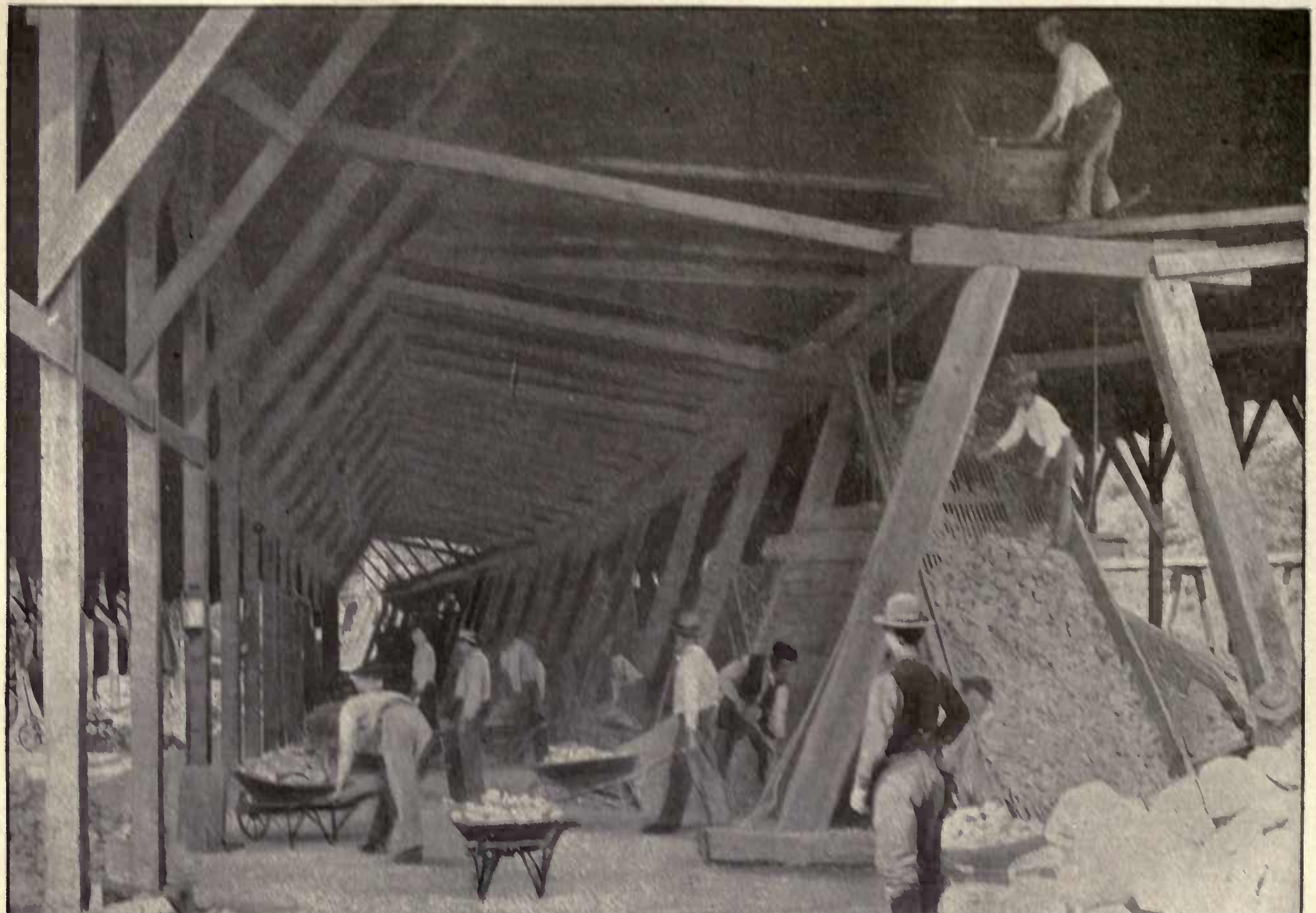
ORE DRESSING AND TRANSPORTATION.

The vein matter, just as it is broken in the labores or stopes of the mine, is run out in cars on an elevated tramway above the planilla or dressing floor belonging to each principal shaft. The most important is the Randol planilla, which is situated at the mouth of the Randol tunnel. All of the rock hoisted at the Randol shaft is trammed out through this tunnel. 6 cars, holding 1.5 tons each, are used to transport the rock. While 2 full cars are being drawn out 2 others are being filled and the other 2 are being dumped. Switches and double tracks at the shaft and mouth of the tunnel enable the change of trains to be made.

The loaded cars are received at the mouth of the tunnel by a man called the "dumper", who runs them into the planilla shed or to the "tepetate" dump, accordingly as they contain "metal" (pay ore) or barren rock from drifts and crosscuts.

The Randol planilla floor is 14.5 feet below the track. At intervals of 32 feet iron bar screens are placed which extend from the track to the floor at an angle of 45°. The screen bars are made of wrought iron and are placed from 1 inch to 1.25 inches apart. The bars are slightly chamfered in cross section to prevent choking. To prevent spreading they are stayed with cast-iron crossbars at intervals of 4 feet, and to take the sudden jar of large rocks dumped from the cars above short pieces of heavy T rails are placed longitudinally in the upper end of the screen. The sides are constructed of heavy scantlings. The outside width of the 9 screens is 5 feet. Upon these screens the metal is dumped, and what passes through is known as "tierras". The coarse fragments which fail to pass the screens are carefully picked over. On account of the tribute system it is necessary to keep the ore produced by each body of miners in a pile by itself, and as the ore produced by each company of footage men is also kept separate, the production of ore ("granza") from each level and ore stope is accurately known. The tierras are allowed to mix indiscriminately. Metal is cleaned only during the daytime, the work being done by men and boys. Rock hoisted during the night shift is dumped on the screens and cleaned the next day, the capacity of the screens being sufficient to allow this without inconvenience.

It has been already mentioned that the breaking and mining of the ores is done by two systems, one called the footage system, the other the tribute system. The ore broken by the footage system on the different levels of the



CLEANING QUICKSILVER ORE.

mine is also kept separated on the planilla in order to credit each level with the amount of ore produced. 2 or more levels are usually so represented on the planilla. For all these reasons the ores coming from different sources have to be dumped over separate screens. In cleaning, the ore which does not pass the screens is piled separately for each company of tributers and for each level, so that it may be weighed separately and credit be given accordingly. There are at times as many as 15 companies of tributers so represented on the planilla, besides the footage labores from 2 or 3 different levels, all of which have their ore piled in separate heaps.

The sorting is done very rapidly, and the rich pieces of ore picked out. All pieces of rock which do not contain any signs of metal are thrown into a car and brought to the waste dump. Large rocks containing some ore and much waste rock are piled on one side to be cleaned by spalling or breaking the rocks with sledge hammers and separating the waste rock. What is left over is taken to the pile of ore where it belongs. The cleaning of the ore in this way is speedily done.

Transportation of ore.—From the planilla floor the ore and tierras are loaded into ore wagons and weighed on platform scales. These wagons, drawn by 4 horses, hold about 3 tons of medium-grade ore, and transport the ore and tierras a distance of about 1.33 miles along a nearly level but very winding road to a series of bins, from which the ore and tierras are dumped into cars. A railroad track extends from here a distance of 1,600 feet to the head of a self-acting incline. The cars in trains are drawn over this track by a mule. The cars hold about 2 tons each, and have a gauge of 3 feet. They are lowered down the incline, the speed of descent being regulated by a brake operated by a long lever. A loaded car brings up at the same time an empty one. 3 rails form the 2 tracks of the incline, except midway, where, to avoid meeting, the cars switch apart on 2 parallel tracks. The connecting cable, a wire rope 1 inch in diameter, passes 3.5 times around an iron drum 6 feet 6 inches in diameter placed at the head of the incline. This drum is controlled by a hand brake acting upon a wheel 7 feet in diameter, and the brake levers are coupled so as to give a leverage of 57 to 1. The brake band is 6 inches wide, and consists of iron lined with hard wood. The incline trucks are surmounted by a horizontal platform upon which the ore cars rest, this platform when at either end of the incline being level with the railroad tracks. The incline is about 830 feet in length, and has a slope of about 28°. The cable is supported by wooden rollers placed between the rails at intervals of 24 feet. From the foot of the incline the cars, in trains of 5, are drawn by another mule on a track to the ore bins and screens near the furnaces. The cars are arranged to dump sidewise, being tilted up by means of levers, while at the same time the side of the car is swung open.

As already mentioned, these cars hold about 2 tons of ore or tierras, but the exact weight is never taken, as the amount shipped each day is reported from the planilla.

Two classes of ore, sorted according to size, thus reach the reduction works at the hacienda, viz, granza (coarse) and tierras (fine). Formerly, when the old dumps were being worked over, the coarse ore so obtained was called "terrero", to distinguish it from the granza of the mine. This class is no longer produced. Old dumps are still being worked for tierras, but all coarse fragments are separated by means of ore forks and rejected if waste rock, or broken small if they contain cinnabar. An intermediate size of ore called granzita is obtained, at the hacienda principally, by passing the mine tierras over screens with 1.25-inch meshes. The ore product is classified as follows:

SIZES OF ORE PRODUCT.

At the mine	Ore or granza, coarse, rich. Tierras, fine, poor.
At the works	Granza, 8 to 3.5 inches, rich. Granzita, 3.5 to 1.25 inches, poor. Tierras, 1.25 inches to dust, poor.

There are 4 screens into which the tierras from the mine are dumped. No. 1 screen consists of 36 cast-iron meshed plates 1 inch thick and 2 by 2.5 feet square. The screen is 4 plates (8 feet) wide and 9 plates (22.5 feet) long, and has an inclination of 45°. The meshes are 1.5 inches square on the upper side, and larger underneath to prevent clogging, the diagonals of the meshes being parallel to the sides of the plate. At the bottom of the screen there are 2 draw chutes, 1 for tierras and 1 for granzita. No. 3 screen is 4 plates (8 feet) wide and 5 plates (12.5 feet) long. The meshes are like those in No. 1, but the plates are placed at an angle of about 40°. No. 6 screen is 4 plates (8 feet) wide and 6 plates (15 feet) long, with an inclination of about 35°. The plates are similar to those in Nos. 1 and 3, except that the sides instead of the diagonals of the meshes are parallel to the sides of the plates—an arrangement not considered so good as that in Nos. 1, 7, and 3. 4 chutes, 2 for tierras and 2 for granzita, are provided. The ore, although screened at the mine, is again screened at the reduction works to free it from the small quantity of fine material produced by the cleansing and transportation.

4 ore bins are provided, having a capacity of 40, 80, 80, and 700 to 800 tons, respectively, all under cover. The 40-ton bin is provided with a screen consisting of longitudinal 1.5-inch wrought-iron bars 2 inches apart and 12 feet long, placed at an angle of about 40°. The ore is loaded into cars from 2 chutes. 2 chutes are also provided for the screened granzita and tierras. The 2 80-ton bins are simply inclosed incline planes, each of which has 2 chutes for discharging the ore into the cars. The 700 to 800 ton bin is a large inclosure for storing ore. Cars

for granzita and tierras are provided with screens on top of the car box. For tierras the meshes are 1.25 inches square and for granzita 2.25 by 3.5 inches.

Granzita taken from the chutes is usually charged directly into the furnaces. The surplus is stored in a shed 19 feet wide, 100 long, and 20 feet high, adjoining furnaces Nos. 1 and 2.

Tierras are rarely sufficiently dry to charge directly into the furnaces. Those containing clay are particularly objectionable, and must be thoroughly dried before being roasted. The driest tierras are dumped into No. 3 screen and brought to the tierra dump under the roof between furnaces Nos. 3 and 8, a place 60 feet square, surrounded on 3 sides by bulkheads, and are there dumped in large piles. Wet tierras are dumped into screens Nos. 1 and 6, and from there are brought into the yard during favorable weather to be spread out and exposed to the drying influences of the sun and wind.

Very wet tierras are stored aside in a shed containing room for about 3,000 tons. The tops of the condensers of Nos. 3, 6, and 8 furnaces are utilized for drying tierras spread out in thin layers over the heated surfaces. A system of tracks and floors renders this distribution very easy. The driers in connection with the first condensers of No. 6 and No. 3 furnaces are fully described in Professor S. B. Christy's article on "Quicksilver condensation at New Almaden", volume XIV of Transactions of the American Institute of Mining Engineers, 1885.

In order to raise the tierras and granzita to the level of the furnaces after the screening and drying operations are ended, 2 water-balance elevators, 1 on each side of the creek, are provided. Each elevator consists of 2 iron tanks of equal size moving in guides and connected by means of a wire rope, which passes over a sheave, and moving in 2 compartments, each formed of 4 8-inch square pieces, which serve to guide the tanks. The tanks are 4 feet by 5 feet by 2 feet deep, having platforms and tracks on top for the cars. Pits are sunk in the floor of each compartment in order to bring the platform of the tanks level with the tracks in the yard. The connecting rope is three-fourths inch in diameter, and passes 2.5 times around the sheave, 6 feet in diameter. A band brake acting on a drum (5 feet 3 inches in diameter) on the sheave controls the speed. The water for overbalancing the loaded car is introduced at the top of the elevator by means of a swinging pipe and is discharged at the bottom through an automatic valve.

The distribution of the tierras and granzita from the chutes to the various required points in the furnace yard is effected by means of wooden cars. The granzita and tierras cars hold 1,000 pounds. The boxes are 13 inches by 30 inches by 49 inches inside. The charging cars for coarse ore or granza are 1 foot 3 inches by 2 feet 9 inches by 6 feet 4 inches, and are lined with sheet iron, the capacity being 1,600 pounds. The tracks have a gauge of 2 feet, and are constructed of steel T rails weighing 12 pounds per running yard. Pivoted iron plates 43 inches in diameter are used as turntables.

WEIGHING CHARGES.

Granzita and tierras charges are estimated by the known capacity of the cars. The granza cars run over platform scales and the contents are accurately weighed, every charge of ore to be exactly 1,600 pounds.

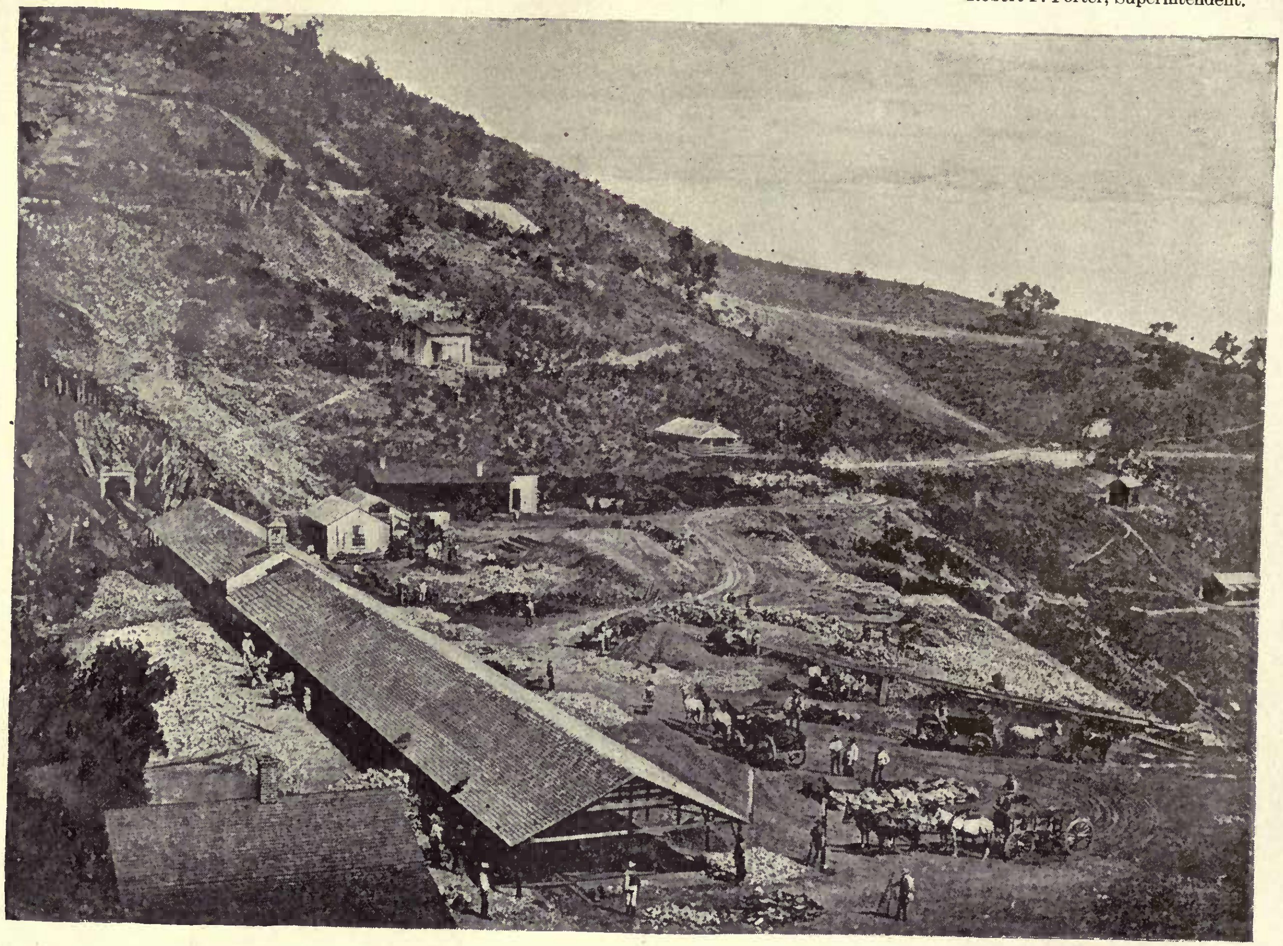
FURNACE YARD.

The furnace yard, as represented by the accompanying map, consists of about 15 acres, situated in the cañon formed by the Alamitos creek. On either side rise steep hills and rocky bluffs, and about a mile to the west is Mine Hill, which has an elevation of about 1,265 feet above the hacienda. The yard is flat and the bases of the different furnaces and condensers are approximately on the same level. The 2 granzita furnaces, Nos. 1 and 2, are on the east bank of the creek. The others are all on the west bank. The ore tramway from the mine enters on the west and follows along the hillside to the ore bins and screens, which are about 60 feet above the furnace floor.

The floors of the furnace inclosures are paved with brick, and the immediate vicinity of the furnaces, condensers, and weighing rooms are covered with a layer of cement or cement and asphaltum.

There are separate weighing and bottling rooms for each furnace except Nos. 7 and 9, 6 and 8, which have 1 room for each 2 furnaces. The floors are cemented and usually have a slope toward the center, with a small cavity to collect quicksilver if spilled. The weighing rooms contain the quicksilver vats, scales, and a number of flasks. The product of each furnace is kept separate, and the quicksilver in the vats is weighed and flasked once or twice every day. The weighing is done by the watchmen, who keep a record of the number of flasks of quicksilver weighed and sent out and the number on hand in each weighing room, and this account is handed in at the office every night. The flasks of quicksilver are piled up in the weighing room to await shipment or to be transferred to the storehouse.

The flasks now used are secondhand, being bought in the market from shippers. All old flasks require overhauling. They are carefully examined to detect cracks and holes and are then scraped inside to remove iron scales and foreign substances. If necessary, they are retapped and fitted with new stoppers. To remove the oil which they acquire in retapping they are piled in a rectangular heap and subjected to heat. Ordinary quicksilver flasks are about 12 inches long, cylindrical, 5 inches in diameter, made of wrought iron three-eighths inch thick, weigh about 13.5 pounds, and have capacity for 85 to 93 pounds of quicksilver if completely filled, but to allow for



THE PLANILLA, AT THE MOUTH OF THE MAIN TUNNEL, NEW ALMADEN QUICKSILVER MINE.

expansion a fixed quantity of 76.5 pounds is weighed in, making the gross weight of flasks and contents for shipment 90 pounds.

Wood for the furnaces is bought from private parties, who bring it to the hacienda from nearly exhausted forests 15 to 20 miles distant. The wood comes in lengths of 4 feet. For furnaces 7 and 9 the wood is cut by a machine at the hacienda into lengths of 2 feet. The wood is piled in the furnace yard and hauled to the different furnaces as needed. An accurate account of the consumption of wood for each furnace is kept, and the average amount of wood necessary for roasting a ton of ore is computed each month. The kinds of wood used are live oak, tan-bark oak, white oak, redwood, pine, manzanita, and madrone. Live oak is usually preferred to white oak, which is much inferior. Pine is good as fuel, but has rather too much flame and produces soot. Redwood makes good fuel if not more than one year old. Redwood and live oak mixed burn well and with the proper amount of heat and flame.

On account of the soot cleaning it is desirable to obtain a certain quantity of ash, which redwood alone will not produce; hence the reason for mixing it with oak wood.

RELATIONS WITH LABOR.

The population of New Almaden, depending upon the working of the mines, lives within easy reach of the mine workings, on what is called Mine Hill, on the flat slopes of which the houses and other buildings are grouped along the most accessible places. Near the oldest workings of the old mine is that portion generally inhabited by the Spanish-Americans and called Spanishtown, while farther to the north and east of Mine Hill is the so-called English camp, where the English-speaking population resides. The population numbers about 1,350 persons. Most of these are Mexicans (native Californians), and the next largest percentage is composed of Cornishmen and their offspring. Americans, English, Germans, Swedes, Italians, and a few Chinamen complete the list of nationalities.

Near the reduction works at the foot of Mine Hill is the hacienda, which consists of the furnaces, office, storerooms, workshops, and dwellings of all employés connected with the reduction works. Both places are upon the lands of the Quicksilver Mining Company, and all local arrangements and sanitary matters are therefore largely under the controlling influence of the mine manager.

The educational interests are taken care of by the state school department. A very neat schoolhouse in the English camp and a smaller one in the Spanish camp are under the direction of a principal and 3 lady teachers, and another is located at the hacienda, under the management of 1 or 2 teachers. The Quicksilver Mining Company does all in its power to foster and assist these interests. At the enumeration for the Eleventh Census there were reported 333 children between 6 and 17 years of age on the hill and 85 children at the hacienda. The average attendance is about 80 per cent in all the schools. During the last year "technical schools" were established at both settlements, furnishing instruction in blacksmithing and carpenter work for the boys and sewing and plain cooking for the girls. Although these schools were open only during the term of vacation in the public schools, very gratifying results were obtained.

There is a Catholic church in Spanishtown and a Methodist Episcopal church at the English camp. A Methodist minister resides at the camp. The Catholic church is attended on Sundays and great holidays by a priest not resident at the place. These churches were built with the aid of private contributions, assisted by the company and manager.

Only 1 saloon is permitted on the hill, and it is allowed to sell only beer and wine, other intoxicating liquors being excluded.

Benevolent institutions are of a private nature. The Englishmen have a mutual benevolent society, the members of which succor each other in times of need or sickness. and the Mexicans have 3 similar societies, called the Guadalupe society (Nuestra Señora de Guadalupe), organized February 1, 1873, and reformed in May, 1886, and the Hidalgo and Philanthropico societies.

The sanitary department is represented by a resident physician and surgeon, assisted by a competent druggist and a complete drug store. This is under the so-called miners' fund of New Almaden, established by general consent in 1870. The rules and regulations of this institution are in substance as follows:

I. Employés of the Quicksilver Mining Company, heads of families, and all other adults residing at New Almaden each pay $1 monthly into said fund. The money so contributed is held by a trustee, to be paid out for the following purposes: first, the salaries of a resident physician and druggist and for the purchase of medical supplies; second, for the relief of contributors whom circumstances may entitle to the same, and for other contingent expenses.

II. Contributors are entitled, without further payment, to the attendance of the resident physician for themselves and their immediate families, except that in cases of confinement the sum of $5 is charged, and medicines are prescribed and furnished on payment of cost.

III. When the fund is subject to any expense for relief of persons indigent or otherwise, as for medicines, nurses, and supplies, it will be regarded in the nature of a gift or as an advance to be repaid, as the trustee may decide to be just, considering the circumstances of each case.

IV. It is expressly agreed that when the resident physician is called to attend any person not a contributor to the fund there shall be a charge of not less than $5 for each visit, to be paid into the fund and to be charged against and collected from the head of the house where such noncontributor may be living.

V. The trustee serves without pay, and in consideration thereof it is understood that the foregoing rules and regulations will be observed by all persons interested therein; and it is expressly agreed that all sums due or to become due to the fund by contributors, or any of them, shall be a lien upon any property of the contributors at New Almaden and upon any money due or to become due them for wages from the Quicksilver Mining Company, which money the company is authorized to pay over to the fund without further notice.

HOSPITALS.—2 hospitals are provided, 1 in the English camp and 1 in Spanishtown, although their use is very rarely required. Nurses are paid from the miners' fund. An employé receiving an injury while on duty or at his work is supplied with medical or surgical supplies without cost, and nurses and sustenance are furnished if necessary, or support given his family during his illness and incapacity for work. Cases of destitution from ordinary sickness or other causes are deservedly considered.

The physician makes a monthly report of (1) the number of visits made each month, (2) the number of office prescriptions, (3) the number of vaccinations, (4) the number of obstetrical cases, (5) the number of cases of salivation. The druggist, who is also a clerk for the mine, makes up the prescriptions, for which he is paid an allowance of $25 per month. The accounts and collections are made by the bookkeeper of the hacienda. He also receives a compensation of $25 per month.

The company provides stabling for the physician's saddle horse, and all the necessary buildings for offices, hospitals, dispensary, and dwelling house for the physician, free of expense.

The report of the physician for the year ended November 30, 1890, is given below. The table treats only of the employés at the mine and at the reduction works. A statement on the following page deals with the entire population residing on the lands of the company.

PHYSICIAN'S REPORT AT NEW ALMADEN FOR THE YEAR 1890.

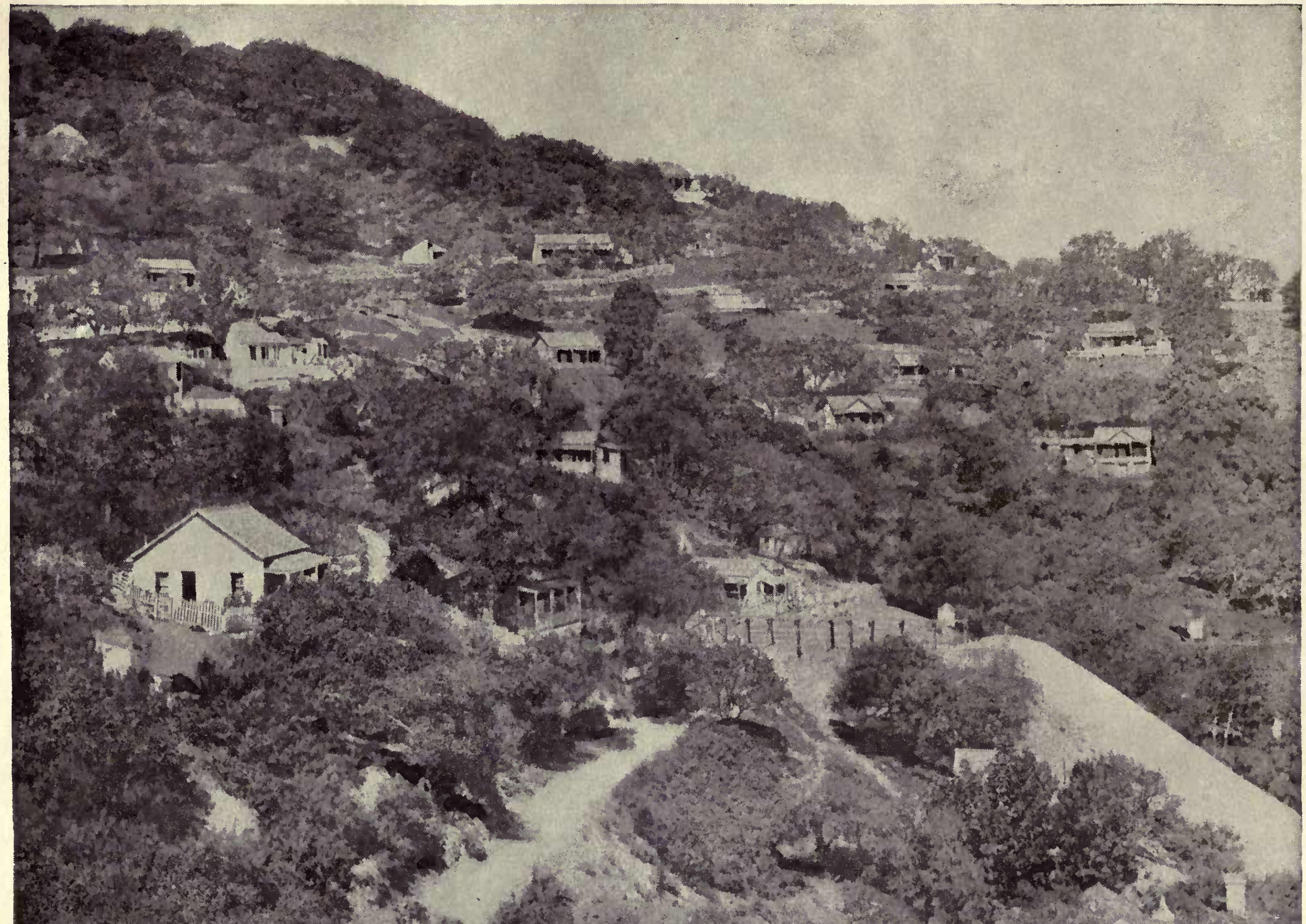
ITEMS.	MINE.		WORKS.	
	Number.	Per cent.	Number.	Per cent.
Average number of employés	316		47	
Number and per cent of cases of mercurialism	33	10.44		
Number and per cent of serious accidents	5	1.58		
Number and per cent of new cases	267	84.50	55	117.02
Total new cases of all kinds	305	96.52	55	117.02
Deaths	3	*a*9.49		

a Per thousand.

The above table shows a decided difference in the salivation rate at the mine in comparison with that at the works, and, being so remarkable, is well worthy an inquiry as to its cause. This difference may in a measure be explained as follows: the miners employed in the extraction of ore work by contract as a rule, and a certain number of careless men, through their own negligence, become victims to mercurial salivation. Men engaged in ore chambers where native mercury is found are requested not to eat, drink, or smoke without first cleaning the face and hands and using a solution of potassium chlorate as a mouth wash. Working stripped to the waist is discouraged.

As the greatest attention is paid toward the attainment of perfect ventilation, which is of prime importance in the prevention of mercurial sickness, it is the physician's belief that if the miners were more thorough in the use of the above precautions the salivation rate at the mine would be under 1 per cent, whereas it is now over 10 per cent It is probable that there will always be a slight amount of mercurial sickness, owing, very likely, to the suspension in the moist atmosphere of the mine of a small amount of the chlorides and possibly other salts of mercury. The absolute immunity from mercurialism of the men employed at the reduction works may be explained on the following grounds, viz: to the thorough sealing of furnaces, condensers, and flues; to the use of forced draft by means of fans; to the discontinuance of soot-cleaning by hand; to the medical prophylaxis, which consists solely in the use of a saturated solution of potassium chlorate as a mouth wash after the slightest exposure to mercurial vapor or other noxious fumes; to the employment at the works of a careful, faithful, and comparatively temperate class of men, this last characteristic being in no small degree responsible for the absence of mercurial sickness; lastly, to the increasing experience now obtaining in the proper reduction of quicksilver ores, and to the efforts on the part of the management to secure absolute immunity from mercurial salivation through the use of the most approved apparatus and appliances. There were but 5 accidents of a serious nature, all of them being fractures, none of which proved fatal.

The high and greatly abnormal sick rate was due to the prevalence of the grippe epidemic in the winter of 1889 and spring of 1890, yet no fatal cases resulted therefrom. The 3 deaths reported as occurring at New Almaden



HILLSIDE COTTAGES, ENGLISH CAMP, NEW ALMADEN QUICKSILVER MINES.

mine were caused by parenchymatous nephritis, pyæmia, and erysipelas following a gunshot wound. A special census taken during December, 1890, gives the information contained in the following table:

SPECIAL CENSUS AT NEW ALMADEN IN 1890.

ITEMS.	Total.	SPANISH-AMERICAN.				ANGLO-AMERICAN AND OTHERS.			
		Over 5 years.		5 years and under.		Over 5 years.		5 years and under.	
		Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.
Hill (mine)	1,132	282	190	47	42	283	214	39	35
Hacienda (works)	223	24	22	4	6	91	57	11	8
Total	1,355	306	212	51	48	374	271	50	43
Number of deaths	25	4	6	7	2	1	2	2	1
Number of births	48	....	28	....	....	....	20	....	....

The analysis of this table shows the following death rate:

DEATH RATE AT NEW ALMADEN IN 1890.

	PER 1,000.
Spanish-American	30.8
Anglo-American (including other nationalities)	8.1
Average death rate	18.5

BIRTH RATE AT NEW ALMADEN IN 1890.

	PER 1,000.
Spanish-American	45.4
Anglo-American (including other nationalities)	27.1
Average birth rate	35.4

The difference in the mortality rate between the Spanish-Americans and the Anglo-Americans, which includes some of other nationalities, is noteworthy, as the 2 classes are living under similar climatic conditions; yet tubercular disease is very common with the former class and caused 10 deaths, while with the latter class not a single case is to be remarked. The diseases which caused death were tuberculosis, 10; cholera infantum, 3; capillary bronchitis, cancer, peritonitis, laryngismus (stridulous), meningitis, erysipelas, tetanus, nephritis, diphtheria, pyæmia, and injuries following a burn, 1 each. Excepting the grippe and measles, no disease has been epidemic during the past year, a fact which serves as a criterion of the excellent hygienic conditions at present existing.

THE HELPING HAND.—A social organization, called the Helping Hand Club, for which the company built and fitted up comfortable houses, on the hill as well as at the hacienda, induces pleasant intercourse among the inhabitants. The hall building at the hacienda is a modern structure in very attractive style, having on its lower floor a large assembly hall and stage for concerts or other entertainments, adjoined by reading and dressing rooms, while the upper floor is divided into 4 bedrooms, for the use of visitors or guests at the reduction works. On the hill the building consists of a large assembly hall, with stage and dressing rooms, a reading room, and kitchen, all on one floor. Both halls are provided with pianos, purchased by the club managers with surplus funds from entertainments given, and the reading rooms have small libraries besides a list of monthly magazines and the best daily and weekly newspapers. The halls are warmed and lighted by the company, and admission is free to all residents at the mine and reduction works who are employés of the company. Entertainments of musical or dramatic character are here given by the club members, and at other times the halls are provided with card tables, where the members may enjoy a pleasant game of checkers, chess, or cards. Every encouragement is given to residents for domestic or public comfort, and the result of this patriarchal régime is seen in the fact that many of the miners have worked here uninterruptedly for 30 years or more; some, in fact, have been born on the soil, are now heads of families, and consider the mine their home for life.

The great majority of the workmen are married and have families, and this class of labor is encouraged and fostered as much as possible, as it forms a more reliable and responsible element than could be had by engaging single men without domestic ties, liable to roam at any moment. It is hardly necessary to add that strikes have never occurred, and are not likely to occur as long as this reciprocated feeling of trust and good will exists between the management and the employés.

The single men employed are boarded and lodged in boarding houses, of which there are 2 on the hill, 1 for the English speaking and 1 for Spanish men. Both are large, substantial dwellings with all the comforts of domestic life, large, well-ventilated dining rooms and sleeping rooms neatly furnished, while there are in the basement rooms in which to change and dry the damp clothing brought from the mine. At the hacienda a similar boarding house, furnished by the company, is kept for single men or visitors. The sleeping rooms for workmen are arranged in a separate building, a similar one being also on the hill.

HOURS OF WORK.—The hours of work on the surface are from 7 o'clock in the morning until 6 o'clock in the evening, allowing 1 hour at noon for dinner or lunch. Miners go into the mine at 7 o'clock in the morning and evening and leave the mine at 5 in the evening and morning, respectively. 1 hour at noon and midnight is allowed for lunch and rest, which, allowing half an hour's time to reach their working places and as much for returning to the surface, makes 8 hours of solid work in the mine.

On Sundays and national holidays work is stopped in the mines and on the surface, except at the pumps of the Buena Vista shaft, which are continued without interruption.

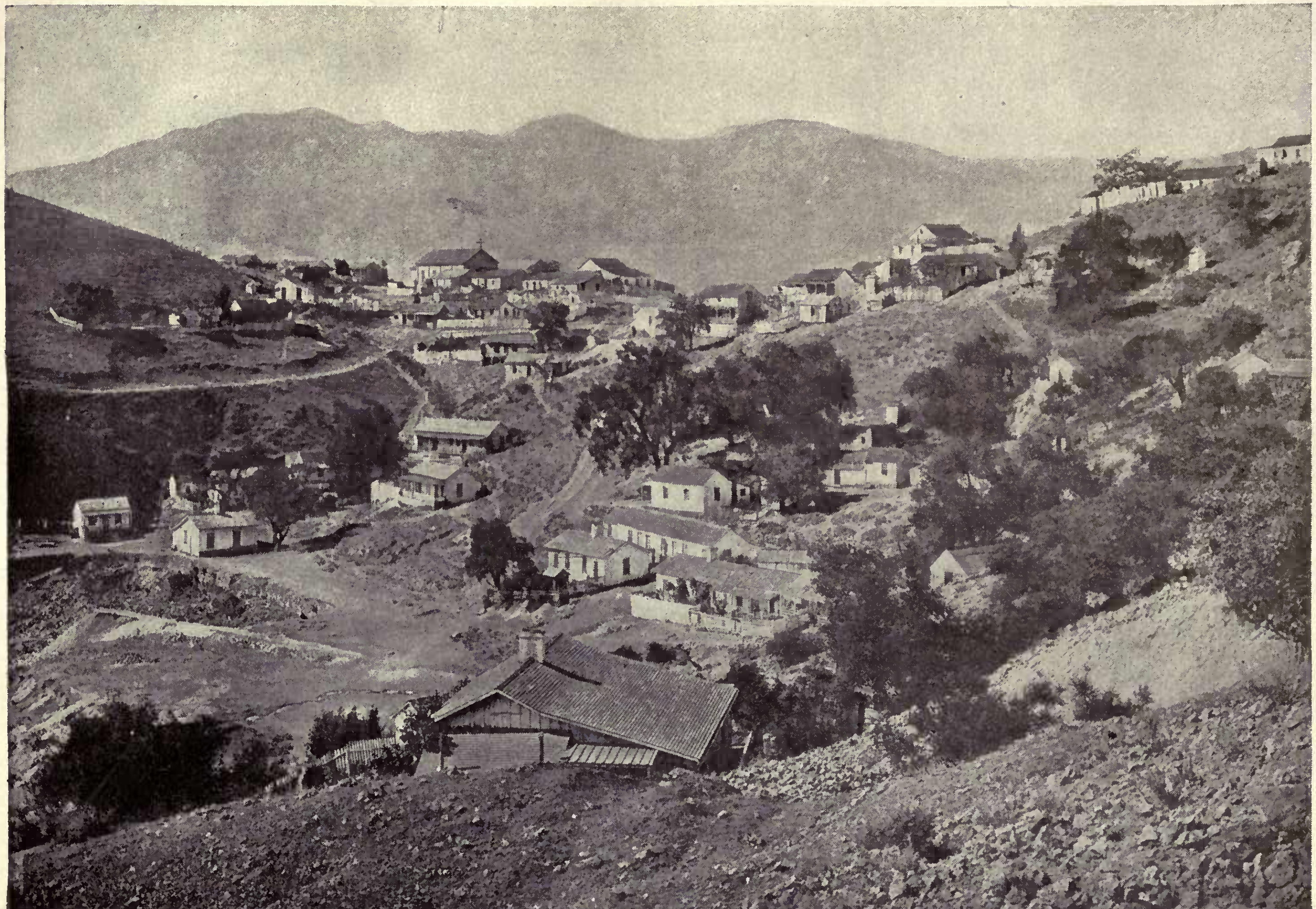
PRODUCTION OF QUICKSILVER AT NEW ALMADEN.

Up to August 31, 1863, the New Almaden mines had produced 23,619,834 pounds of quicksilver, equal to 308,756 flasks of 76.5 pounds each, from 51,157 short tons of ore, or 461.7 pounds to the ton, an average of 23.09 per cent. Including the above, the total to the close of 1889 amounted to 69,191,113.5 pounds, or 904,459 flasks.

PRODUCT OF QUICKSILVER AT NEW ALMADEN FOR 37 YEARS AND 3 MONTHS.

DATES.	Total pounds of ore roasted.	Total flasks of quicksilver produced.	Yield of quicksilver. (Per cent.)
Total and average	1,262,789,640	a893,888	5.41
July, 1850, to June, 1851	4,970,717	23,875	36.74
July, 1851, to June, 1852	4,643,290	19,921	32.82
July, 1852, to June, 1853	4,839,520	18,035	28.51
July, 1853, to June, 1854	7,448,000	26,325	27.04
July, 1854, to June, 1855	9,109,300	31,860	26.76
July, 1855, to June, 1856	10,355,200	28,083	20.75
July, 1856, to June, 1857	10,299,900	26,002	19.31
July, 1857, to June, 1858	10,997,170	29,347	20.41
July, 1858, to October, 1858	3,873,085	10,588	20.91
November, 1858, to January, 1861	....	....	....
February, 1861, to January, 1862	13,323,200	34,765	19.96
February, 1862, to January, 1863	15,281,400	40,391	20.22
February, 1863, to August, 1863	7,172,660	19,564	20.87
September, 1863, to October, 1863	2,346,000	5,520	18.00
November, 1863, to December, 1863	2,359,300	4,447	14.42
January, 1864, to December, 1864	23,277,600	42,489	13.96
January, 1865, to December, 1865	31,948,400	47,194	11.30
January, 1866, to December, 1866	26,885,300	35,150	10.00
January, 1867, to December, 1867	26,023,933	24,461	7.19
January, 1868, to December, 1868	29,405,530	25,628	6.67
January, 1869, to December, 1869	25,458,175	16,898	5.08
January, 1870, to December, 1870	21,097,700	14,423	5.23
January, 1871, to December, 1871	22,034,700	18,568	6.45
January, 1872, to December, 1872	21,416,600	18,574	6.63
January, 1873, to December, 1873	17,330,375	11,042	4.87
January, 1874, to December, 1874	23,454,000	9,084	2.96
January, 1875, to December, 1875	31,106,200	13,648	3.36
January, 1876, to December, 1876	33,316,950	20,549	4.72
January, 1877, to December, 1877	37,231,300	23,996	4.93
January, 1878, to December, 1878	36,942,225	15,852	3.28
January, 1879, to December, 1879	55,065,135	20,514	2.85
January, 1880, to December, 1880	61,354,850	23,465	2.93
January, 1881, to December, 1881	64,141,135	26,060	3.11
January, 1882, to December, 1882	72,147,200	28,070	2.98
January, 1883, to December, 1883	77,162,500	29,000	2.88
January, 1884, to December, 1884	79,251,000	20,000	1.93
January, 1885, to December, 1885	79,069,300	21,400	2.07
January, 1886, to December, 1886	81,398,690	18,000	1.69
January, 1887, to December, 1887	64,151,300	20,000	2.38
January, 1888, to December, 1888	57,325,600	18,000	2.40
January, 1889, to December, 1889	57,775,200	13,100	1.73

a Additional product of Enriquita mine from 1860 to 1863, 10,571 flasks.



MEXICAN CAMP NEW ALMADEN QUICKSILVER MINES.

WAGES AT NEW ALMADEN IN 1889.

EMPLOYÉS.	Per month.	Per day.
MINE.		
Machinists	$100.00	
Machinist's helpers	$60.00 to 75.00	
Engine drivers	70.00 to 80.00	
Firemen	40.00 to 60.00	
Blacksmiths	45.00 to 60.00	
Blacksmiths' helpers	30.00 to 35.00	
Pumpmen	71.00 to 90.00	
Shaftmen	71.00	
Blasters	71.00	
Boilermakers		$2.00 to $2.50
Timbermen (shaftmen)		2.00 to 2.50
Carpenters		3.00
Surface laborers		1.50 to 2.00
Ore cleaners		1.75 to 2.00
Laborers in labores		1.50 to 2.00
Trammers		1.75 to 2.25
Skip fillers		2.00
Landers		1.25 to 1.75
Boys		1.00 to 1.50
HACIENDA.		
Furnace foremen	100.00	
Weighers	85.00	
Machinists	70.00 to 100.00	
Mason	150.00	
Blacksmith		3.00
Blacksmiths' helpers		1.25 to 2.00
Carpenters		3.00
Engine drivers	50.00	
Laborers		2.00 to 2.25
Furnacemen (trammers)		2.00
Furnacemen (firemen and chargers)		2.50
Sootmen		2.10
Transportation, 2-horse teams		4.00
Transportation, 4-horse teams		6.00

SUPPLIES CONSUMED DURING THE YEAR 1889.

ITEMS.	At mine.	At hacienda.
Total	$54,855.15	$31,573.33
Bricks	1.20	38.99
Candles and oils	1,816.40	778.31
Castings and foundry work	144.25	743.93
Coal	19,539.63	2,346.51
Hay and grain	1,031.67	2,064.40
Iron, steel, and hardware	3,128.40	1,062.77
Lagging	1,557.24	
Lime and cement	24.77	82.77
Lumber and timber	17,247.26	2,167.39
Powder, fuse, and caps	2,081.17	
Railroad iron	339.20	28.06
Sundries	2,273.30	1,607.85
Wood	5,670.66	13,738.24
Flasks		6,914.11

DRIFTING, SINKING, AND PROSPECTING ("DEAD WORK") AT NEW ALMADEN.

	FEET.
1880	5,144.79
1881	4,574.25
1882	9,133.00
1883	6,699.50
1884	6,814.50
1885	11,370.50
1886	11,926.00
1887	10,766.50
1888	9,582.00
1889	10,169.00
Total	86,180.04

TABLE SHOWING AMOUNT AND COST OF PRODUCTION OF ORE AND QUICKSILVER AND OF PROSPECT WORK AT NEW ALMADEN, 1880 TO 1889, INCLUSIVE.

YEARS.	Total tons of rock, vein matter, and ore extracted from the mine.	Total tons of granza ore shipped to reduction works.	Total tons of tierras ore shipped to reduction works.	Total tons of all ore shipped to reduction works.	Total tons of all descriptions of ore roasted.	Flasks of quicksilver of 76.5 pounds each produced.
Total	1,109,770.28	73,916.89	263,088.66	337,005.55	346,888.39	217,095
1880	83,666.79	a7,527.67	b4,145.30 a12,125.50	23,798.47	30,677.43	23,465
1881	90,295.65	a8,020.75	b11,697.70 a14,097.50	33,815.95	32,070.57	26,060
1882	120,222.57	a9,236.43	b10,274.00 a14,705.81	34,216.24	36,073.60	28,070
1883	117,579.45	a9,584.20	b11,214.32 a20,289.24	41,087.76	38,581.25	29,000
1884	126,139.61	b8.00 a7,624.23	b11,596.79 a20,038.20	39,267.22	39,625.50	20,000
1885	138,639.52	b81.37 a8,484.77	b4,010.59 a25,039.91	37,616.64	39,534.65	21,400
1886	120,398.85	b183.70 a7,183.96	b5,900.61 a24,717.72	37,985.99	40,699.34	18,000
1887	115,004.15	b60.52 a6,214.52	b7,114.95 a19,642.95	33,032.94	32,075.65	20,000
1888	99,166.54	b22.18 a5,060.95	b4,896.82 a18,196.44	28,176.39	28,662.80	18,000
1889	98,657.15	b24.59 a4,599.05	b3,605.75 a19,778.56	28,007.95	28,887.60	13,100

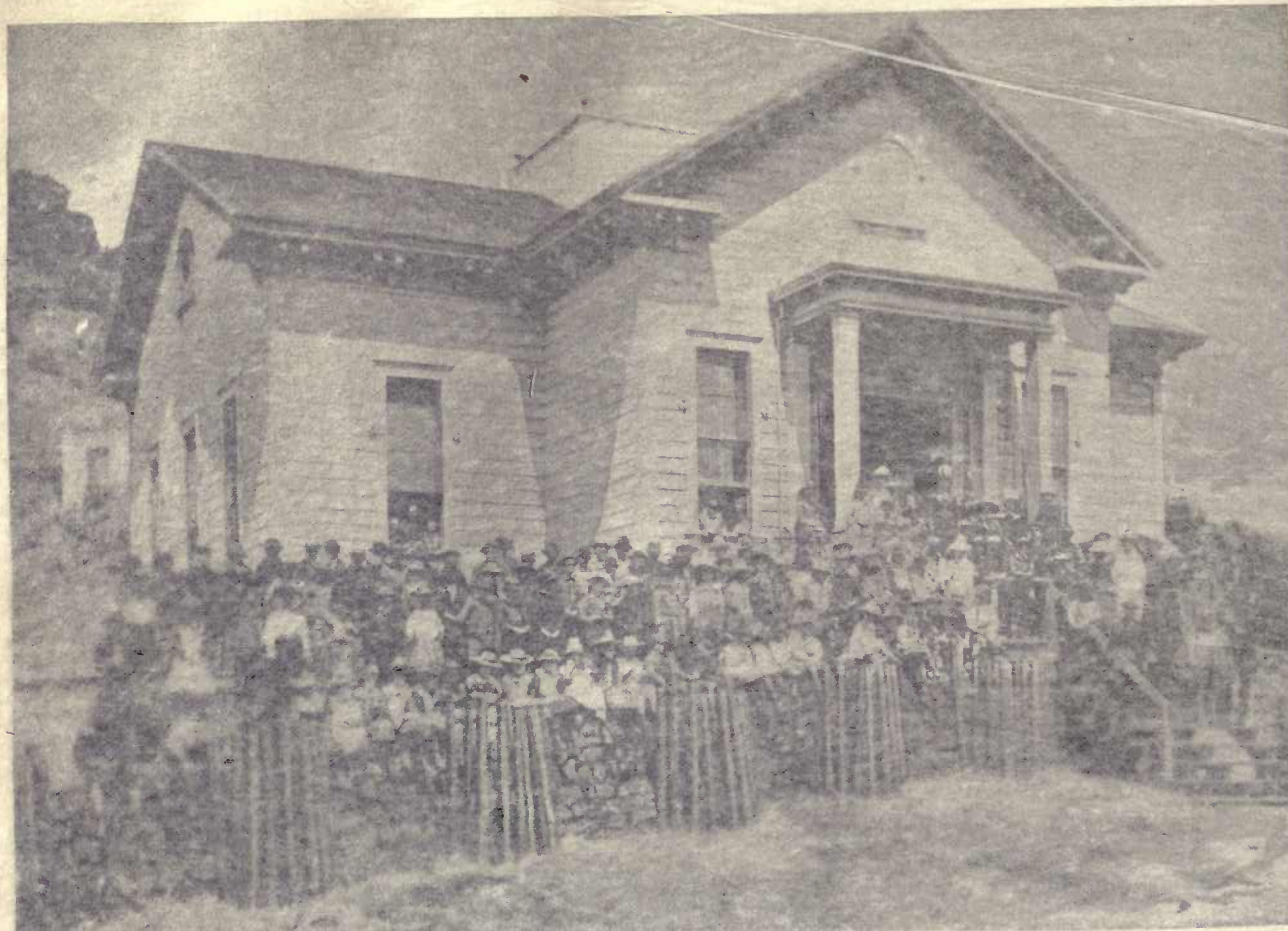
YEARS.	Average yield of all ores roasted. (Per cent.)	Cost per ton for mine supplies, timber, powder, fuse, iron, steel, lagging, candles and oils, railroad iron, and sundries.	Cost for labor per ton for all matter mined.	Cost per ton for all ore delivered at the furnaces; labor, supplies, and transportation.	Cost per flask, embracing all expenses, less receipts from rentals and other sources. (c)	Number of yards drifted, sunk, etc.	Average price paid per yard, not including supplies.
Total and averages	2.39	$0.69	$2.38	$10.46	$21.09	28,110.32	$23.61
1880	2.93	0.62	2.22	10.40	15.25	1,714.93	22.30
1881	3.11	0.55	2.11	7.37	13.25	1,524.75	30.61
1882	2.98	0.59	2.29	10.45	17.13	3,043.63	26.69
1883	2.88	0.65	2.16	8.34	16.10	2,006.87	25.52
1884	1.93	0.74	2.15	9.62	24.00	1,836.53	29.27
1885	2.07	0.88	2.34	12.23	26.75	3,871.58	25.30
1886	1.69	0.82	2.66	11.33	29.14	3,954.18	22.25
1887	2.38	0.71	2.59	11.82	24.75	3,553.82	23.76
1888	2.40	0.71	2.81	12.76	25.24	3,276.45	21.65
1889	1.73	0.55	2.49	11.10	30.41	3,327.58	16.96

a From mine proper. b From surface workings. c Does not include increase or decrease of ore account at hacienda.

THE PRODUCTION OF VERMILION.

As the result of inquiries made, it was reported that 6 manufacturing establishments in the city of New York consumed in 1889 535,728 pounds of quicksilver, equal to about 7,003 flasks, in the manufacture of 600,047 pounds of vermilion.

The manufacturers of mercurial preparations absolutely declined to give any account of the quicksilver consumed in the manufacture of their several products, on the ground that it was impossible to separate the figures, but after much difficulty the aggregate amount of quicksilver consumed by 2 firms was ascertained to be, respectively, 750 and 1,754 flasks. As the desired information could not be acquired from all the manufacturers, the foregoing statement of consumption is only an approximation.



HILL SCHOOL, NEW ALMADEN QUICKSILVER MINES.

TABLE SHOWING AMOUNT AND COST OF [illegible] OF ORE AND QUICKSILVER AND OF PROSPECT WORK AT NEW [illegible], 1880 TO 18[illegible], INCLUSIVE.

YEARS.	Total tons of rock, [illegible] matter, and ore extracted from the mine.	Total tons of granza ore shipped to reduction works.	Total tons of [illegible] ore shipped to reduction works.	Total [illegible] delivered to reduction works.	Total tons of all descriptions of ore roasted.	Flasks of quicksilver of 76.5 pounds each produced.
Total	[illegible]	73,918.[illegible]	[illegible]	[illegible]	346,888.39	217,095
1880	[illegible]	a7,[illegible]	b4,[illegible] a12,12[illegible]	[illegible]	[illegible],677.43	23,465
1881	90,[illegible].05	a8,[illegible]	b11,[illegible] a14,007.50	[illegible]	32,[illegible].57	26,060
1882	120,[illegible]	[illegible]	b10,274.00 a14,705.81	34,[illegible]	[illegible]	28,070
1883	117,[illegible]	a8,58[illegible]	b11,234.32 a2[illegible],289.24	41,087.76	38,581.25	29,000
1884	126,[illegible]	[illegible] a7,[illegible]	b11,596.79 a20,[illegible].20	39,267.22	39,625.50	20,000
1885	138,[illegible]	b41.37 a[illegible]	b4,019.59 a25,030.91	37,616.64	39,534.65	21,400
1886	[illegible]	b[illegible] a7,[illegible]	b6,903.61 a24,717.72	37,985.99	40,699.34	18,000
1887	[illegible]	[illegible] a8,[illegible]	b7,114.95 a19,042.95	33,082.94	32,075.65	20,000
1888	[illegible]	[illegible].18 a5,0[illegible]	b4,[illegible] a16,[illegible]	[illegible]	28,062.80	18,000
1889	[illegible]	524.56 a4,[illegible]	b3,605.7[illegible] a19,778.[illegible]	[illegible]	28,887.60	13,100

YEARS.	Average yield of all ores roasted (Per cent).	[illegible]	Cost for labor per ton for all matter mined.	Cost per ton for all ore delivered at the furnaces; labor, supplies and transportation.	Cost per flask [illegible]	[illegible] of yards drifted, sunk, etc.	Average price paid per yard, not including supplies.
Total and averages	[illegible]	[illegible]	$2.[illegible]	$10.[illegible]	$21.99	28,[illegible]	$23.61
1880	[illegible]	[illegible]	2.22	10.40	15.25	1,71[illegible]	22.30
1881	[illegible]	[illegible]	2.11	7.[illegible]	13.35	1,524.75	30.61
1882	[illegible]	[illegible]	[illegible]	10.4[illegible]	17.13	3,943.63	26.69
1883	[illegible]	[illegible]	2.1[illegible]	8.34	16.10	2,096.87	25.52
1884	[illegible]	[illegible]	2.1[illegible]	9.62	24.00	1,836.53	29.27
1885	[illegible]	[illegible]	2.34	12.23	26.75	3,871.58	25.30
1886	[illegible]	[illegible]	2.66	11.33	29.14	3,954.18	22.25
1887	[illegible]	[illegible]	2.59	11.82	24.75	3,553.82	23.76
1888	[illegible]	[illegible]	2.81	12.76	25.24	[illegible],276.45	21.65
1889	[illegible]	[illegible]	2.49	11.10	30.41	3,327.58	16.96

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HILL SCHOOL, NEW ALMADEN QUICKSILVER MINES.

CONSUMPTION OF QUICKSILVER IN MILLING GOLD AND SILVER ORES.

The following statement has been prepared, after special study of the mines mentioned, to show the quantity of quicksilver consumed in gold and silver milling. The limits are very great, due partly, of course, to the great difference in character of the ores treated, but very greatly also to skill in mill practice.

CONSUMPTION OF QUICKSILVER PER TON OF ORE WORKED.

Years.	Mines.	States and territories.	Number of mills.	Ore worked. (Tons.)	Quicksilver consumed. (Pounds.)	Quicksilver consumed. (Pounds per ton.)
1889	Bimetallic (silver)	Montana	1	23,215	43,528	1.87
1889	Elkhorn (silver and lead)	do	1	8,712	13,387	1.54
1889	Hope	do	1	6,634	8,803	1.33
1887	do	do	1	8,091	7,889	0.98
1888	do	do	1	8,962	9,231	1.03
1885	Montana (limited) (gold and silver)	do	1	33,482	46,545	1.39
1886	do	do	1	41,728	50,235	1.20
1887	do	do	1	75,005	48,434	0.65
1888	do	do	1	83,745	21,503	0.26
1889	do	do	1	78,749	38,638	0.49
1889	Ontario (silver and lead)	Utah	1	34,733	35,580	1.02
1886–1889	Blue Bird (silver)	Montana	1	103,076	85,474	0.83
1884–1889	Granite Mountain (silver)	do	1	120,000	96,000	0.80
1883	Lexington (gold and silver)	do	1	20,281	16,667	0.82
1884	do	do	1	22,138	13,120	0.59
1835	do	do	1	20,749	16,141	0.78
1886	do	do	1	21,379	6,688	0.31
1887	do	do	1	23,789	9,678	0.41
1888	do	do	1	24,594	13,594	0.55
1889	do	do	1	26,361	13,497	0.51
1888–1889	Empire (gold)	California	1	...	...	0.06
1888	North Star	do	1	17,259	842	0.05
1889	do	do	1	20,525	995	0.05
1889	Treadwell	Alaska	1	218,000	2,725	0.01
1880–1890	Homestake	South Dakota	1	2,159,011	14,536	0.01
1880–1890	Idaho (gold and silver)	California	1	278,830	7,879	0.03

At the Bimetallic mine, in Montana, the ore is base silver. It all requires roasting. The average composition of the ore is as follows:

AVERAGE COMPOSITION OF ORE FROM THE BIMETALLIC MINE, MONTANA.

	Per cent.		Per cent.
Silica	64.50	Arsenic	1.53
Iron	7.70	Antimony	0.55
Manganese	2.52	Zinc	5.80
Lime	2.70	Silver	3.07
Sulphur	8.45		
Lead	2.73	Total	100.00
Copper	0.45		

The ore of the Montana (limited) mine contains gold and silver in the proportion of about 64 per cent gold and 36 per cent silver. The gangue is quartz, with a small quantity of broken slate. The ore is free milling, and is treated by the "combination process" of amalgamation before concentration. The principal base in the quartz is copper, of which there is a slight amount, as well as a trace of lead and a very small percentage of manganese.

At the Ontario mine in Utah the country rock is quartzite and limestone; the gangue is quartz; fahlore is the principal silver-bearing mineral, containing galena, zinc blende, copper, and iron pyrites, carrying comparatively little silver and a trace of gold. Near the surface, and also in many portions of the mine below the water level, the sulphurets are more or less decomposed and oxidized. The ore first mined was free milling. At present all the ore has to be subjected to a chloridizing roasting before amalgamation.

There are 2 classes of ore shipped from the Ontario mine. The first, containing from 70 to 80 ounces of silver and from 10 to 12 per cent lead per ton, is sold to the smelters; the second, containing from 35 to 50 ounces silver per ton, with a small percentage of lead, is reduced at the home mill. The percentage of copper and zinc in the ore varies more or less, and has never been accurately determined.

At the Lexington mine, Montana, the gangue is quartz. The ore averages 1 ounce in gold and 50 ounces of silver. The process of reduction is dry crushing, chloridizing, roasting, and amalgamating in pans. Other metals are iron, copper, lead, and zinc as sulphurets, in various proportions, the average being for these sulphurets about

10 per cent, with from 10 to 20 per cent of other gangue material, not quartz, consisting of manganese spar and calc-spar.

The Empire mine, California, has a quartz gangue. The ore is free-milling gold. There are no other metals to speak of in the gangue matter.

The Idaho mine, California, has quartz for the gangue, and the ore yields gold and silver combined; gold about 85.4 to silver 14.6. It is free milling. There are no other metals of value.

At the Granite Mountain mine the ore contains silver, with about one-tenth of an ounce per ton of gold. The ore is refractory, requiring roasting in order to be chloridized and desulphurized. The contents of the average ore are about as follows:

COMPOSITION OF GRANITE MOUNTAIN ORE.

	PER CENT.		PER CENT.
Silica	80	Sulphur	8
Iron	6	Zinc	2
Arsenic	2	Antimony	1
Copper	Trace.		

The zinc, iron, etc., are found in the form of sulphides. The vein matter, outside of the quartz, is mostly decomposed granite.

The Hope mine, Montana, yields silver ore—no gold. It is free milling, not roasted; contains manganese in varying quantities, usually a small percentage. The gangue is blocky quartz, with sulphurets and chloride of silver, between yellow limestone walls, with yellow clay on the hanging wall.

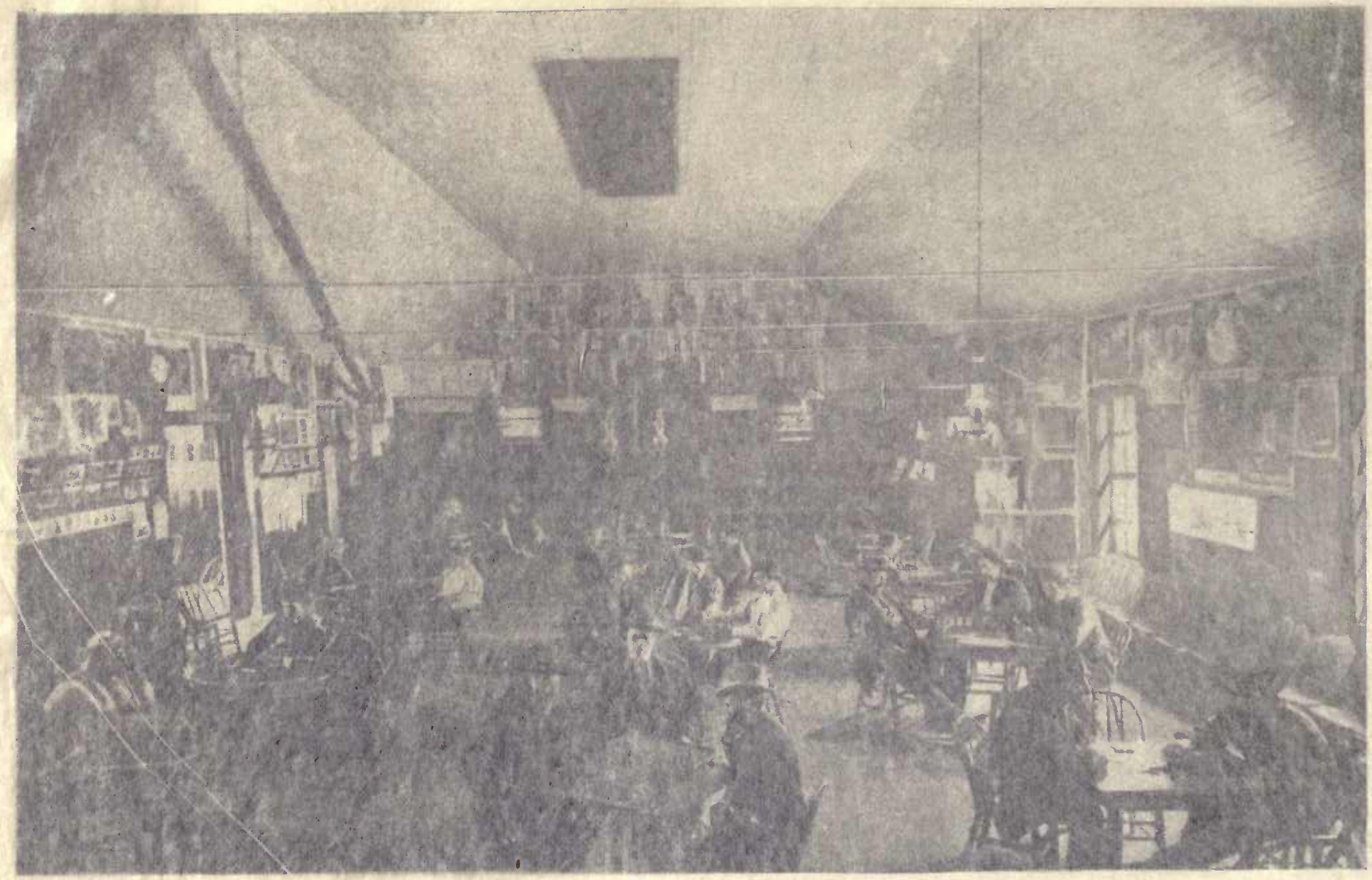
CONSUMPTION OF QUICKSILVER ON THE COMSTOCK LODE, NEVADA.

The following table gives the tons of Comstock ore worked, the amount of quicksilver consumed for each year, and the average number of pounds of quicksilver consumed per ton of ore worked for the period stated. The table does not include all the working mills for the several years given, but does include nearly all those mills that have kept reliable data. These mills were located in Storey, Lyon, and Ormsby counties, in Nevada.

CONSUMPTION OF QUICKSILVER IN MILLING THE ORES OF THE COMSTOCK LODE.

YEARS.	Number of mills.	Ore worked. (Tons.)	Quicksilver consumed. (Pounds.)	Quicksilver consumed per ton. (Pounds.)
Total	50	1, 268, 083	2, 498, 248	1. 97
1880	6	130, 578	246, 347	1. 89
1881	4	47, 890	91, 352	1. 91
1882	4	81, 110	142, 665	1. 76
1883	5	95, 993	176, 201	1. 84
1884	3	83, 120	157, 646	1. 90
1885	3	78, 689	131, 934	1. 68
1886	5	192, 837	371, 570	1. 93
1887	6	159, 666	387, 655	2. 43
1888	7	195, 203	415, 077	2. 13
1889	7	202, 997	377, 801	1. 86

The table following gives the tons of Comstock tailings worked, the amount of quicksilver consumed for each year, and the average number of pounds of quicksilver consumed per ton of ore worked for the period stated. In addition to the remarks for the ore table, it may be stated that the results are not so uniform, due doubtless to the presence at times of foreign matter that sometimes unavoidably gets into the tailings during the rainy season, and other causes not known. The percentage of loss is less, because the tailings already hold quicksilver.



"HELPING HAND" CLUB ROOM, NEW ALMADEN QUICKSILVER MINES.

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Total	50	1, 268, 083	2, 498, 248	1.97
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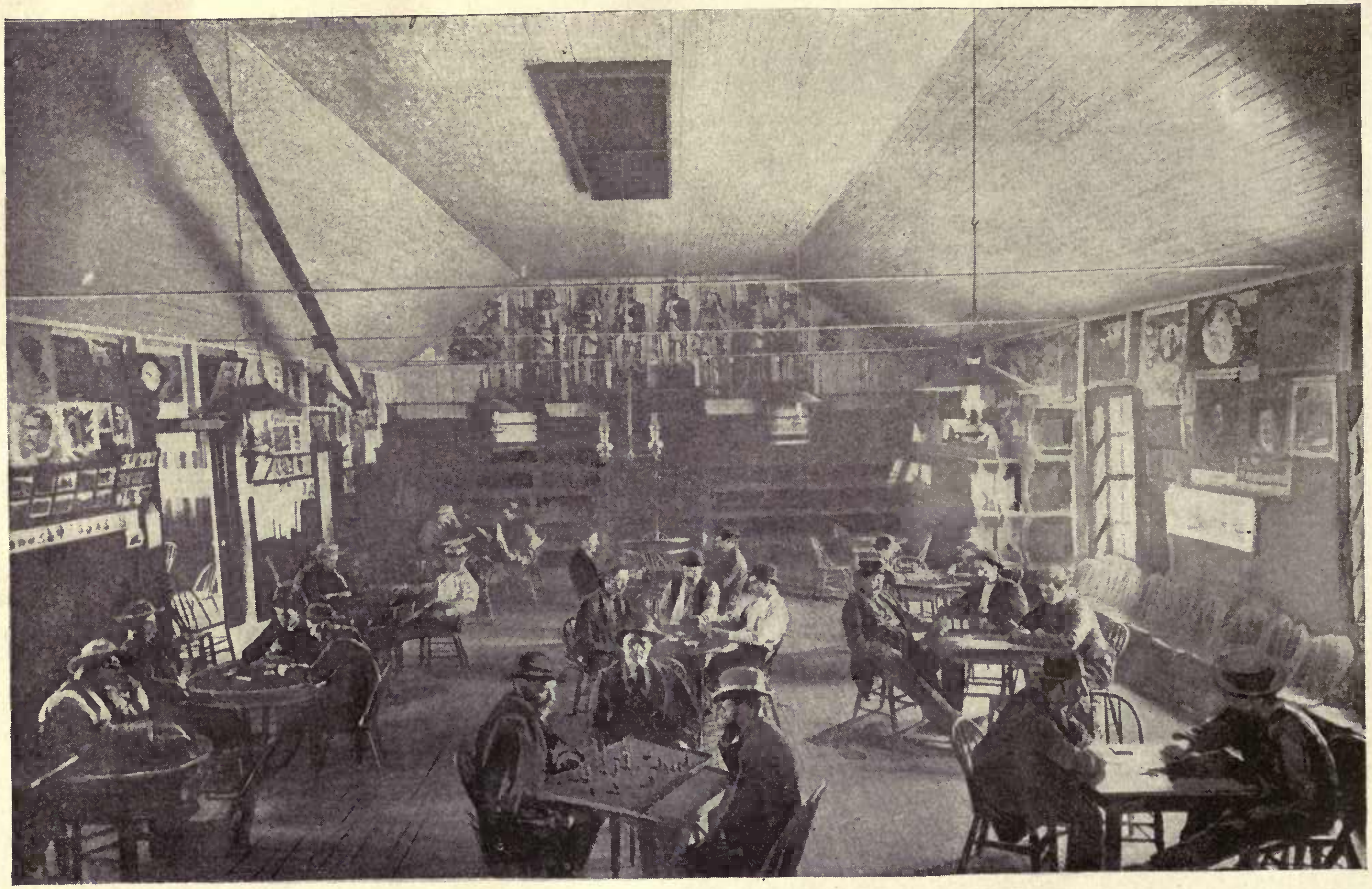
1882	4	81, 110	142, 665	1.76
1883	5	95, 993	176, 201	1.84
1884	3	83, 120	157, 646	1.90
1885	3	78, 689	131, 934	1.68
1886	5	192, 837	371, 570	1.93
1887	6	159, 666	387, 655	2.43
1888	7	195, 203	415, 077	2.13
1889	7	202, 997	377, 801	1.86

The table following gives the tons of Comstock tailings worked, the amount of quicksilver consumed for each year, and the average number of pounds of quicksilver consumed per ton of ore worked for the period stated. In addition to the remarks for the ore table, it may be stated that the results are not so uniform, due doubtless to the presence at times of foreign matter that sometimes unavoidably gets into the tailings during the rainy season, and other causes not known. The percentage of loss is less, because the tailings already hold quicksilver.



"HELPING HAND" CLUB ROOM, NEW ALMADEN QUICKSILVER MINES.

CONSUMPTION OF QUICKSILVER IN WORKING COMSTOCK TAILINGS.

YEARS.	Number of mills.	Ore worked. (Tons.)	Quicksilver consumed. (Pounds.)	Quicksilver consumed per ton. (Pounds.)
Total	22	400, 075	368, 920	0. 92
1880	4	104, 056	86, 680	0. 83
1881	5	68, 714	44, 451	0. 65
1882	3	42, 583	43, 987	1. 03
1883	2	19, 514	34, 346	1. 76
1884	2	39, 871	38, 960	0. 98
1885	2	29, 527	23, 945	0. 81
1886	1	31, 164	32, 752	1. 05
1887	1	19, 806	17, 694	0. 89
1888	1	24, 154	24, 585	1. 02
1889	1	20, 686	21, 520	1. 04

The following table includes all the quicksilver shipped over the Virginia and Truckee railroad into Nevada during the period from 1880 to 1889, both years inclusive. The number of flasks was not reported by the railroad officials at Carson, only the tons and pounds, and the flask has been taken as weighing 90 pounds, gross.

QUICKSILVER SHIPPED OVER THE VIRGINIA AND TRUCKEE RAILROAD, NEVADA, FOR 10 YEARS.

YEARS.	Tons and pounds.		Total in pounds.	Flasks.
Total	2, 156	66	4, 312, 066	47, 912
1880	110	1, 800	221, 800	2, 464
1881	119	1, 554	239, 554	2, 662
1882	120	1, 615	241, 615	2, 685
1883	150	1, 278	301, 278	3, 347
1884	174	1, 535	349, 535	3, 884
1885	267	1, 449	535, 449	5, 949
1886	360	......	720, 000	8, 000
1887	290	1, 180	581, 180	6, 458
1888	375	150	750, 150	8, 335
1889	185	1, 505	371, 505	4, 128