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1904

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THE BUYERS' MANUAL.

THE PROFESSIONAL DIRECTORY.

INTRODUCTION.

The total value of the mineral and metal production of the United States from domestic and foreign ores and bullion in 1904, so far as the items are enumerated in the following table, was $1,467,466,931, as compared with $1,515,401,646, the total for the previous year. This table is given with the sole purpose of affording a comparison between the two years; it is avowedly incomplete, since a large mineral wealth is produced every year the value of which it is impossible to estimate with any approach to accuracy. The table does, however, comprise all important substances and those for which reliable statistics are available. The values of the non-metallic products are given as at point of production; the metals are valued at the average annual market prices at New York, except for quicksilver at San Francisco and pig iron at Pittsburg. In some cases, material of a particular grade has been selected to represent an average of the whole.

Of the total, ores and minerals contributed $961,362,041, and metals $506,104,890; the corresponding figures for 1903 were $976,245,236 and $539,156,410. Certain duplications occur, as in the case of iron and manganese ores used for making pig iron and ferromanganese; bauxite in making aluminum and alum; coal in making coke; lead in making pigments; and certain others.

In the preparation of this volume, the figures previously reported for 1903 have been revised, in accordance with our practice; wherefore it is important to use always the figures in the latest volume of THE MINERAL INDUSTRY. There are no statistical reports of this nature that are absolutely correct, owing to the impossibility of obtaining accurate reports from all producers in extensive and subdivided industries, the absence of records among many producers, the unwillingness of a few to give figures, and a confusion as to the stage in which many products are reported.

For many of the statistics relating to the mineral production of the United States in 1903 and 1904 we are indebted to the Department of Mineral Resources of the United States Geological Survey, and for the production of gold and silver in the United States during these years to George E. Roberts, Director of the Mint. Acknowledgment is due also to various State geological surveys and statistical bureaus for information incorporated in the volume. We have generally credited such information to the proper sources, but this acknowledgment may stand for any unintentional oversights.

PRODUCTION OF ORES AND MINERALS IN THE UNITED STATES.

Products.	Measures.	1903.		1904.	
		Quantity.	Value.	Quantity.	Value.
Arsenic	Sh. T.	611	$36,691	498	$29,504
Asbestos	Sh. T.	887	16,760	1,480	25,740
Asphaltum	Sh. T.	60,102	878,645	85,133	1,083,781
Asphaltic limestone	Sh. T.	2,520	8,800	1,798	4,495
Bituminous sandstone	Sh. T.	38,633	118,001	19,641	71,465
Barytes	Sh. T.	50,397	152,150	65,727	174,958
Bauxite	L. T.	48,087	171,306	48,012	166 121
Bismuth ore	Sh. T.	Nil.	....	61	4,473
Bromine	Lb.	597,000	170,145	879,312	215,431
Calcium borate, crude	Sh. T.	34,430	661,400	45,647	698,810
Carborundum	Lb.	4,760,000	476,000	7,060,380	706,038
Cement nat. hyd	Bbl. (g)	7,030,271	3,675,520	4,866,331	2,450,150
Cement, portland	Bbl. (h)	22,342,973	27,713,319	26,505,881	23,355,119
Cement, slag	Bbl. (h)	525,896	542,502	303,045	226,651
Chrome ore	L. T.	150	2,250	123	1,845
Clay products	......	....	131,062,421	....	131,023,248
Coal, anthracite	Sh. T.	75,317,170	158,241,114	73,674,480	162,151,898
Coal, bituminous	Sh. T.	276,416,702	326,419,212	277,065,582	311,667,680
Cobalt oxide	Lb.	120,000	228,000	22,000	42,600
Coke	Sh. T	23,910,344	62,074,162	22,035,292	54,178,015
Copper sulphate (c)	Lb.	43,124,454	1,811,227	63,234,557	3,161,728
Copperas	Sh. T.	20,240	121,440	16,956	118,692
Crushed steel	Lb.	755,000	52,850	790,000	55,300
Diatomaceous earth	Sh. T.	9,219	76,273	6,274	44,164
Emery	Sh. T.	2,542	64,102	1,932	57,235
Feldspar	Sh. T.	41,891	256 733	45,188	266,326
Flint	Sh. T.	55,233	156,947	52,270	100,590
Fluorspar	Sh. T.	42,523	213,617	36,452	234,755
Fuller's earth	Sh. T.	20,693	190,277	29,480	168,500
Garnet	Sh. T.	4,413	146,955	2,952	89,636
Graphite, artificial	Lb.	2,620,000	178,670	3,248,000	217,790
Graphite, amorphous	Sh. T.	16,591	71,384	19,115	102,925
Graphite, crystalline	Lb.	4,525,700	164,247	4,357,927	162,332
Grindstones	......	....	721,446	....	881,527
Gypsum	Sh. T.	1,041,704	3,792,943	940,917	2,784,325
Iron ore	L. T.	32,471,550	55,201,635	29,462,839	51,559,968
Lead, white	Sh. T.	112,700	12,228,024	126,336	13,896,913
Lead, red	Sh. T.	12,300	1,385,900	13,938	1,672,569
Lead, orange mineral	Sh. T.	1,000	168,000	1,125	168,681
Litharge	Sh. T.	12,400	1,326,800	12,487	1,248,691
Magnesite	Sh. T.	1,361	20,515	2,850	9,298
Manganese ore (d)	L. T.	660,582	1,670,349	454,581	789,132
Mica, sheet	Lb.	619,600	118,088	668,358	109,462
Mica, scrap	Sh. T.	1,659	25,040	1,096	10,854
Millstones	......	....	52,552	....	37,338
Molybdenum ore	Sh. T.	795	60,865	15	2,175
Monazite	Lb.	862 000	64,630	745,999	85,038
Natural gas	......	....	35,815,360	....	38,496,760
Ocher (j)	Sh. T.	20,615	261,627	24,797	261,299
Petroleum, crude	Bbl. (i)	100,461,337	94,694,050	117,063,421	101,170,466
Phosphate rock	L. T.	1,581,576	5,319,294	1,874,428	6,873,625
Precious stones	......	....	307,900	....	315,900
Pumice	Sh. T	885	2,665	1,530	5,421
Pyrites	L. T.	199,387	787,759	173 221	669,124
Quartz, crystalline	Sh. T.	8,938	76,908	31,924	74,600
Salt (k)	Bbl.	18,968,089	5,286,988	22,030,002	6,021,222
Sand, glass	Sh. T.	823,044	855,828	858.719	796,492
Slate, roofing (f)	Squares	1,378,194	5,400,078	1,233,757	4,669,289
Slate, manufacturers	......	....	856,807	....	947,906
Slate pigment	Sh. T.	7,106	59,029	5,370	53 709
Soda, natural	Sh. T.	18,000	27,000	12,000	18,000
Stone, building	......	....	19,795,491	....	18,883,455
Stone, limestone flux	L. T.	12,029,719	5,423,732	10,657,038	4,702,768
Sulphur	L. T.	39,310	(n) 789,738	193,492	3,869,840
Talc, common	Sh. T.	26,671	418,460	27,184	433,331
Talc, fibrous	Sh. T.	60,230	421,600	64,005	507,400
Tungsten ore	Sh. T.	292	43,639	740	184,000
Whetstones and Oilstones	......	....	366,857	....	188,985
Zinc ore exported	Sh. T.	39,411	987,000	35,911	905,782
Zinc, white (m)	Sh. T.	54,034	5,005,394	59,613	4,524,031
Zinc-lead	Sh. T.	4,500	253,125	6,781	474,670
Total enumerated	......	....	$976,245,236	....	$961,362,041

PRODUCTION OF METALS IN THE UNITED STATES.

Products.	Measures.	1903.		1904.	
		Quantity.	Value.	Quantity.	Value.
Aluminum	Lb.	7,500,000	$2,325,700	8,600,000	$2,477,000
Antimony	Lb.	6,174,000	389,579	5,854,000	372,958
Copper (p)	Lb.	714,656,341	95,885,441	833,802,147	108,310,899
Ferromanganese (q)	L. T.	192,661	9,488,554	220.392	9,344,621
Gold (fine)	Troy oz.	3,560,000	73,591,700	3,904,986	80,723,200
Iron, pig	L. T.	17,816,591	285,965,456	16,276,641	225,268,711
Lead	Sh. T.	276,694	23,447,050	302,204	26,043,941
Nickel	Lb.	114,200	45,900	24,000	11,400
Platinum	Troy oz.	110	2,080	200	2 600
Quicksilver	Flasks (o)	37,123	1,564,734	34,553	1,489,716
Silver (fine)	Troy oz.	54,300,000	29,332,000	57,786,100	33 515,938
Zinc	Sh. T.	158,502	17,118,216	181,803	18,543,906
Total	......	....	$539,156,410	....	$506,104,890
Total ores and minerals	......	....	976,245,236	....	961,362,041
Grand Total	......	....	1,515,401,646	....	1,467,466,931

Additional details will be found under the respective captions farther on in this volume. (c) Includes sulphate made from metallic copper. (d) Includes manganiferous iron ore. (f) One "square" covers 100 square feet. (g) Barrels of 300 lb. (h) Barrels of 380 lb. (i) Barrels of 42 gallons. (j) Includes ocher, umber, sienna and Venetian red. (k) Includes salt used in manufacture of alkali; the barrel of salt weighs 280 lb. (m) Includes a small quantity made from spelter. (n) Average price at New York. (o) Flasks of 76.5 lb. (p) Average price of Lake copper at New York. (q) Includes spiegeleisen, although the value is given as for ferromanganese.

Antimony.—The production of antimony from imported ores, including also that contained in hard lead, of both domestic and foreign origin, was 5,854,000 lb. ($372,958) in 1904, as compared with 6,174,000 lb. ($389,579) in the previous year.

Copper.—Production showed a marked increase from 714,656,341 lb. ($95,885,441) in 1903 to 833,802,147 lb. ($108,310,899) in 1904. Every producing State contributed to this increase.

Ferromanganese.—The output of ferromanganese and spiegeleisen was 220,392 long tons ($9,344,621), as compared with 192,661 long tons ($9,488,554) in 1903.

Gold and Silver.—The domestic output of gold, as reported by the Director of the Mint, increased from 3,560,000 fine ounces ($73,571,700) in 1903 to 3,904,986 fine ounces ($80,723,200) in 1904. The output of silver likewise grew from 54,300,000 fine ounces (commercial value $29,332,000) in 1903 to 57,786,100 fine ounces (commercial value $33,515,938) in 1904. Every State but Arizona, Idaho and Virginia contributed to the increase of gold, while Arizona, South Dakota, Virginia and Washington were the only ones to show diminished silver yields.

Iron.—The production of pig iron, not including the manganese irons, fell from 17,816,591 long tons ($285,965,456) in 1903 to 16,276,641 long tons ($225,268,711) in 1904. The latter year's output comprised 9,098,659 tons of bessemer pig and 2,483,104 tons of basic pig, as against 9,989,908 tons of bessemer and 2,040,726 tons of basic in 1903.

Lead.—The recovery of lead from domestic ores in 1904 reached 302,204 short tons ($26,043,941), as compared with 276,694 tons ($23,447,050) in the preceding year. Desilverized, soft and antimonial leads all showed increases. In addition, 98,930 tons was obtained by desilverizing imported base bullion. The average price of lead per pound at New York rose from 4.237c. in 1903 to 4.309c. in 1904.

Nickel.—There has been no production of metallic nickel from domestic ores within the past two years, and statistics as to recovery from imported ores are withheld by the producers. The quantities of nickel and cobalt oxide reported in the tables on pages 2 and 3 were those contained in a matte made at Mine La Motte, not yet treated.

Platinum.—There were 200 troy oz. ($2,600) recovered in 1904, as against 110 oz. ($2,080) in the previous year.

Quicksilver.—The output was 34,553 flasks ($1,489,716) in 1904, as against 37,123 flasks ($1,564,734) in 1903. At the middle of the year, the California producers reduced their flasks from 76.5 lb. to 75 lb. California and Texas supply the whole output.

Zinc.—The output in 1904 was 181,803 short tons ($18,543,906), as compared with 158,502 short tons ($17,118,216) in the preceding year. The average price per pound at New York fell from 5.375c. in 1903 to 5.100c. in 1904.

Ores, Minerals and Chemical Products.

Arsenic.—The production of arsenious oxide was 498 short tons ($29,504) in 1904, as against 611 tons ($35,028) in 1903. A much greater output is expected with the beginning of operations at the Washoe smelter's arsenic plant in 1905.

Asbestos.—The production in 1904 reached 1,480 short tons ($25,740), as compared with 887 short tons ($16,760) in the previous year. A new mine in Virginia is mainly responsible for the increase.

Barytes.—The production in 1904 was 65,727 short tons ($174,958), as compared with 50,397 tons ($152,150) in 1903. The increase came from Virginia and North Carolina; Missouri and Tennessee contribute the largest proportion.

Bauxite.—The output of bauxite showed but little change, having been 48,012 long tons ($166,121) in 1904 and 48,087 long tons ($171,306) in 1903.

Bromine.—The output of bromine, including that contained by bromides. reached the large total of 879,312 lb. ($215,431), as compared with 597,000 lb. ($170,145) in the previous year.

Carborundum.—The output was 7,060,380 lb. ($706,038) in 1904, as compared with 4,760,000 lb. ($476,000) in the previous year.

Cement.—The total output of all kinds of hydraulic cement in 1904 was 31,675,257 bbl. ($26,031,920), as compared with 29,899,140 bbl. ($31,931,-341) in the preceding year. The output of 1904 was constituted by cements in the following amounts, the corresponding figures for 1903 being given for comparison: Portland, 26,505,881 bbl.—$23,355,119 (22,342,973 bbl.—$27,713,319); natural rock, 4,866,331 bbl.—$2,450,150 (7,030,271 bbl.—$3,675,520); slag, 303,045 bbl.—$226,651 (525,896 bbl.—$542,502).

Clay.—The total value of brick and other clay products made in the United States in 1904 was $131,023,248, as compared with $131,062,421 in the previous year. This value was constituted by materials having the following values, the corresponding figures for 1903 being given for comparison: Common brick, $51,768,558 ($50,532,075); vitrified paving brick, $7,557,425 ($6,453,849); front brick, $5,560,131 ($5,402,861); fancy or ornamental brick, $845,630 ($898,076); drain-tile, $5,348,555 ($4,639,214); sewer-pipe, $9,187,423 ($8,525,369); architectural terra cotta, $4,107,473 ($4,672,028); fire-proofing, $2,502,603 ($2,708,143); hollow building tile or blocks, $1,126,498 ($1,153,200); tile (not drain), $3,023,428 ($3,505,329); fire-brick, $11,167,972 ($14,062,369); miscellaneous brick and tile, $3,669,-282 ($3,073,856); pottery, $25,158,270 ($25,436,052). In 1904 the rank of the leading States was: Pennsylvania, Ohio, Illinois, New York, New Jersey.

Coal and Coke.—The total production of coal of all kinds in 1904 was 350,740,062 short tons ($473,819,578), as compared with 351,733,872 short tons ($484,660,336) in the previous year. The total for 1904 was constituted thus, totals for 1903 being given for comparison: Anthracite, 73,674,-480 short tons—$162,151,898 (75,317,170 short tons—$158,241,114); bituminous, 277,065,582 short tons—$311,667,680 (276,416,702 short tons—$326,419,212). Lignite and cannel coal are included in the above totals for bituminous coal; Pennsylvania produces nearly all the anthracite.

Copper Sulphate.—The production of copper sulphate in 1904 reached 63,234,557 lb. ($3,161,728), as compared with 43,124,454 lb. ($1,811,227) in 1903.

Fluorspar.—Production in 1904 was 36,452 short tons ($234,755), as against 42,523 short tons ($213,617) in 1903.

Fullers' Earth.—Output in 1904 reached 29,480 short tons ($168,500); in 1903 it was 20,693 ($190,277).

Graphite.—The output of crystalline graphite was 4,357,927 lb. ($162,-332), as against 4,525,700 lb. ($164,247) in 1903; of amorphous graphite, 19,115 short tons ($102,925), as against 16,591 short tons ($71,384) in 1903; of artificial graphite, 3,248,000 lb. ($217,790), as against 2,620,000 lb. ($178,670) in 1903.

Gypsum.—The output in 1904 was 940,917 short tons ($2,784,325), as against 1,041,704 short tons ($3,792,943) in 1903.

Iron Ore.—The production in 1904 was 29,366,654 long tons ($51,559,-968), as compared with 32,471,550 long tons ($55,201,635) in 1903. Of the total output, 21,726,654 long tons in 1904 and 24,099,550 long tons in 1903 were contributed by the Lake Superior region.

Limestone for Iron Flux.—Iron smelters consumed 10,657,038 long tons of limestone ($4,702,768) in 1904, as compared with 12,029,719 long tons ($5,423,732) in the previous year.

Magnesite.—California, the only producing State, mined 2,850 short tons ($9,298) in 1904; in the previous year, 1,361 short tons, worth $9,298.

Mica.—The output of sheet mica in 1904 was 668,358 lb. ($109,462), as against 619,600 lb. ($118,088) in 1903; of scrap mica, 1,096 short tons ($10,854), as against 1,659 short tons ($25,040) in 1903.

Monazite.—The output was 745,999 lb., worth $85,038, in 1904, as against 862,000 lb., worth $64,630, in 1903.

Natural Gas.—The value of the output in 1904 was $38,496,760, as compared with $35,815,360 in 1903.

Ocher and Oxide of Iron Pigments.—The output of ocher, umber, sienna, and other natural iron oxides ground into pigments under the general name 'Metallic Paint,' and of Venetian red, was 44,154 short tons ($465,676) in 1904, as against 45,718 short tons, worth $474,736, in the previous year.

Phosphate Rock.—The output of phosphate rock grew from 1,581,576 long tons ($5,319,294) in 1903 to 1,874,428 long tons ($6,873,625) in 1904. Florida is the principal producer.

Precious Stones.—The value of the gem stones produced in 1904 was $315,900, as against $307,900 in the preceding year.

Salt.—The output of salt of all kinds in 1904 was 22,030,020 bbl., valued at $6,021,222, as compared with 18,968,089 bbl., worth $5,286,988, in 1903. Rock salt shows the greatest increase over the previous year.

Sulphur and Pyrite.—The production of sulphur rose from 39,310 long tons ($789,738) in 1903 to an amount estimated at 193,492 long tons ($3,869,840) in 1904. This great increase is due to the enlarged scale of operations in Louisiana. Of pyrite, the output in 1904 was 173,221 long tons ($669,124), as compared with 199,387 long tons ($787,579) in 1903.

White Lead and Other Lead Pigments.—The total production of white lead, based on reports from every producer in the country, was 252,671,154 lb., valued at $13,896,913. Owing to a confusion in the returns, we cannot definitely separate this output as to dry or in oil; of the total, 48,515,672 lb. is certainly dry white lead, and it is believed that most of the remainder is white lead in oil. This compares with a total of 225,400,000 lb., valued at $12,228,024, in 1903. In addition to the above 1904 output, 12,955,000 lb. of 'sublimed lead,' consisting essentially of lead sulphate and oxide, was obtained by the oxidizing smelting of galena ores. The output of red lead in 1904 was 27,876,153 lb., valued at $1,672,569, as compared with 24,600,000 lb., valued at $1,385,900, in 1903; of litharge, 24,973,816 lb., valued at $1,248,691, as compared with 24,800,000 lb., valued at $1,326,800, in 1903; of orange mineral, 2,249,075 lb., valued at $168,681, as compared with 2,000,000 lb., valued at $168,000, in 1903.

Zinc-Lead.—The output of this pigment, consisting of the oxides of lead and zinc, was 6,781 short tons, valued at $381,431, as compared with 4,500 short tons, valued at $253,125, in 1903.

Zinc White.—The output of zinc white in 1904 was 59,613 short tons ($5,663,235), as against 54,034 short tons ($5,005,394) in the previous year. This is made largely by the New Jersey Zinc Co.

ALUMINUM.

The Pittsburgh Reduction Company still retains its monopoly of the aluminum-producing industry in this country. Its directors maintain a policy of secrecy, making it impossible to obtain a statement of output.

Use of Aluminum for Power Transmission.—Aluminum has entered into serious competition with copper as the conducting material for electric transmission lines. Details of the largest installations now at work in the United States are:

	Distance Miles.	Number of Cables	Area of each. Circular Mils.	Working E.M.F. Volts.
Electric to San Francisco	154	3	471,034	6,000
Colgate to Oaklands..............	144	3	211,000	40,000
Provo to Mercur.................	90	.	......	40,000
Snoqualmie Falls to Tacoma and Seattle.....................	76	.	......	30,000
Niagara Falls to Buffalo..........	20	3	500,000	......

This extensive replacement of copper has been made possible by the reduction in the cost of aluminum. By a comparison of the respective conductivities, densities and tensile strengths of the two metals, it is found that the weight of an aluminum line is approximately one-half that of a copper line of equal resistance, while its tensile strength is greater. When, therefore, aluminum is obtainable at less than twice the price of copper, it becomes the cheaper material for transmission.[1] The expected saving in the number of poles needed for stringing an aluminum line (from the calculations of the catenary, it is seen that the span of an aluminum wire may be 25% longer than that of an equally conductive copper wire, while the sag and the factor of safety remain the same) is annulled by a consideration of wind pressure. Allowing for a horizontal pressure of 40 lb. per square foot, and using the factor 0.66 as representing the pressure on a cylindrical as compared with a flat surface of the same dimensions, the resultant of gravity and wind pressure is found to be 22% greater on an aluminum span than on an equivalent copper span.[2] The factor of wind pressure has been generally overlooked in statements advocating the use of aluminum, although it is numerically, on the above assumptions, eight times the load, due to the weight of the wire alone. The mechanical difficulties in the stringing of aluminum lines have been largely overcome. Strand cables up

[1] 'Aluminum for Electrical Conductors.' Pamphlet by the Pittsburgh Reduction Company.
[2] W. B. Esson in *The Electrician*, June 2, 1905.

to 1.156 in. diameter are employed, thus avoiding the tendency of a solid wire to crystallize and break, and at the same time permitting greater distances between joints. Connections between individual wires are made by inserting the ends past each other in a malleable sleeve, the whole then being twisted, or by casting melted aluminum around the abutting ends in a cylindrical mold. Cables are spliced either by oppositely threaded terminals forged in the shop to the ends of the sections, or by a malleable sleeve forged around the ends by a portable hydraulic press.

In their behavior with alternating currents copper and aluminum circuits show but slight difference, the loss of voltage by self-induction and by rise in temperature being slightly less in aluminum.

Aluminothermics.—This is an art, of recent origin, which, particularly in its application to welding, ought to lend itself admirably to the mining industry, owing to the ease and rapidity with which welds of iron and steel in all shapes and sizes can be made. It has been developed by Hans Goldschmidt, of Essen-Ruhr, Germany, whose patented 'Thermit' is a mixture of granulated metallic aluminum and the oxide of another metal in nearly atomically equivalent proportions, the idea being to reduce the other metal in a pure state from its oxide through the strong affinity of aluminum for oxygen, alumina being the by-product. The oxidation of aluminum is exothermic to the extent of 7,250 calories, while the reduction of iron from its oxide, as in the mixture employed for steel welding, is endothermic to only half this extent, so that the temperature resulting from this reaction may reach 3,000° C. Activity, however, can be started only by a temperature equal to that of melted steel. The kindling is conveniently accomplished by an ounce of 'ignition powder,' a mixture of aluminum with barium peroxide, the reaction between which, started with a match, develops sufficient heat to begin the thermit reaction. Scrap steel may be added to a large charge to diminish the temperature and give a greater volume of melted iron. Rail welding by this process has become popular in Europe and has been applied in Chicago, Cleveland, Buffalo, Salt Lake City, and at other places in this country. Details of this and of all other applications of the method may be obtained from the Goldschmidt Thermit Company, of New York.

The results of tests on thermit, and on electrically welded rail joints made at Vienna are recorded in the *Mitteilungen* des K. K. Technologischen Gewerbe-Museums in Wien. The rails were not only subjected to bending tests after they had been welded, but actual joints were pulled apart, special welds being cut out for the tests, so that the joint was about in the center of each sample tested. Test pieces were cut from the head, web and foot of the rail. In the electric welding only the head of the rail was welded. Under bending tests an unwelded rail acquired a permanent set under a load of 48.1 tons, and remained unbroken under a load of 68.7 tons, which was the available limit of the testing machine employed. The electrically welded rail broke across the welded joint at 40 tons, while the rail welded with thermit broke at the joint at 60.9 tons. The tensile strength of the thermit joint was found to be 23.93 tons per square inch, and that of the electric weld 12.57 tons per square inch. Several other series of tests are recorded, and the general result indicates that, while the thermit welds showed a tensile strength of from 15.55 to 35.62 tons per square inch, the electrical welds averaged only from 8.5 to 20.63 tons per square inch, and the thermit joints were decidedly superior to those produced electrically.

In the foundry, thermit has been found useful for cleaning and liquefying cast iron, and in the steel plant, for eliminating blow-holes. The mixture used for the former purpose contains a small proportion of titanium, and is held at the bottom of the ladle. The reaction drives slag and gases to the top, increasing the fluidity of the metal. A weight of thermit one-fourth to one-sixteenth per cent of the ladle contents is sufficient. If piping is observed under the solidifying top crust of a steel ingot, a package of thermit may be introduced. As soon as the reaction is complete, melted steel is poured into the hole and the loss by blow-hole may be reduced to only a slight percentage. About 10 lb. is sufficient for a 20-ton ingot.

Recovery of Aluminum from Waste.[3]—A process by which fully 95% of the aluminum contained in slags, cinders, crucible waste, etc., may be recovered consists in heating such material, charged as loosely as possible into a graphite crucible, to a temperature of about 1,300° C. Equal parts of sodium and potassium silicates, or better, of the fluo-silicates, are then added with vigorous stirring. With the impurities, these form a very fusible slag, which comes to the top. The insoluble and infusible impurities go to the bottom, leaving the melted aluminum in the middle. A second or third treatment may be necessary to purify the aluminum sufficiently. In the final treatment, a cover consisting of powdered charcoal, 75 parts; magnesium, 5 parts; and red oxide of iron, 10 parts, may be put over the aluminum bath to prevent oxidation of the metal.

Alloys.—La Metallurgie,[4] January 11 and 18, 1905, gives a list of aluminum alloys as made in the Tergnier-Fargniers foundry, with the results of tests on their tensile strengths. Two of these are found applicable to nearly all cases, and are made almost exclusively: The composition Al, 93.5%; Cu, 6%; W, 0.5%, is hard but brittle, having a tensile strength of 14.5 kg. per sq. mm. (20,640 lb. per sq. in.) and an elongation of 2%. The alloy Al, 75%; Cu, 3%; Zn, 20%; Zn + Mn, 2%, has a strength of 18 kg. per sq. mm. (25,600 lb. per sq. in.) and shows no elongation. The alloy of greatest tensile strength (43,389 lb. per sq. in.) has the composition Al, 94%; Cu, 3%; Zn, 3%, and shows an elongation of 5.2%. The most ductile alloys are those containing tin and manganese, one of them—Al, 94.5%; Sn + Mn, 5%; Zn +

[3] *La Metallurgie,* Dec. 7, 1904.
[4] In this series of articles, beginning with the issue of Nov. 9, 1904, there are many valuable practical details as to the methods of casting, making of alloys, tooling and finishing, plating on iron or copper, and the plating of other metals on aluminum, composition of alloys and the quantitative determination of impurities.

Mn, 0.5%—showing an elongation of 20% and a tensile resistance of 20,640 lb. per sq. in.

As to the influence of silicon,[5] tests made at the Polytechnic School at Zurich show that small proportions of silicon increase considerably the durability of aluminum, but at the same time reduce its tensile strength, while, on the other hand, aluminum bronze, containing 10% Al and a 1.5% compound of iron and silicon, is too brittle for any use. Tests of aluminum bronze warmed to 600° C. and then to red heat show that heating makes them soft and malleable, rendering them particularly fit for impressing, drawing and rolling. The temperature most favorable for ductility is at a clear cherry red; an increase in the proportions of aluminum and silicon reduces the temperature required for such operations. The alloy best adapted for rolling contains between 8% and 10% Al and Si. Experiments on abrasion, made by rubbing against an oiled cast-iron disc, showed that the hardest bronzes (containing less than 89.6% Cu) suffered less wear than regular bearing metal, which was tested at the same time, but that the softest bronzes (less than 6% Al) heated immediately and wore away against the iron disc.

Determination of Impurities in Aluminum.—Methods of quick technical analysis of commercial aluminum are given in *La Metallurgie,* January 18, 1905. Ordinary alloys may be analyzed by any of the well known methods.

Silicon.—This occurs both as graphitic and combined with aluminum. To determine total silicon, dissolve 1 gm. of borings or turnings in a mixture of acids (nitric 1, hydrochloric 3, 25% sulphuric 6). Evaporate to white fumes and continue the heating for 10 or 15 minutes; cool, and take up with water. Filter, and fuse the precipitate with 1 gm. of soda. Dissolve the fusion in dilute hydrochloric acid; add 15 or 20 c.c. of sulphuric acid, and evaporate to white fumes. Taken up with water and filtered, the silica is calcined and weighed. To determine the uncombined silicon, dissolve 1 gm. of metal in mixed acids, and treat the calcined residue with a few drops of sulphuric and a few c.c of hydrochloric acid. The remaining silicon is weighed.

Iron.—Dissolve 1 gm. of borings in mixed acids; evaporate to white fumes, maintaining the heat for a few minutes. Cool, take up with water, and add 1 gm. of powdered zinc to reduce the iron. Titrate at once with potassium permanganate.

Copper.—Treat 1 gm. of borings with 20 c.c. of a 33% solution of caustic soda. When the action has ceased, filter, and wash the residue carefully. Separate from the filter and dissolve the residue in a few c.c. of boiling nitric acid. This dissolves the copper, which can then be determined by the cyanide or any other titration method.

Aluminum.—Dissolve in mixed acids and remove the silica. From the heated filtrate, precipitate iron and aluminum hydroxide by a slight excess of ammonia, and continue heating to expel excess of ammonia. Filter, and

[5] *Revue Industrielle,* Feb. 4, 1905, quoting from *La Nature.*

wash with boiling water; ignite and weigh the mixed hydroxides. Subtract the iron previously determined.

Carbon.—Triturate 2 gm. of borings in a mortar with 10 to 15 gm. of mercuric chloride and 15 c.c. of water. The reaction is rapid, and a gray, heavy residue is obtained. When the last trace of aluminum has disappeared, the residue is evaporated to dryness on the water-bath. It is then heated in a current of hydrogen to expel the mercurial compounds, leaving a mixture of carbon, silicon and silica. This is then burned in a current of oxygen, the carbon dioxide being caught in a known solution of barium hydroxide. The amount of precipitated carbon is then observed.

Sodium.—This element is frequently found in electrolytic aluminum. Attack 1 gm. of borings with 50 c.c. of nitric acid of 1.3 sp. gr., adding a sufficient amount of hydrochloric to insure decomposition. Boil to expel all hydrochloric acid. Place the whole in a platinum dish and evaporate to dryness, heating gently over a Bunsen burner to decompose the nitrates. Loosen the residue, grind and mix it intimately with 1 gm. of ammonium chloride and 8 gm. of precipitated calcium carbonate. Warm gradually to a red heat, which is maintained for 1 hour. Take it up then with warm water and filter. The filtrate will contain the alkalies, as chlorides, and also a quantity of free lime and calcium chloride. Ammonium carbonate is added while cold, and the mixture is vigorously stirred until the precipitated calcium carbonate becomes heavy and granular. Filter into a platinum dish and discard the residue. Evaporate the filtrate to dryness and warm gently to redness to expel the ammonium salts. Take up in a few c.c. of water and add a drop or two of ammonium carbonate. If it gives a precipitate, add an excess and filter. Evaporate the filtrate to dryness, heat gently and weigh the remaining sodium as chloride.

ANTIMONY.

The production of this metal from domestic antimony ores still remains dormant. Most of the known occurrences of ore, of which antimony constitutes the sole value, are too far removed from lines of transportation to permit their output to compete with the abundant supplies of foreign crude material that can be imported free of duty and at low ocean rates.

The imports of antimony regulus or metal during 1904 were 4,056,299 lb., valued at $235,401, and the re-exports were 31,077 lb., worth $1,734. Of antimony ore, consisting largely of partially refined stibnite, 2,490,011 lb. ($50,959) were imported and 427,851 lb. ($10,775) were re-exported. It may be noted that the imports of metallic antimony, bearing a duty of 0.75c. per pound, were nearly double those of the duty-free ores, or estimating the recovery from the latter at 40% of metal, the antimony that entered without paying duty amounted to only 24.5% of the whole importation.

The production of hard lead, estimated on the best authority to contain 23% antimony, was 10,876 tons, most of which came from domestic impure lead ores, although a small part may have originated in British Columbia.

Antimonial compounds have a limited use in medicine, but metallic antimony is used exclusively to make alloys, of which lead is the principal constituent. For this reason, metallic antimony is never recovered from hard lead, but the impure bullion is used directly in the manufacture of bearing and type metals. The percentage composition of several alloys into which antimony enters, as given by Hofman, and others, is shown in the following table:

COMPOSITION OF ANTIMONY ALLOYS.

Alloy.	Lead.	Antimony.	Tin.	Copper.
Eutectic (m.p. 177° C.)	41.5	3.5	55	....
Eutectic (m.p. 237° C.)	88.5	11.5	....	....
Type metal	55	30	15	....
Type metal	60	25	15	....
Type metal	70	18	10	2
Type metal	82	14.8	3.2	....
Linotype metal	84.5	13.5	2	....
Bearing metal	77.8	16.3	5.9	....
Magnolia metal	80	15	5	....
Original babbit metal	....	7.3	89	3.7
Plumbers' solder	67.5	2	30.5	....
Terne metal	80.25	1.25	18.5	....

IMPORTS, EXPORTS, PRODUCTION AND CONSUMPTION OF ANTIMONY IN THE UNITED STATES.

Year.	Imports.					Exports.			
	Metal or Regulus.		Ore.		Total	Metal or Regulus.		Ore.	
	Pounds.	Value.	Pounds.	Value.	Value.	Pounds.	Value.	Pounds.	Value.
1900....	3,632,843	$285,749	6,035,734	$78,581	$364,330	23,520	$2,352	Nil.	....
1901....	3,674,923	255,346	1,731,956	24,256	278,597	Nil.	....	49,655	$1,536
1902....	5,742,703	397,899	1,639,043	29,476	377,375	73,184	2,710	208,531	4,602
1903....	5,125,515	279,957	2,673,142	51,489	331,446	79,917	4,478	Nil.	....
1904....	4,056,299	235,401	2,490,011	50,959	286,360	31,077	1.734	427,851	10,775

Year.	Production.			Imports of Antimony Metal.	Consumption.
	In Hard Lead.	From Domestic Ores.	From Imported Ores. (a)		Total Supply.
	Short Tons.	Short Tons.	Short Tons.	Short Tons.	Short Tons.
1900..........................	2,476	151	1,599	1,827	6,053
1901..........................	2,235	50	364	1,837	4,486
1902..........................	2,904	Nil.	328	2,871	6,103
1903..........................	2,552	Nil.	535	2,563	5,650
1904..........................	2,515	Nil.	412	2,028	4,955

(a) Estimated 40% extraction from net import of ore.

During the year 1904, values, as usual, ruled within narrow limits, with the exception of the last few months, when the shortage of supplies, caused by the Russo-Japanese war, resulted in quite a sharp upward movement. The year opened with Cookson's antimony selling at 6¾ to 7c.; Hallett's at 6 to 6¼c.; United States, Japanese, French, Hungarian and Italian at 5½ to 5⅝c. During February a somewhat firmer tone developed, owing to the fact that it was expected, in case of war between Russia and Japan, that shipments from the latter country would be interfered with. When hostilities actually broke out, strong efforts were made to raise prices, and at the beginning of March values had improved about 1c. per pound. Consumers, however, remained rather apathetic, and prices crumbled away from month to month, until, at the end of September, they again reached the low level of the opening quotations of the year. During the last week of October an attempt was made to corner the spot supplies in New York, which were comparatively small. Inasmuch as shipments from Japan had been much restricted for some time past, owing to the war, these efforts were partially successful, and at the beginning of December prices had advanced to 8½c. for Cookson's, 8¼c. for Hallett's, and 8⅛c. for the outside brands. During the remainder of the year the market ruled very quiet, the closing quotations being given as 8¼@8½c. for Cookson's, 8@8¼c. for Hallett's, 8@8⅛c. for United States, Japanese, Italian and Hungarian.

Electrolytic Refining of Antimony.[1]—A. G. Betts, Troy, N. Y., has described a process of depositing pure antimony electrolytically. A solution

[1] English patent No. 15,294, July 8, 1904.

containing 8 per cent of antimony trifluoride, 2 per cent of sodium sulphate, and 4 per cent of sulphuric acid, is electrolyzed, using an insoluble anode; metallic antimony is deposited on the cathode, and hydrofluoric acid is formed at the anode, the latter consisting preferably of lead rods wrapped in layers of cloth. By using impure antimony as the anode, purified antimony is deposited, and valuable impurities remain as anode residue.

AVERAGE MONTHLY PRICES OF ANTIMONY IN NEW YORK. (Cents per pound.)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1900.	$	$	$	$	$	$	$	$	$	$	$	$	$
Cookson's	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.10	10.00	10.00	10.00	10.34
Hallett's	9.75	9.75	9.75	9.75	9.69	9.62	9.53	9.50	9.30	9.25	9.25	9.25	9.25
Others	9.50	9.50	9.50	9.50	9.50	9.50	9.50	9.50	9.30	9.25	9.25	9.25	9.43
1901.													
Cookson's	10.00	10.00	10.00	10.31	10.25	10.25	10.25	10.25	10.12	10.09	10.00	10.00	10.12
Hallett's	9.12	9.22	8.90	8.94	8.75	8.75	8.75	8.43	8.50	8.47	8.37	8.31	8.74
Others	9.25	8.85	8.77	8.73	8.63	8.63	8.63	8.50	8.37	8.34	8.25	8.00	8.55
1902.													
Cookson's	10.00	10.00	9.87	9.87	9.87	9.87	9.75	9.75	9.69	9.44	9.25	9.20	9.71
Hallett's	8.17	8.04	8.06	8.06	8.17	8.25	8.25	8.15	7.92	7.72	7.44	7.25	7.96
Others	7.86	7.75	7.75	7.75	7.90	8.00	8.00	7.90	7.65	7.37	7.22	6.92	7.67
1903.													
Cookson's	8.25	8.25	8.25	8.25	8.00	7.50	7.44	7.15	7.00	7.00	6.56	6.75	7.53
Hallett's	7.00	7.00	6.87	6.87	6.75	6.69	6.50	6.40	6.34	6.25	6.25	6.35	6.69
Others	6.75	6.62	6.50	6.50	6.50	6.44	6.25	6.19	6.00	6.00	6.00	5.95	6.31
1904.													
Cookson's	6.938	7.594	7.875	7.875	7.531	7.200	7.188	7.188	6.913	6.984	7.592	8.388	7.439
Hallett's	6.250	6.781	6.825	6.750	6.578	6.438	6.485	6.688	6.537	6.578	7.328	8.160	6.783
Others	5.688	6.203	6.475	6.406	6.203	5.961	5.969	6.062	6.015	6.172	7.204	8.088	6.371

WORLD'S PRODUCTION OF ANTIMONY ORE (in metric tons).

Year	Austria.		Bolivia.		France and Algeria.		Hungary.		Italy.		Japan.	Mexico. (a)	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Tons.	Value.
1899.	410	$15,244	1,213	454,866	7,592	130,493	1,956	$34,205	3,791	$44,862	712	10,382	115,292
1900.	201	7,065	1,174	440,775	7,963	115,978	2,373	37,720	7,609	72,468	81	2,313	23,319
1901.	126	4,557	190	38,309	9,867	156,834	323	6,000	8,818	68,513	119	5,103	51,064
1902.	18	654	126	7,917	9,715	143,944	748	12,200	6,116	49,868	88	1,279	12,798
1903.	41	601	45	4,115	12,380	147,484	205	5,000	6,927	40,431	153	...	.....

Year	New South Wales. (b)		New Zealand.		Portugal.		Queensland.		Spain.		Turkey. (c)	United States.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons	Value.	Tons.	Tons.	Value.
1899.	332	$13,470	Nil.	.....	59	$2,123	41	$1,000	50	$1,560	1,173	544	$20,000
1900.	252	12,145	5	$505	38	554	Nil.	.....	30	900	267	300	10,500
1901.	90	5,915	30	680	126	2,650	Nil.	.....	10	150	224	100	3,500
1902.	57	2 710	Nil.	.....	Nil.	.....	Nil.	.....	67	1,005	....	Nil.	.....
1903.	13	(d) 675	Nil.	.....	Nil.	.....	Nil.	.....	42	630	....	Nil.	.....

(a) Export figures, values in Mexican dollars. (b) Metal and ore. (c) Export figures. Of doubtful accuracy. (d) In 1904, 111 tons, valued at $2,515.

ARSENIC.

The United States is a large consumer of arsenic and its compounds, and although we have large resources of mispickel—the principal ore of arsenic—yet we produced in 1904 only 498 short tons of white arsenic (arsenious oxide, As_2O_3), valued at $29,504. Most of this was recovered at the Everett plant of the American Smelting & Refining Company, from arsenical pyrite from the Monte Cristo mine in Washington. The Brinton mine in Virginia, still under development, started its refinery in October, and shipped sample lots until January, 1905, when the monthly capacity of the plant was increased to 90 tons of pure white arsenic. This property is owned by the United States Arsenic Mines Company, of Pittsburg, Pa., capitalized at $500,000, which began work at the mine on March 13, 1903, and ten months later inaugurated operations at the refinery. The ore is mispickel, reported to carry from 25 to 35 per cent arsenic. This property was described in The Mineral Industry, Vol. XII. The deposit at Mineral Creek, Wash., discovered in 1903, is being developed by the Mineral Creek Mining & Smelting Company, which has produced a small quantity of white arsenic during the experimental stage, preparatory to the beginning of active work, in February, 1905. When completed, this plant will have an output of 3 or 4 tons of white arsenic daily. The ore is a massive realgar, associated with gold, silver and lead ores.

A unique enterprise is the large arsenic plant being erected at the Washoe smelter of the Amalgamated Copper Company, at Anaconda, Mont. When completed (probably in 1905), several tons of flake arsenic per day will be recovered from the long flue that leads to the tall chimney of the smelter works. The process will consist in settling the fumes (from roasting the main-flue dust in the Brunton furnaces) in brick chambers (kitchens) alongside the smelter flue; after crystallization, the product will be heated in reverberatory furnaces in the arsenic refinery. The fumes from these furnaces will pass through another set of chambers, used for the refined product only. Finally the arsenic will be powdered, and shipped to market in air-tight 400-lb. barrels.

Imports.—Seven countries marketed arsenic and its compounds to the United States during 1904; these were Germany, France, Belgium, Spain, Denmark, Great Britain and Canada. The total imports were 6,391,566 lb. ($226,481), as against 7,146,362 lb. ($256,097) in 1903; 6,110,898 lb. ($280,055) in 1902, and 6,989,668 lb. ($316,525) in 1901. The American tariff places arseniate of analine, white arsenic, arsenic sulphide and arsenious acid on the free list; arseniate of soda is dutiable at 1.25c. per pound, and metallic arsenic, or 'cobalt crystals,' at 20 per cent *ad valorem.*

New York Market.—Notwithstanding competition, resulting from the introduction of new brands of foreign arsenic into the domestic market, prices have been well maintained. The monthly average prices for white arsenic (arsenious oxide), free of duty, f. o. b. New York, were in 1904: January, 3.125@3.25c. per pound; February, 3@3.125c.; March, 3@3.125c.; April, 3.125@3.25c.; May, 3.10@3.25c.; June, 3.10@3.25c.; July, 3@3.125c.; August, 3@3.125c.; September, 2.75@3.125c.; October, 2.75@3.125c.; November, 2.875@3.125c.; December, 3@3.375; year, 3.09c. For red arsenic (imported from Germany, free of duty) the monthly prices were almost stationary at 6.375@6.625c. per pound, because deliveries were mostly on renewal contracts. Makers of Paris green have become reconciled, as is shown by the fact that prices varied little from 11c. per pound throughout the year.

Uses.—The more important uses of white arsenic are in the manufacture of Paris green and other pigments; as a preservative of wood and animal skins; in dyeing and calico printing; in cosmetics and in medicinal wafers; as a vermicide in agriculture; in making glass, and in the casting of lead shot.

THE WORLD'S PRODUCTION OF ARSENIC AND ITS COMPOUNDS. (METRIC TONS.)

Year.	Canada. (a)		Germany. (b)		Portugal.		Spain. (a)		United Kingdom. (a)		United States.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons	Value.	Tons	Value.	Tons	Value.
1900	275	$22,725	2,414	$263,250	1,031	$62,522	150	$18,036	4,148	$335,140	Nil.	....
1901	630	41,676	2,549	256,570	527	35,277	120	14,400	3,416	197,270	272	$18,000
1902	726	48,000	2,828	247,520	736	33,063	71	8,520	2,131	96,610	1,226	81,180
1903	233	15,420	2,768	241,332	698	....	1,088	87,040	916	(c)	554	36,691
1904	66	6,900	2,829	258,000	.....	....	.....	....	992	(c)	452	29,504

(a) Arsenious oxide. (b) Sulphide, oxide and other compounds. (c) Value not reported.

Australia.—A large part of the arsenic used locally for dipping sheep is produced at the Spottiswoode smelting works, near Melbourne.

Canada.—Successful work was done in 1904 on the extensive deposits of cobalt-nickel arsenides in the Timiskaming district, 5 miles from Haileybury, Ont., discovered in 1903. During the summer of 1904 at least $200,000 worth of ore was shipped to New York for treatment. In future the ore will probably be treated locally, as New York capital has already $200,000 worth of ore was shipped to New York for treatment. The mispickel ores that are abundant on Net lake, near Lake Temagami, are also being exploited. At the Deloro mines, owned by the Canadian Goldfields, Ltd., work in 1904 was intermittent; the production was 73 short tons, valued at $6,900. This arsenic was exported to New York, where it sold at prices comparing well with those of the British product. The output in 1903 was 257 short tons, valued at $15,420, of which 198 tons, valued at $10,584, were exported.

Germany.—This is the principal source of the world's supply. The industry is centered in Prussia and Saxony. White arsenic is made at Freiberg by subliming the flue-dust from the roasting furnaces. Arsenic glass is made from nickel arsenide. The production of arsenic compounds for several years has not varied much from 2,700 metric tons. In 1903 the total was 2,768 metric tons, valued at $253,500. The Freiberg arsenic works are described in detail in The Mineral Industry, Vol. IV.

Italy.—The annual consumption of arsenious acid, chiefly in the manufacture of glass, and in tanning leather, is estimated at 400 to 500 tons, of which only about one-tenth is imported. The domestic production is supplied by the Bovisa works in Milan, where an auriferous pyrite, mined near by, containing from 10 to 12 per cent arsenic and about 34 per cent sulphur, is roasted. The gold is partly recovered, but the silver is not saved. The method employed at the Bovisa gold-arsenic plant has been fully described in The Mineral Industry, Vol. V.

Japan.—Realgar (As_2S_2) and orpiment (As_2S_3) are found associated with silver-lead ores, and a quantity is also present in the copper ore of the great Ashio mines. The annual production of arsenic has remained almost stationary between 5 and 10 tons, consumed locally.

Portugal.—Production, amounting to 698 metric tons of white arsenic in 1903, shows a relaxation in the industry. Arsenic ores are mined at Oliveira, in the Aveiro district. Imports, though small, are being made from Germany.

Spain.—The improved demand for the high-grade arsenic, exported to America, has stimulated the local industry. The bulk of the marketed arsenic is recovered from mispickel in the vicinity of Barcelona. In 1903 the production of arsenious acid amounted to 1,088 tons, valued at $87,040. In the province of Oveido also, 22 tons orpiment, valued at $4,450, was mined in 1903. The arsenical pyrite deposits in the province of Orense were opened in 1904 by a new company. It is said that the ore contains 25 to 40 per cent arsenic, besides some gold.

Turkey.—Although it is difficult to obtain statistics, it is understood that Macedonia produces quantities of arsenic-bearing ores. Occasionally discoveries of rich deposits of auriferous arsenical pyrite, analyzing as high as 42 per cent arsenic, are reported. Orpiment and realgar, however, predominate, and the annual production, between 2,000 and 3,000 tons, is shipped to France for treatment. The Government collects a substantial royalty on production.

United Kingdom.—This country was once the principal producer of arsenic; to-day its supply is small. In 1904 the output was 976 long tons arsenic and 43 tons arsenical pyrite. In 1902 the production was 4,093 tons arsenic and 6,886 tons arsenical pyrite. Depression in business has greatly affected the arsenic industry of Cornwall and Devon, aided by increased competition with new sources of supply, especially in the American market.

Yellow Arsenic.—According to Erdman and Unruh (*Zeitschrift für anorganische Chemie,* 1904), the yellow modification of arsenic, observed by several chemists, corresponds to white phosphorus and is produced by rapidly cooling the vapor of arsenic. The yellow powder can be kept indefinitely in the dark at a temperature of 70° F., but on exposure to light, even in solution, it quickly changes to ordinary arsenic. From a determination of the molecular weight, the molecule was found to correspond to As_4.

New Method for the Separation of Arsenic.—H. Cantoni and J. Chautems[1] find that arsenic can be separated from antimony by making use of the volatility of methyl arsenate at the ordinary temperature. The solution containing the arsenic and concentrated hydrochloric acid is treated with methyl alcohol, and introduced into a 250-c.c. flask connected with a condenser, the other end of which dips into a flask containing sodium hydroxide solution and provided with a guard-tube. A current of dry air is then led into the apparatus through a tube reaching to within a few mm. of the surface of the arsenic solution. Under these conditions the whole of the arsenic is stated to be carried over into the sodium hydroxide solution, while any antimony present remains behind.

[1] *Archive* Société physique naturelle, Geneva, XIX, 364. *Chemische Centralblatt,* 1905, I, 1,481.

ASBESTOS.

The asbestos output of domestic producers during 1904 reached the record figure of 1,480 short tons, valued at $25,740, showing a great increase as compared with the 887 tons, valued at $16,760, of the preceding year, but marking also a decline from $18.90 to $17.40 in the average value per ton at the mines.

PRODUCTION AND IMPORTS OF ASBESTOS IN THE UNITED STATES.

Year.	Production.			Imports.		
	Short Tons.	Value.	Value per Ton.	Manufactured.	Unmanufactured.	Total.
1900	1,100	$16,500	$15.00	$24,155	$331,796	$355,951
1901	747	13 498	18.08	24,741	667,087	691,828
1902	1,010	12,400	12.27	33,313	729,421	762,734
1903 (a)	887	16,760	18.90	32,058	657,269	689,327
1904 (a)	1,480	25,740	17.40	51,290	700,572	751,862

(a) Statistics of the United States Geological Survey.

The increase is due largely to the Sall Mountain Asbestos Company, whose workings are in White county, Ga., but more particularly to the growth of a recent enterprise in Virginia, the mine of the American Asbestos Company, at Bedford City. In addition to its output of true asbestos, which alone is included in the above total, this company produces a large amount of low-grade asbestos or actinolite, the iron-bearing member of the fibrous amphiboles, which, on account of its ferrous contents, is less suitable for those uses that call for fire resisting properties than the tremolite variety, although it is entirely suitable for lagging and many other purposes.

Neither of the amphibole varieties can compare with chrysotile, or fibrous serpentine, in adaptability to those uses that require strength of fibre as well as resistance to heat. Chrysotile deposits are not uncommon, but are worked on a commercial scale at only a few localities; the New England product is of this character. The relatively great difficulty in mining this material, which occurs only in thin veins ramifying through a mass of worthless serpentine rock, is the reason why the constantly increasing demand for this kind of fibre has to be supplied by importations from Quebec.

Among the most promising developments of chrysotile deposits may be mentioned a seam that is being opened by the Hance Asbestos Company at

Grand View, Ariz. The property is in the north wall of the Grand Cañon, nearly 4,000 feet below the rim, and although the engineering problems present some difficulty, the excellent quality of the fibre makes the prospect worthy of investigation, especially as railroad connection is now complete. No shipments were made during the year. Another similar deposit, prospected by M. L. Shackleford, of Needles, Cal., is situated at the head of Pinto Creek, 23 miles west from Globe, Ariz. The fibres reach a length of 4 and 5 in., are of fine quality, and are abundantly distributed along the contact of a serpentine mass. A North Carolina prospect, owned by O. H. Blocker, of Old Fort, shows an excellent quality of chrysotile contained in a serpentine dike 300 ft. long and 60 ft. wide. This property is two miles from railroad facilities.

Manufactures.—The H. W. Johns-Manville Company, of New York, is the leading manufacturer of asbestos articles. Two of its recently evolved products are marketed under the names of 'Transite' and 'Electrobestos.' The former is a dense, smooth, rigid mass of asbestos fibre, compressed into sheets, moldings and panels of various thicknesses from ⅛- to ¾-in., and ranging in standard sizes up to 42 in. by 7 ft. It can be sawed, chiseled, planed and machine-tooled, will hold screws, and can be handled like wood in every particular, but is, of course, absolutely incombustible. It can be stained, painted and decorated, has strong wearing qualities, and is superior to metal in many applications, as it is not affected by acids, gases or weather. Electrobestos is an agglutinated mixture of asbestos and non-conducting materials, which can be molded into all shapes required by the electrical industry. It possesses to a high degree the qualities of incombustibility, non-conductivity and non-absorption of moisture, and is being extensively used in connection with electric lighting and heating in buildings and in street cars.

A recent United States patent (No. 769,087), issued to T. H. Ibotson and R. Meldrum, of England, covers a process of making asbestos boards. Asbestos fibre is made into a pulp with magnesia and the mixture is treated with an alkaline-silicate solution before being pressed into shape.

The Keasbey & Mattison Company, of New York, has been making some comparative tests of building material made of asbestos and of magnesia. Results show that both these materials are superior to wood in the applications for which they are designed, but that the asbestos lumber is better than the magnesia. Asbestos sheathing for roofs and walls is also being extensively used. The same company makes shingles composed of asbestos fibre and hydraulic cement in colors gray, slate and red. They are molded into squares 4.5 in. on a side, and are said to be stronger than slate and also lighter.

The American Asbestos Company, at Terre Haute, Ind., makes a specialty of boiler lagging. Its 'Plasbestos' is easily applied to boilers and steam pipes by simply mixing with water and molding by hand in thin layers, allowing each layer to dry before the next one is put on. When great durability is desired a turn of wire cloth may be put around between two layers. As the mixture contains no lime or cement, it is easily removed when repairs are needed by the ironwork, and may be replaced at once. Ten pounds of plasbestos will cover 1 sq. ft. of surface to a thickness of 2 inches.

Asbestos in Canada.

BY J. OBALSKI.

Since the first shipment of asbestos from Canada, twenty-seven years ago, when but a few hundred tons a year was considered as the maximum production justified by the limited demand, this industry has been growing rapidly as more uses have been found for the shortest fibres, material which used to be left on the dumps. The Province of Quebec now has a flourishing industry, employing 1,800 men, who earn half a million dollars a year in wages, burning 40,000 tons of coal a year and shipping 48,000 tons of material, valued, at the mines, at a million and a quarter dollars. Fourteen companies, of private or limited ownership, are operating the asbestos mines with plants which represent several millions.

The industry is controlled by the following companies: Thetford—Bell Asbestos Company, King Brothers Company, Johnson's Company, Beaver Asbestos Company. Black Lake—American Asbestos Company, Johnson's Company, Standard Asbestos Company, Manhattan Asbestos Company, Montreal and Glasgow Asbestos Company, Union Asbestos Mine, James Reed. East Broughton—Broughton Asbestos Company, Quebec Asbestos Company. Danville—Asbestos and Asbestic Company.

In the early days of this industry the separation of the fibre from the serpentine rock was made by hand. It was quite an expensive process, and fibre shorter than 0.5 in. was lost. By 1887, demand having increased, the companies put up steam plants for working their mines, and started to experiment in the treatment of rock containing short fibre. They met with such success that now every mine is provided with a mill for that purpose, and the old dumps are being re-worked. The mining plants also have been improved by the adoption of compressed air for drilling, cable derricks for hoisting and small locomotives for hauling cars from the quarries to the dumps or to the mills.

Asbestos being irregularly disseminated throughout the rock in veins of varying widths, mining is done exclusively in open quarries, the deepest being about 220 ft.; drilling and blasting are done in the usual ways. A first sorting is effected in the quarry into (*a*) waste, (*b*) rock for the mill and (*c*) rock for hand cobbing, the latter constituting the crude. The crude is sorted, according to the length of fibre, into two classes under the names 1st and 2d crude; this is done by breaking the serpentine with a small hammer, thus separating the fibre. The work is done at a fixed rate per 100 lb., under the supervision of a foreman; the discard is sent to the mill.

The process of separating fibre in the mill is as follows: The rock is first broken by a large crusher, generally of the Blake type; it goes then to smaller crushers, and from them it passes between rolls, either plain or corrugated. The serpentine and asbestos, now in the form of a coarse sand, are conveyed to inclined shaking-screens at the lower ends of which the loose fibres are lifted by a suction fan. The material left on the screen is sent to a cyclone grinder, after which it passes through the screening and suction process again. The fibre of different grades is received in settling rooms and is then bagged in 100-lb. sacks. This process is the one most generally used, but it is varied somewhat by the different companies. Some of them do not use the rollers, but make the defiberization with disintegrators of different types. The crushers are not all of the same pattern and some companies use rotary crushers. In the newest mill, built by the American Asbestos Company, the small crushers and rollers are replaced by rotary crushers of the Sturtevant make, followed by disintegrating beaters. It has been found advisable to dry the material before proceeding to the defiberization, and now practically all the rock after being crushed, or even before, if the material comes from a dump, passes through cylindrical inclined dryers heated from outside, and in some cases with a current of hot air inside to remove the vapor.

Whatever the variations in the process, the companies prepare several different grades under special names, but they may be put under the two general denominations, fibre and paper stock. The first comprises the longest asbestos. The ground serpentine resulting from this process is known as asbestic sand and asbestic, and is sold directly or kept in special dumps waiting for shipments. An indication as to the value of the different grades and qualities is given by their prices, which I quote below. They vary according to the companies' subdivisions or with special orders:

1st crude	$120 to $200
2d crude	110 " 125
Fibre	40 " 60
Paper stock	10 " 25
Asbestic	1 " 5

Prices are on tons of 2,000 lb., f. o. b. stations near the mines. The proportion of asbestos obtained from the rock varies; at Thetford mines, for instance, the rock gives 1 to 2% of crude (1st and 2d) and 6 to 7% of fibre and paper stock.

The mines are distributed as follows: Four at Thetford, seven at Black Lake, two at East Broughton and one at Danville. Thus far Thetford is the largest producing district. These mines have produced, since the beginning, over 300,000 tons of material, valued at about $12,000,000. The table below gives the production for the last four years in tons of 2,000 lb.:

	1901		1902		1903		1904	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
1st crude	2,083	$348,579	1,319	$240,401	930	$117,847	1,645	$251,818
2d crude	2,660	263,855	3,131	305,312	2,354	227,919	2,727	265,961
Fibre	14,659	450,193	15,502	412,388	9,650	311,248	7,771	229,801
Paper stock	14,054	211,688	10,682	203,869	16,327	259,956	23,336	439,215
Total	33,456	$1,274,315	30,634	$1,161,970	29,261	$916,970	35,479	$1,186,795
Asbestic	6,831	10,114	9,764	12,738	9,906	13,292	13,149	13,124

The latest improvement in the operation of mines and mills has been the introduction of electric power obtained from the river St. Francis, about 12 miles from the mines. The American Company was the first to use this power, and its entire plant is run successfully by electricity.

Asbestos occurs exclusively in serpentine rock. This covers a large area in the eastern townships, but only a narrow belt can be profitably worked This is found in the townships of Wolfeston, Ireland, Coleraine, Thetford and Broughton, with a small outcrop in Shipton. The mines situated there afford remarkable facilities for working, being on small hills in close proximity to railroad lines and in a well settled country where labor is relatively cheap and abundant. The serpentine belt has been well prospected and all the valuable ground has been taken up.

Asbestos of a lighter color has been found in several parts of the Laurentian formation north of the St. Lawrence, especially in the Ottawa district, where some attempts had been made to develop it. The fibres, although very fine, are rather short and are not so abundant as in the above mentioned townships. Recently a wide belt of green serpentine has been discovered in the Chibagoma district, 400 miles north of Quebec. Some very good asbestos has been found there, which may later on be developed by the construction of a railroad. this country having remained, so far, practically unexplored.

ASPHALTUM.

The whole production of asphaltic materials in the United States in 1904 totaled 106,569 short tons, valued at $1,159,881, as against 101,255 tons, worth $1,005,446, in the preceding year. In the totals for both years is included the residual product from the refining of crude petroleum.

PRODUCTION OF ASPHALTUM AND BITUMINOUS ROCK IN THE UNITED STATES.
(Tons of 2,000 pounds.)

States.	1902.			1903. (a)			1904. (a)		
	Tons.	Value.	Per ton.	Tons.	Value.	Per ton.	Tons.	Value.	Per ton.
BITUMINOUS SANDSTONE.									
California	33,489	$79,809	$2.38	24,080	$69,862	$2.90	6 814	$19,264	$2.83
Kentucky	22,498	68,704	3.05	11,628	38,763	3.33	5,670	31,185	5.50
Indian Territory	c 1,050	4,580	4.36	1,710	3,908	2.29	5,457	12,516	2.30
Arkansas	800	4,000	5.00	1,215	5,468	4.50	1,700	8,500	5.00
Total	57,837	$157,093	$2.72	38,633	$118,001	$3.05	19,641	$71,465	$3.64
ASPHALTIC LIMESTONE.									
Indian Territory	1,130	4,020	3.56	2,520	8,800	3.49	Nil.	......	....
Texas	Nil.	......	....	Nil.	......	....	Nil.	......	....
Arkansas	700	3,500	5.00	Nil.	......	....	Nil.	......	....
Missouri	....	......	....	....	......	....	1,798	4,495	2.50
California	29	262	9.03	Nil.	......	....	Nil.	......	....
Total	1,859	$7,782	$4.19	2,520	$8,800	$3.49	1,798	$4,495	$2.50
ASPHALTUM (b)									
California (d)	34,511	448,643	13.00	50,487	632,764	12.53	53,465	626,165	1.17
Indian Territory	376	3,219	8.56	877	15,442	17.61	Nil.	......	....
Missouri	....	......	....	....	......	....	937	16,676	17.80
Texas	245	3,992	16.29	2,158	30,550	14.16	25,000	250,000	10.00
Total	35,132	$455,854	$12.98	53,522	$678,756	$12.68	79,402	$892,841	$11.24
GILSONITE (e):									
Utah	4,052	125,612	31.00	5,619	188,357	33.52	3 528	155,080	43.93
Indian Territory	....	......	....	....	......	....	1,000	25,000	25.00
MASTIC:									
California	....	......	....	11	132	12.00	Nil.	......	....
Kentucky	....	......	....	950	11,400	12.00	Nil.	......	....
Pennsylvania	....	......	....	....	......	....	1,200	10,800	9.00

(a) From the Mineral Resources of the United States. (b) Includes hard and refined, or gum, liquid or maltha, and oil residues. (c) Includes production of Oklahoma Territory (d) Includes 1.600 tons of liquid asphaltum valued at $20,137. (e) Includes gilsonite, elaterite and grahamite.

As compared with the year before, the strongest declensions occurred in output of bituminous rock, sandstone dropping nearly one-half and limestone nearly one-third, and of oil residue. The output of all other asphaltic products was greater in 1904 than in the previous year. The asphaltic oils of California came into prominence in 1902, when 20,826 tons of asphaltum was recovered. In 1903 the output of this residual asphalt rose to 46,187 tons, valued at $11.31 per ton, but in 1904, as a result of the over-production of the previous year, only 36,030 tons were made, the average value of which fell to $10.44 per ton.

Asphaltum in the United States.

Arkansas.—Bituminous sandstone was quarried during 1904 at a point two miles from Pike, and was used to pave streets in Little Rock. The output was about 1,700 tons.

California. (By T. H. Boorman.)—Efforts to continue the 'control' for the sales of California asphalts, organized in 1903, proved a failure in 1904, and both sales and prices fell off considerably. Large stocks had accumulated and prices fell from $13 to as low as $6 per ton f. o. b. California for the ordinary D grade. This would not account for the reduced production, which is probably due to increased demand for Texas maltha and hard asphalt. A large refinery was built in the summer of 1904 at Bakersfield, but other refineries previously erected had to close down in consequence of over-production. Several refiners had looked to sales of distillates to compensate them for the low figures obtainable for asphalt, but the Standard Oil Company reduced prices on these high-grade oils, so that a number of refiners had to shut down their works. The rapidly growing demand for liquid asphalt for dressing roads will prove helpful to some of the refiners in placing the crude material. The use of liquid asphalt for this purpose began in 1898, and by 1904 this system of waterproofing roads has become an important industry. Riverside, Cal., has miles of streets so treated.

Indian Territory.—The most valuable asphaltic product of this Territory is of the species 'grahamite,' of which 1,000 tons was mined in 1904. In addition, there was an output of 5,457 tons of bituminous sandstone. A technical description of the industry,[1] by W. R. Crane, will be found on a following page.

Kentucky.—Bituminous sandstone is mined by the Wadsworth Stone & Paving Co., of Pittsburg, Pa., at Pittsburg Landing, Laurel county, Ky. Part of this is sent to Pittsburg for the manufacture of mastic, the output of which is credited to Pennsylvania. The Wadsworth company is inaugurating a new application for the crude rock in the making of roadways equal to regularly laid asphaltic pavements, at half the expense. To use it, the dirt bed is shaped or rolled in the usual way; a 6-in. layer of 2-in. crushed stone is then placed and rolled; on this foundation a 2-in. layer of the same sized stone is spread and this is topped, before rolling, with 1 in. of crushed asphaltic rock, no heating being required, and the two layers are rolled simultaneously. The asphalt sinks into and binds the rock layers, which thus receive the wear of traffic, consequently prolonging the life of the composite beyond that of an asphalt pavement as ordinarily laid. This Kentucky 'rock asphalt' has been tested, with excellent results, in Nashville, Memphis and Birmingham. The initial cost of the asphalt road is 15 or 25c. per square yard higher than that of ordinary stone macadam; the difference is said to be recovered in the longer life and in saving of repairs.

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[1] See also the article by the same author in The Mineral Industry, Vol. XII, p. 25.

Texas. (By T. H. Boorman.)—In 1903 considerable strides were made towards bringing Texas maltha and asphalts into prominence, and in 1904 the production was certainly more than that of California in 1902. The Texas asphalts are the residuum of heavy asphalt oils, similar in character to the California malthas, but with slightly different chemical properties. These asphalts have not been used for paving without mixture with other asphalts, and have therefore not attracted the attention given to California products. It is said, however, that Texas maltha has very generally taken the place of California maltha as the fluxing material used with the harder asphalts for sheet asphalt pavements throughout the country east of the Mississippi river. This maltha has been extensively used in manufacturing artificial bitumens, and it has been used in conjunction with Cuban hard asphalt, Trinidad manjak, gilsonite and other asphalts requiring large amounts of softening material to give them pliability. The production in 1904 has been estimated at from 25,000 to 30,000 tons. A large refinery was operated at Marcus Hook, near Philadelphia, but exact statistics of production there and in Texas are not available.

Utah.[2]—Various mineral waxes are found in the southern part of the Uinta Indian Reservation, including gilsonite (uintaite), elaterite, würzilite, nigrite, ozocerite, besides bituminous limestone. The center of elaterite mining is Indian cañon, a southern tributary of the Duchesne river, where the Raven mine, owned by the Raven company, of Chicago, is operating. Gilsonite is obtained 60 miles east of this point, and ozocerite is mined at Soldier Summit, on the Denver & Rio Grande Railroad, somewhat nearer, on the west.

The mineral elaterite is probably not a definite compound, but a mixture of hydrocarbons, and is intermediate between maltha (mineral tar) and würzilite. It is soft and elastic, brown in color, of an average composition, 85.13% carbon; 12.63% hydrogen, and is by no means of common occurrence. The term is applied, however, to much of the asphaltic material mined near Indian cañon, most of which more closely resembles würzilite. Its occurrence is similar to that of würzilite, as described by George H. Eldridge.[3] The minerals are found in small vertical veins only a few inches wide, and are confined to the cliff-making series of the Green River formation of the Eocene, mostly calcareous shales and shaly limestones. Beyond a slight tilting, and these small fissures, no evidence of disturbance is seen. The formation itself carries beds of asphaltic limestone, which are thought to be the source of the mineral waxes.

The uses of elaterite and würzilite are the same, to which they are adapted by their superior elasticity. Both, however, are less readily and completely soluble in the ordinary solvents than the gilsonite that is mined in larger quantities and at a lower cost in the eastern Uinta region.

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[2] Private communication from Dr. Charles P. Berkey, Columbia University.
[3] United States Geological Survey, 22d *Annual Report.*

Asphalt Mining in Foreign Countries.

Barbados.[4]—The output of manjak, the local name for a kind of glance pitch, in 1904 was 925 long tons, valued, at the mine, at $57,500, as compared with 651 tons in 1903. The price ranges from $36 to $96 per ton, according to quality. The deposits are capable of a much heavier production, but the market is narrowly limited, and during the last three years sales in the United States have been maintained only by the sacrifice of prices, owing to the competition of gilsonite from Utah. Gilsonite has been selling at New York for $35 per short ton; manjak commands an advance of $6, owing to its superiority in that it yields a larger amount of varnish, which also is of a more intense black color than that made from gilsonite, varnish made from the latter often requiring the addition of a foreign black substance. In connection with the manjak mines, a little petroleum is obtained, which supplies a small local demand for fuel from sugar plantations, gas companies and others.

Cuba.[5]—The asphalt deposits of Cuba are widely distributed and have in past years attracted some activity; during 1904, however, the only producers were the Cuba Minera Industrial, at Mariel, Pinar del Rio, which shipped between 6,000 and 8,000 tons, and the West Indies Co., of New York, which obtained about 2,000 tons from its Angela Elmira mine, near Bejucal, Havana. The Matanzas Asphalt Co. sent about 50 tons of bituminous limestone to be tested as paving material in Havana. The Talaren mine, Puerto Principe, which yields glance pitch only, made a small production, all of which was shipped to Germany, not being able to compete in the American market with Utah gilsonite.

Germany.—This is the largest handler of asphalt on the European continent. In 1904 Germany produced 91,736 tons, imported 85,749, and exported 55,360 tons; its imports included 40,522 tons from Sicily. The principal mines are situated at Limmer, near Hanover, Magdeburg, and at Lobsann, in Alsace. Rock asphalt mastics, manufactured in Germany were extensively imported into this country prior to the passage of the Dingley bill. Since that time the duty ($3 per ton) has to a great extent reduced the importation.

Italy.—Exports of asphalt from Sicily in 1904 totaled 79,610 tons, 40,959 tons from Syracuse, 34,583 tons from Mazzarelli, and the rest from Catania. Germany took 40,522 tons; Holland, 15,762 tons; United Kingdom, 7,877 tons; the United States, 4,600 tons, and the rest was scattered among other European countries. The falling off of the export to this country was due to the fact that no shipments were made in 1904 by the Compagnie Generales des Asphaltes de France, which formerly owned the New York Mastic Works, and had been a large shipper in former years.

Mexico.—In 1904 the United States began to receive shipments of an

[4] Private communication from R. H. Emtage, A. M. I. C. E., Bridgetown, Barbados.
[5] Private communication from Charles F. Wiebusch, of the West Indies Co., New York.

THE WORLD'S PRODUCTION OF ASPHALTUM AND ASPHALTIC ROCK.
(In metric tons.)

Yr.	Austr.	France	Ger.	Hung.	Italy.		Russ.	Spain.		Trinidad. (b)	United States.		Venezuela. (Bermudez)
	Asph. Rock.	Asph. Limestone. (a)	Asphaltum	Asphaltum	Asphaltum (c)	Asph. Rock.	Asph.	Asph.	Asph. Rock.		Asphaltum.	Asph. Rock.	
1900	887	34,093	89,685	2,900	33,127	101,738	25,090	2,331	4,193	161,299	8,326	41,029	17,981
1901	541	29,815	90,193	2,878	31,814	104,111	(d)	4,182	3,956	167,253	19,882	37 393	22 115
1902	901	34,000	88,374	2,773	33.684	64,245	26,622	6,064	6,301	167,253	36,923	35,072	10,770
1903	1,273	(d)	87,454	2,422	(d)	89,690	12,360	4,372	6,277	196,883	48,555	37,334	14,567
1904	1,435	....	91,736	(d)	(d)	(d)	(d)	(d)	(d)	137,089	.....	.....	23,535

(a) France produces a large amount of bituminous shales, used for distilling oil, which is not included in these statistics. (b) Exports (crude equivalent) reported by The New Trinidad Lake Asphalt Co. (c) Including mastic and bitumen. (d) Not yet reported.

NOTE.—There is a considerable production of asphaltic stone in Switzerland of which no account is taken in the above table, the Swiss Government not publishing any mineral statistics. The production of asphalt in Cuba and of manjak in Barbados are not included in the statistics given.

asphalt refined from oil, under the direction of pioneers in the California oil-asphalt industry, operating at Ebaño, near Tampico. This asphalt is said to differ from the California product in being less sensitive to changes of temperature and in having a higher melting point. It has been used extensively for paving streets in the City of Mexico.

Trinidad.—Exports of asphalt from Trinidad were smaller in 1904 than for several years previous. The larger part of the output is derived from Pitch lake, but smaller amounts are obtained from adjacent land along the courses of overflows from the lake.[6] The supposed inferiority of this 'land' asphalt to that obtained from the lake is now proved to be fictitious.

EXPORTS OF ASPHALT FROM TRINIDAD.
(In long tons.)

Year.	Pitch Lake Asphalt.		Land Asphalt.		Total.	
	To United States.	Elsewhere.	To United States.	Elsewhere.	To United States.	Elsewhere.
1900(a)	70,938	51,805	34,796	448	105,734	52,253
1901	80,449	55,605	31,767	3,150	112,216	58,755
1902	104,956	34,220	25,153	290	130,109	34,510
1903(b)	123,582	41,950	18,478	4,886	142,060	46,836
1904(c)	63,033	48,655	22,582	660	85,615	49,315

NOTE:—A small proportion of the output undergoes a slight refining process before shipment. The above figures give the total exports, after recalculating, the "épuré and dried" to their equivalent original amounts of crude material. Shipments elsewhere than to the United States are mainly to Europe. (a) Epuré and dried are not reduced to original crude in 1900. (b) For thirteen months ending January 31, 1904. (c) Year ending January 31, 1905.

For paving streets, refined Trinidad asphalt by itself is too brittle to form a proper bond, and it is, therefore, always thinned by mixture with some other kind. California liquid asphalt is said to be the best ingredient for this purpose, although petroleum residue has been more commonly used on account of its cheapness.

[6] For descriptions of Pitch Lake in Trinidad see *American Journal of Science*, S. F. Peckham, July, 1895, p. 33; also *Pacific Oil Reporter*, T. Hugh Boorman, March 5, 1904, p. 4.

Venezuela.—Conditions at Bermudez lake are in disorder. In July, 1904, the Venezuelan Government forcibly confiscated the property of the New York & Bermudez company on the alleged grounds that the obligations of the Hamilton concession, the earliest of the arrangements under which the company was operating, and expiring in 1908, had not been fulfilled, and that the company had aided the Matos revolution. The company had prepared for the lapse of the Hamilton concession by purchasing, in December, 1888, a definitive title to Bermudez lake, with the right to exploit it for 99 years, and an absolute title and property right in 4,800 hectares of public land containing the lake and some adjacent territory. In the confiscation both these later titles were ignored. The lake is now being worked by a receiver for the benefit of the other claimants to the deposit, of whom several have been encroaching for a number of years, and who have been suspected of instigating the violent action of the Government.

During 1904, up to the time of the seizure, the New York & Bermudez company had mined 15,064 tons from Bermudez lake. It is estimated that between that date and the end of the year the receiver mined and shipped 8,100 tons, of which 7,300 tons came to the United States, the rest going to Europe.

Asphalt in the Indian Territory.

BY W. R. CRANE.

Two general types of asphaltic compounds are found in the Indian Territory—the so-called natural, or bituminous, rock asphalt, and grahamite or albertite. The former is in a liquid or a semi-liquid state, and occurs in beds of sand, sandstone and limestone, which have been more or less impregnated with it; the latter is in the solid state, occurs in fissures, and is commonly known as 'asphaltic coal.' The workable deposits of asphalt in the Indian Territory, so far discovered, are largely confined to the Chickasaw and Choctaw nations, although thorough and systematic prospecting is yearly showing the existence of many new and extensive deposits outside of these areas, even extending into the neighboring States of Texas and Arkansas, while traces are found in Kansas and Missouri.

The natural, or bituminous, rock deposits, as a rule, are found in the less disturbed portions of the above-named sections, lying in the extreme southern part of the Territory, although a few extensive deposits have been located considerably further to the north. The asphaltic coals—the solid forms of asphalt, more properly called asphaltites (albertite, grahamite and impsonite, all closely related) are, on the contrary, found where the formations have been more or less disturbed by orographic movements, as evidenced by the folded and fissured condition of the strata. In fact, the asphaltites occur in fissures only, and, as a rule, in none except the very steeply pitching ones. So closely do the asphaltites of this section resemble the semi-anthracite coal, which occurs in large quantities a short distance to the north, that prospectors are often mistaken as to its identity, especially where considerable excavating is necessary to make clear the relation and association of the strata. That the Government maps, of recent date, indicating the segregated asphaltic lands, are not to be relied upon, is shown by the frequent taking up of asphaltic lands outside of the areas so set aside. The large coal companies are especially active in discovering and acquiring such properties.

Bituminous rock deposits have been prospected and worked at Dougherty, Tar Springs, Ravia, Ardmore, Elk, Marietta, Page, Emet, Oakland, Saint Jo, and Coalgate, but especially at the first four mentioned localities. The Tar Springs deposits are typical of the sandstone variety, while those at Ardmore and Dougherty are chiefly in bituminous limestone. The former deposits are largely made up of beds of loose sand and sandstone, interstratified with several feet of yellow and red clay and shales, and must be excavated as earth, while the latter are solid beds of limestone and can be quarried. As the bituminous-rock foundations, especially the sandstone variety, outcrop or are exposed over large areas, the expense of removing the overburden and loosening and excavating the asphaltic materials is slight, seldom exceeding 10c. per cubic yard.

Attempts have been made, and are still in progress, as at the Tar Springs locality, to separate and refine the asphalt, but so far with little success. The main difficulties appear to be the safe removal of the accompanying heavy oil (petrolene), which ranges from 8 to 30% of the total content of the sand and sandstone, and the cooling of the concentrated asphalt.

After being separated from the containing sand, which is usually accomplished by the aid of hot water and hydraulic classifiers of the spitzlutte type, the oil and liquid asphalt are passed through tanks, heated by steam coils, in which the water and the lighter oils are gradually eliminated by evaporation. The process is continued until the proper consistency is reached, when the residual asphalt, still in a liquid state, is cooled and barreled. So far the experience of asphalt refining in the Indian Territory has been an unbroken series of explosions, fires and similar disasters. In California the problem has practically been solved, and open distillation, as practiced in the Indian Territory, is a thing of the past.

Probably no better quality of natural-rock asphalt has been found in the United States than is available in immense quantities in the Indian Territory, but so far the cost of production in paying quantities has been excessive. Probably the chief hindrance to the development of these deposits is lack of railroad facilities. The principal use to which the natural-rock asphalts have been put is in paving streets and sidewalks. A mixture of finely ground asphaltic sandstone and limestone or other broken rock, in the proper proportions, which will vary somewhat with the character of the asphaltic material used, will, when properly mixed and placed, make an excellent street covering. In fact, in the regions where they are found, these materials are often placed in the roughest possible way, and yet they make quite durable wearing surfaces.

The localities in the Indian Territory where asphaltites have been found in economic quantities are surprisingly few, and some of those, even, that were esteemed of considerable importance have, on development, proved of little value. Workable deposits have been opened up at Antlers and Loco, and others have been reported near Howe. These and similar deposits are found in the Arbuckle and Ouachita mountains. The uplifts and disturbances accompanying them were responsible for the fissuring of the formations, thus forming receptacles for the asphalt. The asphaltites occur in fissures, cutting beds of sand, sandstone and shale; they have a pencillate cleavage perpendicular to the walls of the fissures; they are hard and glossy black, and rapidly disintegrate on exposure to air and moisture. The fissures are extremely irregular in both dip and strike, especially the former; they are very pockety, seldom reaching a depth of over 150 ft., and range in width from a few inches to 10 ft. The vertical and lateral extents of the individual pockets are seldom over 25 or 30 ft. When the deposits have clay walls, which is the rule rather than the exception, much trouble is experienced from caving, especially during the wet seasons; surface and underground waters combine to soften the walls of shale and clay as fast as they are exposed by the mining operations. Under such conditions it is necessary to place the shafts quite close together, say from 60 to 150 ft. apart, and to work out the mineral adjacent to them as rapidly as possible. Underhand stoping is the method of mining usually employed; this keeps the working face dry, and, with the shafts close together, requires little or no underground handling except shoveling. Hoisting to the surface is done entirely by bucket. Most of the deposits so far worked have pinched out at a depth of 100 to 150 ft., and it is a subject of much speculation as to their possible continuance. Prospect drilling, which has been rather extensively employed in certain localities, has not thrown much light on the subject.

The output of all asphaltic materials from the Territory during 1904 probably has not exceeded 1,000 tons, the greater portion of which has been grahamite. The price paid for grahamite is $15 per ton and the market is good. The cost of transportation by wagons over rough country roads, for distances ranging from 15 to 25 miles, is about $3 per ton. The cost of mining is very close to $1.50. The profit, then, per ton placed on the cars is about $10. With increased railroad facilities the output could be greatly enlarged and a very profitable industry built up.

BARYTES.

The production of barytes in the United States during 1904 was 65,727 short tons, valued at $174,958, showing a great increase over the production of the previous year—50,397 tons, valued at $152,150. Five States contributed to this output, in order of importance: Missouri, Tennessee, North Carolina, Virginia and Kentucky. The first two mentioned States showed but little increase over the previous year, while the outputs of North Carolina and Virginia were nearly doubled. The Kentucky mines, owned by the Marion Zinc Company, have not yet reached the productive stage, and the recently discovered occurrence at Richville, New York, is still in process of development, a few carloads having been mined but not shipped.

PRODUCTION, IMPORTS AND CONSUMPTION OF BARYTES IN THE UNITED STATES.
(In tons of 2,000 lb.)

Year.	Production.			Imports.				Consumption.	
	Quantity.	Value.		Crude.		Manufactured.			
		Per Ton.	Total.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1900...	41,466	$3.90	$161,717	2,568	$8,301	2,454	$24,160	46,488	$194,178
1901...	49,070	3.22	157,844	3,150	12,380	2,454	27,062	54,674	197,286
1902...	58,149	3.21	186,713	3,929	14,322	3,908	37,389	65,986	238,424
1903(a)	50,397	3.02	152,150	4,344	22,777	5,716	48,726	62,457	223,653
1904(a)	65,727	2.66	174,958	6,689	27,463	5,920	48,658	78,336	251,079

(a) Production statistics from the United States Geological Survey.

PRODUCTION OF BARYTES IN THE PRINCIPAL COUNTRIES.
(a) (In metric tons.)

Year.	Belgium.	Canada.	France.	Germany.	United Kingdom.	United States.
1900............	38,800	1,207	3,635	74,160	29,937	37,816
1901............	22,800	592	4,145	88,646	28,054	44,516
1902............	33,000	994	4,323	......	23,986	52,661
1903............	21,000	1,055	5.731	......	24,050	45,732
1904............	(e)	1,254	(e)	......	21,468	59,643

(a) From official reports. (e) No statistics available.

Missouri.—The supply comes mainly from Washington, St. François and Crawford counties, southwest of St. Louis, and from Cole and Miller counties, south of Jefferson City. The American Lead and Baryta Company, whose plant is at Mineral Point, Washington county, and the Washington Land and Mining Company are the leading producers, but a number of smaller operators dispose of their product to selling and manufacturing firms in St. Louis.

Tennessee.—The barytes mines of this State are found in the mountainous region along the eastern boundary, in Monroe, Loudon, Cocke, McMinn and Sevier counties. The manufacturing centres are Bristol, in the north, and Sweetwater, in the south, controlled respectively by John T. Williams & Sons and William D. Gilman. The latter has recently obtained a patent (No. 770,963) on a process for the bleaching of barytes and the recovery of Glauber's salt as a by-product. The ground ore is treated with a solution of niter-cake and heated. This dissolves the impurities. The solution is withdrawn and the residue washed with hot water. An alkali solution of sodium is added to the filtrate, whereby the impurities are precipitated and Glauber's salt is formed in solution. This is then recovered by concentration and evaporation.

Virginia.—The largest output of barytes comes from the mines of the Tri-State Mining & Manufacturing Company, at Richlands, Tazewell county, on the western border. Other mines, farther east, owned or controlled by Nulsen, Klein & Krausse, of St. Louis, are situated along the Southern Railway in Campbell and Pittsylvania counties, but no production was reported from them in 1904, the properties being still under development. The mines near Evington, Campbell county, have been abandoned as exhausted.

Barytes in this part of Virginia occurs in pockets or lentils, with smaller veins and seams, dipping at an angle of 40 or 45°. The different mines and deposits extend almost rectilinearly northeast-southwest. A deposit is first located by surface indication, and the mining is begun by sinking a vertical timbered shaft, equipped with a steam hoist, rope and bucket. When the vein is reached, timbered drifts are run, following the lead of the ore; from these the ore is taken out through the vertical shaft. The ore varies from 10 to 60 ft. in width; the hanging wall is usually sandstone or slate, and the foot-wall is limestone; the ore is imbedded in black dirt or red clay. The prosecution of this industry has given employment to a large number of natives and has proved a boon to many poor farmers who have found such sources of revenue upon their unproductive land. The royalty ranges from 50c. to $1 per ton.

Uses.—The larger part of the barytes output is pulverized and mixed with oil, generally in combination either with white lead, zinc-white, or other white pigments. The natural barytes has a disadvantage not possessed by the artificial barium sulphate, blanc fixe, in that, no matter how finely ground, it will not mix uniformly with other pigments on account of its high specific gravity. Its advantage over white lead lies in the facts that it neither is affected by sulphurous gases, by which lead carbonate is slowly transformed into dark colored lead sulphide, nor does it attack the oil with which it is mixed, saponifying and rendering it soluble, as is done by lead carbonate, owing to its invariable trace of lead hydroxide. The oxide and the sulphide of zinc both possess these same valuable qualities.

In point of body or covering ability, barytes is inferior to any of these other white pigments, owing to the fact that it cannot be ground to a uniform degree of fineness. The artificial sulphate, however, is not open to this objection.

Bleaching Barytes.[1]—In preparing barytes for market the mineral is first crushed, then washed, after which it is ready for bleaching. The fineness depends on the amount and character of the iron present, varying from pea-size, if the iron be in the form of a scale, to ½-in. if the mineral be only iron-stained. In the former case, the bulk of the iron can sometimes be removed by jigging.

The crushed mineral is bleached in circular wooden tanks, lined with sheet lead. Each tank is provided with a 2-in. lead pipe, coiled in the bottom, closed at the end, and provided with small perforations 7 in. apart. Steam escaping from the perforations agitates and heats the bleaching solution. This is sulphuric acid diluted to about 20° or 30° B. The mineral is charged into the tanks to a depth of about 3 ft., after which the acid solution is run in and steam is turned on. The time required to bleach the mineral varies from 6 to 80 hours, depending on the iron content. It is the usual practice to leave the steam on continuously, although good results may be obtained by cutting it off for half an hour at intervals of one hour.

After the bleaching is finished, the cleaned mineral is transferred to a washer, where the last traces of clay and acid are removed, after which the mineral is dried on a pan or in a rotary dryer. The dry mineral is reduced to the size of fine sand by rolls, and finally to an impalpable powder by buhr stones, when it is ready for barreling and shipping.

The quantity of mineral that can be bleached and milled in 24 hours depends upon its iron content and its friability. The average mineral can be bleached in 24 hours, and from 30 to 40 tons can be milled in 24 hours by 12 buhr stones of 3.5 ft. diameter.

A slight reddish or yellowish tint in the finished product, due to incomplete bleaching or washing, is sometimes neutralized by a small quantity of blueing, from 0.5 to 3 oz. per ton of material, but this practice is not general, being objectionable to some of the trade.

Manganese dioxide, a common impurity in barytes, cannot be removed by the use of sulphuric acid alone. Such mineral has to be ground to pass a 40-mesh screen, is mixed with nitrate of soda and sulphuric acid in proper proportions, and transferred to a specially constructed furnace. This process converts the iron and manganese into sulphates, which are completely removed by washing and settling the mineral in a series of tanks, generally three in number.

A tank 4.5 ft. high and 8 ft. in diameter is a convenient size for bleaching, containing, when charged to a depth of 3.5 ft., approximately 14 tons.

[1] Edwin Higgins, Jr., in *Engineering News*, February 23, 1905.

It should be made of stout, well-seasoned wood, preferably cypress, should be well braced on the outside, and lined on the inside with heavy sheet lead. Connections should be provided so that either steam or water may be supplied through the perforations in the lead pipes. These perforations are best located at an angle of 45° off the vertical rather than directly on top, in order to prevent clogging of the pipes with fines.

One of the greatest items of expense in the process is the steam for heating and agitating the bath. This may be greatly reduced by use of an ordinary injector, using a mixture of air and steam instead of steam alone. The amount of air can easily be regulated, so that the acid will not be too much cooled. The temperature may be kept at 200° F.; better agitation will result; the acid will suffer less dilution from condensing steam, and the steam consumption will be reduced one-half. The weak acid drawn off from the bleaching tanks, containing iron in solution, is run into a special tank, wherein the iron can be precipitated together with calcium sulphate by the addition of milk of lime. This precipitate, when dried and roasted, makes a very good red pigment.

The artificial sulphate of barium, known as blanc fixe, is prepared by mixing finely ground barytes with one-fourth its volume of coal and heating to a high temperature in a crucible or retort. The barium sulphate is reduced to sulphide, dissolved in dilute hydrochloric acid, and the solution filtered. From this solution barium sulphate is precipitated by sulphuric acid. The resulting product is absolutely white, entirely free from grit, and is more valuable than the best grade of barytes produced by any other process.

A History of the Barytes Industry.

BY WILLIAM D. GILMAN.

The manufacture of barium products in the United States began at Kansas City, Mo., about 1887. The process at first consisted in selecting the whitest barytes and grinding it in buhr mills, after which it was water-classified into two grades. The 'floated' barytes, when bleached, owing to the natural softness of the Missouri ore, was, and still is, much superior to the material imported from Germany. A large part of the product, however, marketed as 'water floated', received no other treatment than the preliminary grinding. At this time 'floated' cost about $12 and sold around $26 per ton.

Large quantities of the unbleached material were bought by the pork and beef packers, who made from it the yellow paint with which they coated the canvas casings of hams and dried beef, adding sometimes a pound and a half to the weight of an article. The Armour company alone used 2,000 tons per year, buying it at $18 per ton and disposing of it as meat at around 15c. per pound. This lucrative practice came to an end through competition among the packers, who thenceforth cased their best goods in unweighted canvas.

Deprived of their best market, with prices cut in half, and remote from manufacturers of paint, many of the mills were put out of business, and all of them worked at a loss. The writer, having a large deposit of iron-stained barytes, was driven to experiment with the well-known process of making artificial barium sulphate, blanc fixe, by roasting the ground ore mixed with coal, then dissolving the reduced barium sulphide in dilute hydrochloric acid and precipitating the barium with sulphuric acid, at the same time recovering dilute hydrochloric acid for further use. The expense of shipping acid from Chicago was prohibitive.

Some time before this the National Mining & Milling Company had been organized in Baltimore. Its mineral proved to be refractory, both to grinding and to conversion into blanc fixe. Bad financial management, a large part of the capital having been distributed among the promoters instead of being applied to construction, made it necessary to carry on extensive experiments. The writer finally evolved a process in which niter cake was used instead of sulphuric acid, sodium sulphide being recovered as by-product. Another process of making precipitated carbonate and another for barium chloride were also perfected and put into immediate operation. The first year's work was exceedingly profitable, owing partly to a growing demand for sodium sulphide. The production during the year 1900 was: Carbonate, 2,800 tons; chloride, 2,400 tons; sodium sulphide, 3,600 tons; blanc fixe, 800 tons. The chloride was made at the Highlands works of the General Chemical Company, where acid could be secured without the payment of freights. All that would have been needed at this time to drive the German material from the market were firm management and increased production. With care, the German market even might have been invaded, but, elated with their success, the controlling interests of the National Company decided to acquire complete control and to form a new company under the title American Lead & Baryta Company. This was capitalized at $10,000,000, and extravagant schemes were laid out for the acquisition of mineral lands in Missouri, town sites, railroads and factories. The Baltimore and the Highlands plants were immediately dismantled for transportation of their equipment to St. Louis. Such recklessness naturally led to utter failure in the proposed scale of operations, and German goods are now again predominant in the American market.

The success of the first year's operations was sufficient to prove that domestic production can be made to supply all demands, with a good profit. It also proved that large quantities of precipitated carbonate are being imported under the name witherite. It is impossible to tell what quantities of barium salts are imported under the general head of 'Chemical Salts,' but as an approximation they could be stated at about: Precipitated carbonate, 8,000 tons; blanc fixe, 2,000 tons; chloride, 3,600 tons; nitrate, 350 tons; oxide, 800 tons; hydrate, indeterminable. As to the hydrate, a factory at Niagara Falls began to manufacture it about three years ago by the Jacobs process, in an electrical furnace. This process was expensive, costing about $80 per ton, and the output was no larger than from the usual coal furnace. The market price for this hydroxide is $55 per ton.

The manufacture of barium salts has been undertaken without proper preparation by many business men who have no qualifications to undertake a task requiring technical knowledge. When, however, professional ability has been brought to bear, the manufacture of barium salts has been most successful. For example, lithophone (a mixture of barium sulphate and zinc sulphide) was made, eight years ago, by only one firm, Cawley, Clarke & Co.; today seven factories are turning out this pigment at the rate of 10,000 tons per year. This pigment is the very best for certain uses, such as oil cloth, and its use is growing rapidly in all applications where great lasting ability is needed.

The legitimate use of barytes as a pigment is coming to be recognized as possessing great recommendations. In the earlier days barytes was mixed lavishly with white lead, simply for the purpose of adulterating it, but now barytes itself is recognized as having certain valuable characteristics as a pigment. Pure white lead always contains a small proportion of lead hydrate; upon being mixed with oil, this hydrate has the same effect as the alkaline hydrates in saponifying the oil, but to a much less violent degree. This is the reason for the dusty appearance of pure white lead paint after having been exposed to the weather for a few months. A mixture of two parts of white lead with one part of blanc fixe gives a pigment which will last twice as long as one of pure white lead. The white lead may even be entirely displaced, as for example in Masury's 'Railroad Lead,' which has the following composition, as reported by Ledoux & Co.: Zinc oxide, 57.70 per cent; barytes, 44.30 per cent. The lasting qualities of this paint are well known; under favorable conditions it has been said to remain in good condition for twenty years. The prejudice against the use of barytes is, of course, traceable to the reckless manner in which this, an inexpensive ingredient, was used to adulterate white lead in the earlier days, but it is almost certain that barytes would have reached its present degree of utility had it cost ten times as much as it does. The use of ground barytes has one serious objection. However finely the barytes may be ground, it will not mix satisfactorily with other pigments, owing to its high specific gravity. The precipitated sulphate or carbonate, however, is not open to this objection, as either will mix uniformly with lead or zinc pigments. When examined under the microscope at a magnification of 280 diameters, blanc fixe is found to consist of minute crystals, of uniform size, but ground barytes of the finest grade on the market, when examined under a magnification which will fail to distinguish the crystals of blanc fixe, will appear as a mixture of irregular particles, showing the greatest diversity in size.

Up to the formation of the lead trust, each factory made at least two brands of "off" lead, one of them containing one-third barytes and the other 70 to 80 per cent barytes, the latter being in demand as a cheap paint. When the combination went into effect, it was found advisable to maintain a uniform grade for purposes of interchange. The white lead now made is not inferior to that made a few years ago, the popular idea to the contrary notwithstanding, but it is now understood that the addition of zinc pigments or of barytes, either natural or artificial, adds greatly to the lasting power of a paint.

Twelve or more firms are now engaged in the grinding of barytes, of which Nulsen, Klein & Krausse, of St. Louis, familiarly known as 'The Trust,' is the largest, having four plants under its control, two in Missouri, one in Illinois and one in Virginia, with a combined output of 200 tons per day. A large proportion of the enterprises, especially those started in recent years, have been failures, owing to lack of foresight and to reckless management. The geographical distribution of the mines is such as to prevent economical combination.

The most profitable enterprise at present is the manufacture of barium oxide. The Hedsworth Barium Company, of London, turns out about 5,000 tons annually, which it sends abroad after supplying all its domestic demands. It receives $160 per ton for its product, and the price in New York is about $200. In parts of this country it would be possible to manufacture this compound for $90 per ton, and a plant with a 500-ton annual output could be installed for not over $30,000. A reduction in price is certain to be followed by greatly increased demand, and the same is true of other barium salts. The artificial sulphate ought to be made for $25 per ton as against its present price of $40, and the extensive manufacture of barium compounds offers an extremely attractive field for the investment of capital, while the possibility of disposing of the valuable by-products is now much better established than it ever has been. Operation on a large scale, however, in order to compete with the German product, is absolutely essential.

BAUXITE.

The production of bauxite in the United States in 1904 was 48,012 long tons, valued at $166,121, showing only a slight decrease as compared with the output of the previous year, which was 48,087 long tons, valued at $171,306, and a decrease of 10 cents in its average value per ton.

PRODUCTION, IMPORTS, EXPORTS AND COMSUMPTION OF BAUXITE IN THE UNITED STATES.

Year.	Production.			Imports.		Exports.		Consumption.	
	Long Tons.	Value.	Per Ton.	Long Tons.	Value.	Long Tons.	Value.	Long Tons.	Value.
1900	23,445	$85,922	$3.66	8,656	$32,968	1,000	$3,000	31,101	$115,889
1901a	18,905	97,914	4.23	18,313	66,107	1,000	3,000	36,218	144,021
1902	29,222	128,206	4.39	15,790	54,410	Nil.	......	43,112	175,875
1903a	48,087	171,306	3.56	14,889	49,684	Nil.	......	62,976	220,990
1904	48,012	166,121	3.46	15,475	49,577	Nil.	......	63,487	215,698

(a) Statistics of the United States Geological Survey.

Only three States contributed to this output, as follows: Arkansas, 24,016 tons; Georgia, 16,909; Alabama, 7,087 tons. The New Mexico locality has not yet been brought within range of transportation facilities.

The feature of greatest interest is the rapid development of the Arkansas locality. This was discovered in 1891, but the first shipments were not made until 1899. In 1903 and the following year, the output from Arkansas was in excess of that from the Alabama-Georgia area. This rapid development is due to the energy of the Pittsburg Reduction Company, whose new plant at East St. Louis draws all its ore supply from the Arkansas district. The bauxite deposits extend in a narrow range from near Little Rock southwest for 20 miles toward Benton, being best developed toward the ends of its extent.[1] The ore is found in beds, ranging up to 40 ft. thick, interstratified with Tertiary rocks and always associated with intrusive masses of syenites, from the decomposition of which the bauxite appears to have been derived. It occurs in two forms: granitic, at the base of the deposits, resting upon the unaltered syenite, and retaining traces of its original feldspathic crystallization; and pisolitic, found toward the tops of the beds. The former is the purer, and corresponds closely to the species gibbsite, $Al_2O_3,3H_2O$.

[1] See *Bulletin* No. 11 of the Geological Survey of Georgia. "Bauxite Deposits of Georgia," by Thomas L. Watson.

The Georgia-Alabama bauxites are different in their occurrence and origin from all other known deposits of the ore. They are not stratified, and they have not been immediately derived by the decomposition in place of pre-existing rocks, but are found in pockets as well-defined, compact masses, altogether distinct from surrounding material. They extend in an irregular belt from Adairsville, Ga., to Jacksonville, Ala., and are limited to the Coosa valley.

The deposits usually occupy the summits and slopes of hills, being covered with a layer of silicious clay 1 to 10 ft. thick. In this position they are easily attacked by horizontal trenches driven into the hillsides. In other cases, open pits are sunk, the material being raised by derricks or inclined tracks. Only the simplest machinery is used. The ore can usually be dug with picks; it is then loaded into tram-cars and carried to the washing and drying plants. Simple log washers remove the clay, in which form the objectionable silicious impurity is contained, and rotary cylinders, employed by all the large mines, dry the ore. The greater part of the bauxite mined in the South is used in the manufacture of alum, the Arkansas deposits furnishing the main supply for the reduction of aluminum.

A recent evolution is the tendency to distinguish more sharply between the various grades of bauxite as adapting them specifically for extraction of aluminum or for the preparation of alum. The appropriate requirements of ore to be used in the manufacture of 'alundum,' an artificial corundum, or of refractory brick are also becoming defined, but not so clearly.

The following selected analyses will give an idea as to the variation in quality of the material furnished by different localities:

	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	H_2O
Arkansas, Pulaski Co.	62.05	1.66	2.00	3.50	30.31
Arkansas, " "	46.40	22.15	4.89	....	26.68
Alabama, Cherokee Co.	61.00	2.20	2.10	3.12	31.58
Alabama, " "	40.93	22.60	8.99	....	20.43
Georgia (average of 28)	58.62	1.51	4.27	3.79	31.44
Baux, France	60.	25.	3.	....	12.
Baux, "	75.	12.	1.	....	12.

Ore that is to be converted into sulphates should contain a large proportion of soluble alumina, 50° Baumé sulphuric acid being the basis of comparison, and it should not carry large percentages of iron, silica and other impurities. It is said that satisfactory alum can be made from ore carrying 10% ferric oxide and 20% silica, but the demand has always been for high-grade mineral. A recently installed method of making alum consists in treating bauxite with niter-cake. This is said to be cheaper than the use of free sulphuric acid.

The American Bauxite Company, of Little Rock, Ark., is the pioneer in the successful use of bauxite for the manufacture of refractory brick. The method is covered by United States patent No. 775,887, dated November 22, 1904. The value of bauxite as a refractory material has been known for several years, but heretofore it has not been possible to make satisfactory brick on account of the lack of cohesive qualities. It is said that this difficulty has been overcome by the new process, and practicable brick are now being made for basic furnace lining, which are much cheaper than the magnesite brick that are now extensively used. The Berger patent covers the use of a binder with calcined bauxite. In making these brick, a natural bauxite from Arkansas is used, which is very low in silica, and it is bonded by a small proportion of plastic fire-clay. The brick contain from 88 to 90% alumina, and from 10 to 12% ferric oxide, titanic acid and silica. The percentage of silica is so low that it is not appreciably detrimental to the basicity.

Bauxite brick seems to be especially adapted for the linings of basic open-hearth furnaces. The highest grade are used in the floor and walls up to the slag line, being protected by a bed of calcined bauxite. Above the slag line cheaper brick, with a lower percentage of bauxite, can be used. These brick are manufactured by the Laclede Fire Brick Company, of St. Louis, for the American Bauxite Company. They have been severely tested in some prominent steel works, and have given very satisfactory results. Their cost is considerably less than that of magnesite brick.

Special tests of these brick have been made by immersing them, with others, in a bath of white-hot basic slag. In this bath most of the other bricks disappeared at least 10 minutes before the bauxite brick began to show signs of distress. Under the most severe trial a good-sized core of unaffected brick remained, even when the other bricks had wholly dissolved. The company is now putting in a plant to wash the bauxite, and expects to be able to make a brick with not more than 5 or 6% silica. These are to be used for the basic furnaces at the Bethlehem company's armor-plate plant.

PRODUCTION OF BAUXITE IN THE PRINCIPAL PRODUCING COUNTRIES OF THE WORLD.
(In metric tons.)

	1900	1901	1902	1903	1904
France	58,530	76,620	96,900	133,890	(a)
United Kingdom	5,873	10,357	9,192	6,226	8,700
United States	23,556	19,207	29,690	48,856	48,780
Total	87,959	106,184	135,782	188,972	

(*a*) Figures not yet obtainable.

BISMUTH.

The production of bismuth ore in the United States in 1904 amounted to 61 short tons. There was no production in 1903, and only 37 tons in 1902. Of the 1904 output, 36 tons, averaging 8.17 per cent bismuth, came from the President and the Big Six mines at Leadville, and the remainder, carrying about 10 per cent bismuth, was contributed by a new mine near Banning, Riverside county, Cal. No metallic bismuth was reduced in this country.

A discovery has been made 40 miles west of Tonopah, Nev., where the ore occurs as bismuthinite and as oxychloride of bismuth, assaying 4.48 to 4.83 per cent bismuth, 7 to 80 oz. silver, with a trace of gold. The vein has been opened for 900 ft., showing a width ranging from 20 in. to 4 ft. High-grade ore, in association with copper ore, is reported from Newfoundland, Boxelder county, Utah.

An engineer, examining a property in Durango, Mexico, reports the finding of fine specimens of bismuth ore, but the mine is not yet developed. A small production from a new source is reported from the Percy river, Etheridge district of Queensland. The existence of chiviatite ($Pb_2Bi_6S_{11}$; 62% Bi) in the San Mateo district, Department of Lima, Peru, was reported in 1902.[1] Bismuthinite (Bi_2S_3; 82.3% Bi) and chiviatite have since been found at two other localities, at Yauli in the same Department, and Jauja, in Junin, a specimen from the latter showing a content of 48.84% Bi_2O_3, with 23.42% Fe_2O_3. The ore is a compact mass of earthy material, yellow in color, and considerably decayed.

The main source of the world's supply of bismuth is Saxony, where the mining and treatment of bismuth ores are under government control. Part of the ore treated in Germany comes from mines in the vicinity of La Paz, Bolivia. In England, Johnson, Matthey & Company, Ltd., is the only smelter, and these two interests govern the industry. A reduction plant intended to treat the bismuth ores of San Bernardino county, Cal., was begun in the summer of 1904 at Garvanza, just outside the city limits of Los Angeles, in the hope of competing successfully with Saxony. The residents, however, complained that its operation would destroy vegetation, and work has not yet begun.

A good deal of the marketed bismuth is a by-product from the treatment of the ores of other metals. Bismuth is the most objectionable impurity in a lead intended for corroding, but is also the one most difficult of removal

[1] *Boletin* de la Sociedad Nacional de Minera, March 31, 1905.

by the Parkes process. The Pattinson process removes it more effectually, but is not employed in this country. The Betts electrolytic process makes a clean elimination of bismuth, and as its use widens it may afford the principal supply of bismuth metal.

Uses.—Metallic bismuth is the principal constituent of easily fusible alloys, such as are used for safety plugs in boilers and in automatic fire-extinguishers. In the laboratory they are useful as baths in which a constant temperature below that of boiling water is desired. Rose's metal (Sn, 1; Pb, 1; Bi, 2) fuses at 94° C., and Wood's metal (Sn, 1; Cd, 1; Pb, 2; Bi, 4) at 60.5° C. Of the bismuth salts, the sub-nitrate and the tannate are widely used in surgery as antiseptics and healing agents, while the oxy-chloride and the sub-nitrate, on account of their creamy consistency when in a fine state of division, were formerly in demand as cosmetics, for which use they are now displaced by the cheaper zinc-white. Other salts are used in glass-making and in coloring.

Trade and Market.—The imports of metallic bismuth into the United States were 185,905 lb., valued at $339,058, in 1904; 147,295 lb. ($235,199) in 1903; 190,837 lb. ($213,704) in 1902; and 165,182 lb. ($239,061) in 1901. Small quantities of bismuth salts were also imported. The market is narrowly limited and the available supply greatly exceeds the demand. The war in Manchuria is just now stimulating the demand for bismuth salts. The metal sells, in quantity, at $1.25@$1.50 per lb., and the market price of ore, fixed by assay, ranges from $8 to $15 per unit, 10-per cent ore being the lowest salable.

Determination of Bismuth—Gravimetrically.—Prof. E. H. Miller and F. V. D. Cruser announce[2] that the precipitate of bismuth ammonium molybdate obtained by precipitating acidified bismuth solutions with excess of ammonium molybdate may be utilized for the gravimetric determination of bismuth, since it is converted on ignition into a mixture of bismuth and molybdenum oxides of the composition $Bi_2O_3 + 4MoO_3$. By washing the molybdate precipitate with ammonium nitrate solution, drying at 160° C., and igniting at a dull red heat, results were obtained which showed that this process was capable of as great accuracy as the volumetric method. In the course of preliminary experiments, it was found preferable to carry out the ignition of bismuth nitrate in a porcelain crucible, the results obtained when platinum was used being somewhat low. In the precipitation of bismuth ammonium molybdate, Congo red is preferable to methyl orange as an indicator, and washing the precipitate with ammonium nitrate solution gives more accurate results than when ammonium sulphate solution is used.

Electrolytically.—A method for the separation and determination of bismuth in the presence of copper and lead has been announced by A. Hollard and L. Bertiaux.[3] To separate from copper, the solution of the

[2] *Journal* of the American Chemical Society, 1905, XXVII, 116.
[3] *Comptes Rendus*, 1904, CXXXIX, 366.

sulphates containing not too great an excess of sulphuric acid is heated to boiling, phosphoric acid added in excess, and the solution allowed to stand overnight, to complete the precipitation of the bismuth. The precipitate is filtered, washed with dilute phosphoric acid (1 vol. of acid of sp. gr. 1.711 diluted to 20 vol.) and finally, to remove the copper more readily, with a mixture of potassium cyanide and ammonium sulph-hydrate, 100 c.c. of which contain 5 gm. of cyanide and 5 c.c. of the sulph-hydrate obtained by saturating 10 per cent ammonia with hydrogen sulphide. The bismuth phosphate is now dissolved in nitric acid diluted with an equal volume of water, and evaporated with 12 c.c. of sulphuric acid till thick white fumes are given off. The solution, which now contains the bismuth as pyro-phosphate, is diluted to 300 c.c., and the liquid electrolyzed with a current of 0.1 ampere for 24 hours. The deposited bismuth should be free from copper, but should it contain any, the copper can be estimated colorimetrically, and its amount deducted. To separate from lead, the solution of the nitrates is evaporated with 12 c.c. of sulphuric acid, together with the quantity equivalent (approximately) to the contained metals, till thick white fumes appear. Allow to cool, dilute with water to 300 c.c., add 35 c.c. of absolute alcohol and electrolyze with a current of 0.1 ampere for 48 hours. Very small amounts of bismuth can in this way be accurately separated from large amounts of lead; the deposited bismuth is absolutely free from lead.

BROMINE.

The United States made an extraordinary output of bromine in 1904, it amounting to 879,312 lb., an increase of 282,312 lb., or 47.3 per cent, over the output of the previous year. Of this total, 861,902 lb., or 98 per cent, was marketed as bromides of the alkalies, all of which was made in Michigan. As will be seen in the following table, Michigan produced nearly three-quarters of the entire output, followed by Ohio, Pennsylvania and West Virginia:

PRODUCTION OF BROMINE IN THE UNITED STATES.

Year.	Michigan. (a)	Ohio and Penn.	West Virginia.	Total.	Metric Tons.	Value.	
						Total.	Per Lb.
1900	210,400	196,774	114,270	521,444	237	$140,790	27 c.
1901	217,995	227,062	106,986	552,043	250	154,572	28
1902	226,452	194,086	93,375	513,913	233	128,742	25
1903	320,000	180,000	97,000	597,000	271	170,145	28½
1904	646,249	147,807	85,256	879,312	399	215,431	24½

(a) Includes the bromine equivalent of the product recovered as bromide.

The producers of bromine in the United States are as follows: The Dow Chemical Co., Midland, Mich.; St. Louis Chemical Co., St. Louis, Mich.; Saginaw Salt Co., St. Charles, Mich.; John A. Beck Salt Co., Allegheny, Pa.; J. L. Dickinson & Co., Malden, W. Va.; Hope Salt & Coal Co., Mason, W. Va.; Liverpool Salt & Coal Co., Hartford, W. Va.; Hartford City Salt Co., Hartford, W. Va.; Syracuse Salt Works, Syracuse, O.; Coal Ridge Salt Co., Pomeroy, O.; Buckeye Salt Co., Pomeroy, O.; Excelsior Salt Works, Pomeroy, O.; Slagel Salt Co., Pomeroy, O. The Pomeroy Salt Association Co., at Pomeroy, will begin operations in 1905.

The producers along the Ohio river were affected by the coal strike in that district, owing to which their furnaces were shut down from March until about the middle of September. The Dow Chemical Co., with works at Midland and at Mt. Pleasant, Mich., turns out more than half the entire production.

No interesting developments have occurred in the industry within a year. The attempt by the Telluride Reduction Co., of Colorado Springs, to utilize the bromination process of gold extraction proved a failure, and bromine is not likely to find any extension of demand in this direction.

The market has been demoralized by the increased output in the absence of any growing demand for the products. The understanding between the National Bromine Co. and the producers at Stassfurt and Leopoldschall, Germany, by which each party was to confine its sales to its own continent, was originated in the early eighties, abrogated in 1891, reinstated the next year, and remained in force until 1901. Since then, the American producers, with a growing feeling of independence, have been exporting heavily to England and the Continent, for which the German producers are now retaliating by invading the American market with a cut of one-half in prices of bromide. Potassium bromide ranged around 15c. per lb. in New York for most of the year. The possible output of this country is much in excess of the present consumption, so that it is to be hoped the output of bromine will not grow until other applications are found for it.

CARBORUNDUM.

The output of carborundum by the sole manufacturer in 1904 was 7,060,380 lb., showing an increase of 2,300,380 lb. when compared with the 4,760,000 lb. produced in the previous year. In the two years since 1902 the output has been nearly doubled.

PRODUCTION OF CARBORUNDIUM IN THE UNITED STATES.

Year.	Quantity. Pounds.	Value.
1900	1,741,245	$216,090
1901	3,838,175	345,435
1902	3,741,500	374,150
1903	4,760,000	476,000
1904	7,060,380	706,038

As an abrasive, carborundum has already established the reputation of being superior to emery, 1 lb. of the former being equal to 3 lb. of the latter. From 8 short tons reported in 1893 the production of carborundum has increased to 3,500 tons in 1904, while the price, influenced by the larger domestic and European consumption, has fallen from an average of $2,125 per ton to $200 in 11 years. At present, carborundum grains are quoted at 10c. per lb., and powder at 8c., f. o. b. Niagara Falls, New York. The expansion in production and the large decline in selling price are suggestive factors in the competition of carborundum with emery, corundum, crushed steel, and like abrasive materials.

Attention is now being drawn to the possibilities of carborundum as a refractory material. In recent years, several patents have been issued in this country and abroad for refractory brick, cement and other materials whose principal constituent is carborundum. Generally, pulverized carborundum is mixed with a binder of clay, an alkali silicate and lime. In patents issued to the Carborundum Company (Great Britain, 9,963 of 1904) and to Frank J. Tone (United States, 772,262), however, no admixture is used, the cohesion required being attained by subjecting the superficially oxidized particles of crystalline or amorphous carborundum to a high temperature in the electric furnace. Aside from the regularly shaped refractory articles, carborundum firesand (amorphous carborundum), specific gravity 2.7, mixed with No. 1 fireclay and a solution of sodium silicate, serves excellently as a coating or lining for brass, lead, copper or other high-temperature furnaces. Carborundum firesand is worth $1.05 per 100 lb., f. o. b. Niagara Falls.

As a constituent of steel (French patent 344,906, July 13, 1904), W. Kaufmann and A. Bouvier state that the silicon carbide is introduced in equal quantities at regular intervals into the molten metal as it runs into the ladle or mold. The molten metal should be as hot as possible, and free from slag; otherwise the carbide will be decomposed. The proportions of carbide used are 0.11 to 0.12% for steel intended for tires; 0.37 to 0.39% for molded steel; 0.075 to 0.08% for mild basic steel.

Siloxicon.—E. G. Acheson has lately discovered a new refractory material having the composition Si_2C_2O, which he calls siloxicon. It is said to be made more cheaply than carborundum. It can be oxidized at a temperature of 2,674° F. in an atmosphere containing a large amount of free oxygen. In the absence of an oxidizing atmosphere, it can be heated to 5,000° F., the formation point of carborundum, before decomposition occurs.

CEMENT.

The production of cement in the United States in 1904 was as follows: Portland, 26,505,881 bbl., valued at $23,355,119, as compared with 22,342,-973 bbl. ($27,713,319) in 1903; natural hydraulic, 4,866,331 bbl., valued at $2,450,150, against 7,030,271 bbl. ($3,675,520) in 1903, and slag cement, 303,045 bbl., valued at $226,651, against 525,896 bbl., valued at $542,502, in 1903. The production of these three cements in the United States for the last five years is shown in the following table:

PRODUCTION OF CEMENT IN THE UNITED STATES. (a)
(In barrels.)

Yr.	Portland.			Natural Hydraulic.			Slag Cement			Total.	
	Barrels.	Value.	Per bbl.	Barrels.	Value.	Per bbl.	Barrels	Value.	Per bbl.	Barrels.	Value.
		$	$		$	$		$	$		$
1900	8,482,020	9,280,525	1.09	8,383,519	3,728,848	0.45	446,609	567,193	1.27	17,312,148	13,576,566
1901	12,711,225	12,532,360	0.98	7,084,823	3,056,278	0.43	272,689	198,151	0.73	20,068,737	15,786,789
1902	17 230,644	20,864,078	1.21	8,044,305	4,076,630	0.50	478,555	425,672	0.81	25,753,504	25,366,380
1903	22,342,973	27,713,319	1.19	7,030,271	3,675,520	0.50	525,896	542,502	1.03	29,899,140	31,931,341
1904	26,505,881	23,355,119	0.90	4,866,331	2,450,150	0.50	303,045	226,651	0.75	31,675,257	26,031,920

(a) From the Mineral Resources of the United States.

PORTLAND CEMENT INDUSTRY OF THE UNITED STATES.

STATE.	1900.		1901.		1902.		1903.		1904.	
	Wks.	Pcr cent of Output.	Wks.	Per cent of Output.	Wks.	Per cent of Output.	Wks.	Per cent of Output.	Wks.	Per cent of Output.
California	1	0.5	1	1.1	2	1.7	3	2.8	3	3.8
Illinois	3	2.8	4	4.2	4	4.5	5	5.6	5	5.0
Indiana	1	0 3	2	1.8	3	3.1	3	4.8	4	5.1
Kansas	1	0.9	1	(a)4.6	1	4.8	1	4.5	2	9.9
Michigan	6	7.7	10	8.1	10	9.2	13	8.8	16	8.5
Missouri			....	......	1	(c)	2	3.7	2	(c)
New Jersey	2	13.7	3	12.7	2	12.5	3	12.1	3	10.6
New York	8	5.4	7	4.8	10	6.7	12	7.1	12	5.1
Ohio	6	6.2	7	5.4	7	3.3	8	3.2	7	3.4
Pennsylvania	14	58.7	13	55.8	15	50.9	17	43.7	17	43.4
Virginia	1	0.6	1	(b)	1	1.9	1	2.4	1	3.2
All others	7	2.3	7	1.5	9	1.4	10	1.3	11	2 0
Total	50	100.0	56	100.0	65	100.0	78	100.0	83	100 0

(a) Includes Colorado. (b) Included in Ohio. (c) Included elsewhere.

PRODUCTION, IMPORTS, EXPORTS AND CONSUMPTION OF CEMENT IN THE UNITED STATES
(Barrels of 380 pounds.)

Year.	Production.		Imports.		Exports.		Consumption.	
	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.
1900....	17,312,148	$13,576,566	2,512,300	$3,330,445	147,305	$289,186	19,677,143	$16,617,825
1901....	20,068,737	15,786,789	994,624	1,305,692	303,380	752,057	20,759,981	16,340,424
1902....	25,753,504	25,366,380	2,100,513	2,582,281	367,521	575,268	27,486,496	27,373,393
1903....	29,899,140	31,931,341	2,439,948	3,027,111	312,163	466,140	32,026,925	34,492,312
1904....	31,675,257	26,031,020	1,101,361	1,383,044	816,640	1,158,572	31,959,978	26,256,392

The portland cement industry has had a rapid growth during the last ten years, its output having passed the million-barrel mark as recently as 1896, surpassing the output of natural rock cement for the first time in 1900. The production of natural cement has shown but little fluctuation within the last 15 years, although the increasing cheapness of portland, especially toward the end of 1904, has tended to limit its output. Slag cement has been made only within ten years, but its production shows a steady growth. Foreign cement (over half of which comes from Germany) during recent years has supplied only a small part of consumption in this country, viz., 7.5% in 1903 and 3.3% in 1904. Exports remained fairly steady until the latter half of 1904, when they showed a sharp increase. Deliveries are mainly to Canada.

More attention is now being given to the use of cement in special industries, as in the manufacture of pigments, bricks, shingles, tiles, pipes, etc. Patents for new uses of cement are multiplying. Unfortunately, the industry both here and abroad has of late suffered heavy pecuniary losses, because of a relaxation in the demand in America—the largest consumer in the world. Prices are, however, slowly recovering, though the margin of profit is still small. In Germany 14 of the larger plants in Rhenish Westphalia have united, by an agreement running until 1913, to regulate production, fix prices, tax exports, carry a sufficient surplus to meet outside competition, and divide the balance of profits *pro rata*.

Review by States.

California.—Imports of cement at San Francisco fell from 466,770 bbl. in 1903 to 187,786 bbl. in 1904, while imports at San Diego suffered a similar decline, owing to the growth of the home industry. Production began in 1891, but only in 1902 did it reach notable importance; output was 631,151 bbl. in 1903 and 1,014,558 bbl. in 1904. The old cement plant at Colton, in southern California, now suspended, reached a total of 50,000 to 60,000 bbl. a year. Now the home product comes from two new plants, just north of San Francisco bay—the Standard and the Pacific—which have been completely successful from the start. One has a capacity of 2,000 bbl. a day, and the other 1,500 bbl. The latter doubled its plant during 1904, and is now putting out 3,000 bbl. per day.

Kansas.—The portland cement resources of southeastern Kansas have been described[1] by the State Geologist. The region should be an attractive one for the portland cement industry on account of the occurrence of abundant supplies of high-grade raw materials, the limestone being particularly pure and of uniform composition over wide areas, and the presence of a supply of natural gas fuel. Three large plants were erected in 1904, one at Independence, by the Western States Portland Cement Company; one at Neodesha, by the American Portland Cement Company, and one at Iola, by the Kansas Portland Cement Company.

The Independence plant is connected by a 3-mile spur from the Missouri Pacific railway and is built upon an exposure of Drum limestone, which reaches a thickness of 100 ft. at this point, and is nearly pure calcium carbonate. The limestone is overlain by a good grade of shale, while large gas wells are close by, and a supply of water in the Verdigris river. The plant at Neodesha will use the Iola-Allen limestone, 55 ft. thick, and underlain by suitable shale. Natural gas is contracted for at 3c. per 1,000 ft. A new plant at the west base of Table Mound, on the Elk river, is contemplated. Here a 45-ft. bed of pure crystalline Piqua limestone is underlain by 120 ft. of shale and a thin bed of Iola-Allen limestone, while gas and water are plentiful.

New York.—Edwin C. Eckel describes[2] the location, extent, and chemical composition of the limestones in New York suitable for cement making. These are the (1) Chazy limestone (Ordovician); (2) Trenton limestone (Ordovician); (3) Helderberg and Onondaga limestone (Silurian and Devonian); (4) Tully limestone (Devonian); (5) marls (Quaternary). All of these limestones, except the first, are now utilized in the portland cement industry. The following analyses are selected from the several given for each limestone, but represent closely the average composition:

ANALYSIS OF NEW YORK CEMENT LIMESTONE.

Limestone.	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	CO_2
Chazy (a)	0.79	0.14	0.12	54.36	0.67	43.45
Trenton (b)	3.30	1.30	(g)..	52.15	1.58	40.98
Helderberg (c)	5.96	3.16	1.34	49.70	1.44	40.13
Tully 1 (d)	7.88	4.01	(g)..	48.10	0.53	.....
Tully 2 (e)	4.0	26.0	(g)..	33.6	2.6	....
Marl (f)	0.40	0.20	0.20	53.50	0.30	.....

(*a*) From Chazy, Clinton County. *Report* of the New York State Geologist for 1897, p. 433. This represents the purest type of this limestone. (*b*) Glens Falls, Warren County. MINERAL INDUSTRY, VI, p. 97. (*c*) Strobel quarry, Leroy, Genesee County. *Bulletin* New York State Museum, No. 44, p. 784. Its silica is about 1% above the average of the 31 given analyses; lime and magnesia are about average. (*d*) Bottom bed, Portland Point, Tomkins County. (*e*) Willard, Seneca County. *Transactions* New York Agricultural Society, 1850, p. 611. (*f*) Iroquois Portland Cement Company, Caledonia, Livingston County. Contains also 1.7 % of sulphur trioxide. (*g*) Included in alumina.

[1] Erasmuth Haworth and F. C. Schrader in 'Contributions to Economic Geology, 1904'; *Bulletin* No. 260, United States Geological Survey.

[2] *Bulletin* No. 260, p. 522, *op. cit.*

The Chazy limestone, although exceptionally pure, being confined to the Lake Champlain valley, is too remote from coal supply and cement markets to be available. The Trenton limestone is usually non-magnesian, and of dark color. It is widely distributed, and is quarried for lime and cement making at Plattsburg and Crown Point, on Lake Champlain; at Glens Falls and Sandy Hill, in the upper Hudson valley; at Amsterdam, Palatine Bridge and Little Falls, along the Mohawk river; and at Trenton Falls, Lowville, Watertown and many other towns on the Black river and along the east shore of Lake Ontario. The upper and lower Helderberg groups, separated throughout most of their extent by a thin bed of Oriskany sandstone, extend eastward from Buffalo to Oriskany Falls and thence southward along the Hudson into Pennsylvania and New Jersey. They are minutely described in the thirteenth annual report of the New York State Geologist, pp. 197-228; 229-262; 289-372.

The Tully limestone is low in magnesia but carries a high percentage of silica, alumina and iron oxide, at times approaching the composition of Lehigh cement rock. The disadvantage of its thinness is offset by its wide extent and the favored position of its exposures. Its line of outcrop crosses all the Finger lakes of central New York and is crossed by numerous railroads bringing coal northward from Pennsylvania. Its most available outcrops are along the east shore of Cayuga lake. It is underlain by shales which are applicable for mixture with the limestone, as shown by their use in the portland plant near Ithaca. The Quaternary marl deposits are not of commercial value in eastern New York, but towards the west they are frequent and of large size, being or having been used for portland cement manufacture in Cayuga, Onondaga, Genesee, Steuben and Chautauqua counties. Other, as yet, unworked deposits are known in Cortland, Ontario and Orleans counties.

According to the Assistant State Geologist, the cement production of New York in 1904 was 1,377,302 bbl. of portland, valued at $1,245,778, and 1,881,630 bbl. of natural rock cement, valued at $1,207,883. Ten companies made portland and 14 made natural cement. Low prices, resulting from the overproduction of the year before, caused a suspension among some manufacturers. The Rosendale district felt the decline most severely.

Virginia.—That section of Virginia lying west of the Blue Ridge is reported by *Bulletin* 225[3] of the United States Geological Survey to be bountifully supplied with materials suitable for use in the manufacture of portland cement. The argillaceous limestones of the Trenton formation, which furnish the well-known cement rock of the Lehigh district of Pennsylvania and New Jersey, are well developed throughout the valley of Virginia. These limestones, with the overlying Hudson slates and shales, occur in a belt closely paralleling and in places touching the Valley branch

[3] See also *Bulletin* No. 260, p. 531 'Cement Materials of the Valley of Virginia.' R. S. Bassler.

of the Baltimore & Ohio Railroad from the State line to Strasburg. From that point they lie close to the Southern Railway as far as Harrisonburg, and again from Harrisonburg to a point some miles south of Staunton, Va., they are near the Baltimore & Ohio Railroad. The only portland cement plant at present in the State is that of the Virginia Portland Cement Company, which is at Craigsville.

ANALYSES OF SOME BRANDS OF AMERICAN PORTLAND CEMENT.[4]

Brand.	CaO	SiO_2	Fe_2O_3	Al_2O_3	MgO	SO_3	Loss on Ignition.	Insoluble Residue.
Alma	63.34	21.96	4.76	6.18	1.14	1.89	0.45	0.38
Alpha	63.08	21.01	2.82	7.52	3.09	1.01	0.36	0.28
Alsen	61.77	20.86	3.23	6.92	1.43	2.25	1.22	0.47
Atlas	59.95	21.59	2.60	6.87	3.77	1.39	1.86	0.44
Bronson	63.17	20.95	3.12	9.74	0.75	0.86	....	....
Coplay	61.80	22.70	2.05	6.15	1.37	2.00	....	....
Dragon	62.00	22.60	1.03	6.75	1.80	2.13	....	....
Detroit	62.96	21.43	3.02	6.22	3.88	1.25	....	....
Edison	62.71	20.14	3.33	7.51	2.34	1.64	....	....
Empire	60.92	22.04	3.41	6.45	1.20	0.52	0.62	0.30
Giant	61.12	22.08	4.81	8.52	1.71	0.44	0.80	0.42
Iron-clad	62.85	21.51	2.93	7.09	2.16	1.56	0.84	0.41
Lehigh	61.26	23.18	2.60	6.05	3.10	1.40	0.76	0.47
Medusa	62.38	23.08	6.16	2.90	1.21	1.66	....	....
Nazareth	57.74	20.83	2.34	6.70	3.49	1.07	3.82	0.99
Saylor's	60.58	23.36	1.90	4.86	4.96	2.00	0.52	0.54
Victor	58.84	14.09	2.16	4.52	1.73	0.98	15.65	1.07
Vulcanite	63.68	21.08	2.48	7.86	2.62	1.25	....	....
Whitehall	62.15	21.60	2.17	6.80	3.05	2.16	....	....

CHARACTER AND STRENGTH OF SOME AMERICAN PORTLAND CEMENTS.[5]

Brand.	Fineness passing 100 mesh	Set.		Sp. gr.	Tensile Strength.			
					Neat.		1 ce.: 3 sand.	
		Initial.	Final.		7 days.	28 days.	7 days.	28 days.
	Per cent.	Min.	h. m.		lb. per sq. in.	lb. per sq. in.	lb. per sq. in.	lb. per sq. in.
Alma	97.4	45	2 30	3.15	695	803	189	265
Alpha	91.0	55	3 15	3.14	644	744	196	269
Atlas	92.0	58	6 54	3.11	713	866	185	256
Ajax	92.0	70	5 30	3.10	378	470	110	176
Alsen	92.0	50	3 35	3.10	517	678	224	285
Bronson	92.0	99	5 45	3.17	454	602	235	270
Coplay	98.0	35	4 ..	3.11	643	741	188	356
Catskill	96.0	23	1 ..	3.12	473	634	140	245
Dragon	96.5	83	2 57	3.13	512	672	248	345
Detroit	93.0	90	5 35	3.14	744	888	282	368
Edison	99.8	120	6 30	3.16	677	...	256	331
Empire	93.0	38	2 ..	3.11	667	747	159	253
Giant	93.0	90	6 ..	3.12	452	578	201	244
Iron-clad	92.0	110	6 25	3.10	536	647	272	329
Iroquois	92.5	105	6 30	3.12	494	602	193	259
Lehigh	94.0	103	3 10	3.14	607	789	213	322
Medusa	93.0	55	2 15	3.13	588	742	213	346
Nazareth	98.0	38	1 40	3.12	600	716	198	320
Vulcanite	92.5	69	6 ..	3.12	610	1,036	216	344
Wabash	96.0	120	7 ..	3.12	615	855	201	289
Whitehall	92.0	45	2 15	3.13	616	886	211	294

[4] *Mémoirs* de la Société des Ingénieurs Civils de France; 6° Série, No. 5, p. 700. 'Cement Industry of the United States,' by George P. Roux.
[5] *Loc. cit.*

Cement Industry in Foreign Countries.

Canada.—The cement production of Canada is rapidly gaining ground. Ontario is the center of the industry, although a portland plant at Longue Pointe, Quebec, and a natural rock plant at Winnipeg, Manitoba, contributed to the output of 1903. In 1903, Ontario had five producers of natural rock cement and eight producers of portland cement; portland cement plants proposed, in process of erection, or completed during 1903 included two in Quebec, two at Winnipeg, and seven in Ontario.

PRODUCTION, IMPORTS AND EXPORTS OF CEMENT IN CANADA.

Year.	Production (a).				Imports (b).			
	Natural Rock.		Portland.		Natural Rock.		Portland.	
	Bbl.	Dol.	Bbl.	Dol.	Bbl. (c)	Dol.	Bbl. (c).	Dol.
1900	125,428	99,994	292,124	562,916	3,742	4,711	342,463	498,607
1901	133,328	94,415	317,066	565,615	4,680	6,865	424,324	654,595
1902	127,931	98,932	594,594	1,028,618	7,786	17,755	518,846	833,657
1903	92,252	74,655	627,741	1,150,592	3,603	6,333	609,700	868,131
1904	56,814	49,397	900,358	1,272,992	......	......	2,746,208 (d)	1,061,056

(a) Sales. (b) Fiscal year ending June 30. (c) Barrels of 380 lb. (d) Calendar year. (e) Exports were valued at: $3,296 in 1900; $1,514 in 1901; $2,267 in 1902; $2,851 in 1903.

Although the output of portland cement showed a great increase in 1904, its value, owing to the weakness of the market, showed but a slight gain. A duty of 12½c. per 100 lb. is levied on imported cement, most of which comes from the United States.

Chile.—An Austro-Hungarian consular report from Valparaiso states that the two cement works at La Colera have some importance, although the product is inferior to European cement. It can, however, be used for foundations in local construction, and, in part, for other similar purposes. In 1903, the imports of German and English cement totaled 18,533 metric tons, worth $741,335 (Chilean). The approaching canalization at Santiago, and particularly the construction of a new harbor at Valparaiso, should make a strong demand for European cement.

Denmark.—The production of cement in Denmark during 1904 was about 1,200,000 bbl. of 470 lb. each, or 282,000 tons, produced by five mills. A considerable part is exported to the United Kingdom and to transatlantic ports, where Danish cement has acquired a very good repute.

Germany.—The cement industry has for several years suffered from ruinous competition, but its regulation by agreement among manufacturers is now practically assured. Conventions between several local associations have already been effected or are nearing completion. However, there are still important interests outside the local syndicates which stand in the way of a comprehensive and universal organization. The local syndicates embrace Silesia, Pomerania, South Germany, and a group of 15 works in

Rhenish-Westphalia. The Hanoverian works are contemplating the formation of an association. Negotiations towards an understanding between the Rhenish-Westphalian group, the South German syndicate, the Hanoverian works and a Belgian syndicate are being carried on at present. The so-called Middle-German Works (in Thuringia and elsewhere) are ready to co-operate in a general organization; it is in Hanover and in the Lower Elbe region that the idea of a general syndicate meets with opposition from some of the large works, which maintain that a fruitful organization of the whole industry must be preceded by the stoppage of the small works.

Germany's foreign trade in cement is shown by the following table:

GERMANY'S FOREIGN TRADE IN CEMENT. (*a*)

	1901.		1902.		1903.		1904.	
	Met. Tons.	Value.	Met. Tons.	Value.	Met. Tons.	Value.	Met. Tons.	Value.
Imports	87,262	$668,500	52,018	$315,250	49,870	$277,000	60,188	$336,250
Exports	560,612	4,608,500	699,378	4,999,000	742,381	4,500,250	635,248	4,181,500
Distribution:								
To Belgium	29,582	175,500	26,313	131,500	31,929	164,250	60,102	350,250
To Holland	89,097	568,000	108,649	637,250	123,202	672,750	137,763	834,250
To United States	108,809	951,000	246,730	1,850,000	221,672	1,385,250	94,117	647,000

About half the imports came from Austria-Hungary. Exports are heavy to South Africa and Brazil; the decline in exports to the United States during 1904 is marked, but is compensated by increased shipments to Holland.

Russia.—As a remedy for the burden of excessive transportation costs, under which the Russian cement industry has dwindled, it has been suggested that future producing plants should be erected near the center of the consuming territory. In 1901, ten producers in the Black Sea region made 2,950,000 bbl., little more than half of which was consumed. Since that time, several of the works have closed indefinitely on account of low prices.

New South Wales.—Brands of locally produced cement were tested in England and at Sydney and compared favorably with standard European brands. They were more rapid in setting, but their tensile strength was considerably above departmental requirements. The two producers are enlarging their plants to respond to a heavy demand created by the excellence of their cement. The value of the output during the last three years has been $262,800 in 1904; $267,552 in 1903; $223,200 in 1902.

South Africa.—An old English cement firm has discovered closely adjacent deposits of portland cement materials near Kroonstad, Orange River

(*a*) *Statistisches Jahrbook für das Deutsche Reich.*

Colony, along the main line of the railway between Bloemfontein and Johannesburg, and intends to erect a portland cement plant. The ocean and land freights on cement carried from England to Johannesburg amount to four times the original cost.

Technical Progress in Cement Manufacture.

From a consideration of the manufacture of portland cement, and the improvements in its manufacture within the past ten years in all cement-producing countries, it appears that the greatest progress has occurred in the introduction of revolving kilns and improved forms of grinding apparatus, which have superseded the old forms of intermittent kilns and millstones. The effect of this improved apparatus appears in a great reduction in the price of portland cement, and a consequent enormous increase in its uses. The quality of portland cement has also shown a marked improvement within the past ten years. The substitution of improved kilns and better methods has necessarily involved a larger capital outlay in the cement works of the present period. Plants, therefore, are now on a correspondingly larger scale, with more business-like administration; hence, the quality and uniformity of the product are better maintained than was possible in the earlier days.

Chemical Composition of Portland Cement.—According to Dr. Michalis, the hardening of portland cement when mixed with water results from a re-arrangement of the molecules aside from, and as a consequence of, the taking up of water. About one-third of the whole content of lime crystallizes out as calcium hydrate. This separated lime has a tendency to destroy the preparatory cohesion of the cement mass. A portion of it remains permanently in that isolated condition, as is evidenced by the deposition of an efflorescence on the surface of the concrete. If, however, slag is added to the cement, its soluble silica furnishes the molecular equivalent necessary to convert the whole of this lime hydrate into a lime hydro-silicate, thereby converting an element of weakness into an element of strength, with an increased volume of cement produced by such addition.

The Prussian minister of public works, jointly with the Prussian ministers of war, agriculture, and trade and industry, the imperial secretary of the navy, and the German Society of portland cement manufacturers, issued a call for a prize competition of essays on the chemical processes which take place during the hardening of hydraulic cements. Prizes to the amount of 15,000 marks are offered, the contest closing December 31, 1906. The scope of the investigation is indicated by the following questions to be solved:

Demonstration of the properties and of the hardening process of calcareous hydraulic cements, synthetically, analytically, microscopically, mineralogically (hardening in air, fresh water, and sea water).

(*a*) To prove whether silicic acid, alumina, and oxide of iron combine with lime as crystalloids in stable proportions, or as colloids in varying proportions.

(*b*) To prove whether double combinations result between silicic acid, alumina, and oxide of iron with lime, and in what manner these substances are engaged in the hardening process.

(*c*) Consideration of the swelling phenomenon which accompanies the hydraulic hardening.

(*d*) Consideration of the influence of the temperature and length of time of the burning process on the different kinds of hydraulic cements.

(*e*) Properties of puzzolana and its hardening with lime; beginning with silicic acid as the most active and prevailing puzzolana, alumina, oxide of iron, and manganese, independently and in combination with silicic acid, either as natural or artificial puzzolana.

The competitors may choose for the purpose of investigation any or all of the foregoing questions.

Calcining Temperature of Portland Cement.—H. P. Bonde, of Copenhagen, using an electric kiln, made in 1904 a series of tests of the calcining temperature of cement. He used pieces made of raw cement meal with a little water. The pieces had about the shape of Seger cones, but were only half the size. The results obtained showed that the calcining temperature for normal portland cement (75 to 76% $CaCO_3$) and of slag cement is close to 1,400° C. A reduction of 3% in carbonate of lime reduced the calcining temperature 50°. Various finenesses of the ground materials gave no indication of requiring different temperatures. Trial of a rather abnormal mixture (only a trace of Fe_2O_3 and only 70% $CaCO_3$) indicated that alumina is a stronger flux than iron oxide. The author concludes that it is only through contact with the acidic fine clay that the strongly basic cement mixture can be fused at temperatures which can occur inside a cement kiln in actual practice.

Packing and Shipping Cement.—Cement is packed in barrels, cloth sacks, or paper bags, notes *The Cement Age.* A barrel of portland cement contains 380 lb. net of cement and weighs about 400 lb. A barrel of Eastern natural hydraulic cement should contain 300 lb. net of cement. A barrel of Western natural hydraulic cement should contain 265 lb. net of cement. Slag cement weighs 330 lb. to the barrel. Cloth sacks contain one-fourth of a barrel of portland cement, and ordinarily one-third of a barrel of natural hydraulic cement. A car-load of portland cement usually means 100 barrels (40,000 lb.); 75 barrels is the minimum car-load, or the same quantity by weight in cloth or paper bags. When cement is ordered in cloth sacks, the sacks are charged at cost, viz.: 10c. each in addition to the cost of cement; but when the sacks are returned to the works in good condition, freight prepaid, 10c. is allowed for each, with a deduction of 2c. for wear and tear in some cases.

Sand weighs from 80 to 100 lb. per cubic foot loose, and about 20 lb more when well rammed. Crushed limestone weighs about 90 lb. per cubic foot, varying somewhat either way with the size and amount of fine dust. Concrete weighs about 140 lb. per cubic foot. Lime paste, composed of 1 cubic foot of quick lime, and 1 cubic foot of water, occupies 1⅛ to 1¼ cubic feet. Portland cement, loose, weighs 70 to 90 lb. per cubic foot; packed, about 110 lb. per cubic foot. One barrel is 3½ cu. ft. Foreign cement barrels contain 3⅓ or less cubic feet. Natural hydraulic cement, loose, weighs 50 to 57 lb. per cubic foot; packed, about 80 lb. per cubic foot. Weights of cement and volumes of barrels are not uniform.

Standard Specifications for Cement.

United States.—Natural Cement.[6]—This term shall be applied to the finely pulverized product resulting from the calcination of an argillaceous limestone at a temperature only sufficient to drive off the carbon dioxide. The specific gravity of the cement thoroughly dried at 100° C. shall be not less than 2.8. It shall leave by weight a residue of not more than 10% on the No. 100, and 30% on the No. 200 sieve. It shall develop initial set in not less than 10 minutes, and hard set in not less than 30 minutes, nor more than three hours. The minimum requirements for tensile strength for briquettes 1 in. square in cross section shall be within the following limits, and shall show no retrogression in strength within the periods specified.

Age.	Neat Cement.	1 Cement: 3 Standard Sand.
24 hours in moist air	50–100 lb.	....
7 days (1 in moist air, 6 in water)	100–200 lb.	25–75 lb.
28 days (1 in moist air, 27 in water)	200–300 lb.	75–150 lb.

Pats of neat cement about 3 in. diameter, ½ in. thick at center, tapering to a thin edge, shall be kept in moist air for a period of 24 hours; (*a*) a pat is then kept in air at normal temperature; (*b*) another is kept in water maintained as near 70° F. as practicable. These pats are observed at intervals for at least 28 days, and, to pass the tests satisfactorily, should remain firm and hard and show no signs of distortion, checking, cracking or disintegrating.

Portland Cement.—This term is applied to the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials, and to which no addition greater than 3% has been made subsequent to calcina-

[6] *Proceedings,* American Society for Testing Materials, IV, 1904. Report of the Committee on Standard Specifications for Cement. Reprinted here by permission of the Secretary.

tion. The specific gravity of the cement, thoroughly dried at 100° C., shall be not less than 3.10. It shall leave by weight a residue of not more than 8% on the No. 100, and not more than 25% on the No. 200 sieve. It shall develop initial set in not less than 30 minutes, but must develop hard set in not less than one hour, nor more than 10 hours. The minimum requirements for tensile strength for briquettes 1 in. square in section shall be within the following limits, and shall show no retrogression in strength within the periods specified.

Age.	Neat Cement.	1 Cement: 3 Standard Sand.
24 hours in moist air....................	150–200 lb.	....
7 days (1 in moist air, 6 in water).......	240–550 lb.	150–200 lb.
28 days (1 in moist air, 27 in water).....	550–650 lb.	200–300 lb.

Pats of neat cement about 3 in. diameter, ½ in. thick at the center, and tapering to a thin edge, shall be kept in moist air for a period of 24 hours; (*a*) a pat is then kept in air at normal temperature and observed at intervals for at least 28 days; (*b*) another pat is kept in water maintained as near 70° F. as practicable, and observed at intervals for at least 28 days; (*c*) a third pat is exposed in any convenient way in an atmosphere of steam, above boiling water, in a loosely closed vessel for five hours. These pats, to pass the requirements satisfactorily, shall remain firm and hard and show no signs of distortion, checking, cracking or disintegrating. The cement shall not contain more than 1.75% of anhydrous sulphuric acid (SO_3), nor more than 4% of magnesia (MgO).

Russia.—Russian specifications describe portland cement as the product obtained from natural marl or artificial mixtures of clay and calcium carbonate, kilned until sintering occurs, and then ground to the fineness of flour. The ratio of lime and alkalis to silica, alumina and ferric oxide must not be less than 1.7 nor more than 2.2; sulphur trioxide must not exceed 1.75%; magnesia, 3%; nor foreign substances, 2%. Setting must not begin in less than 15 minutes, and must not be complete in less than 1 hour, but in less than 12 hours. Cakes must show no curving or cracking at their edges when left in water for 27 days, or when heated in an oven to 120° C. for 1½ hours, after having set for 24 hours. On a screen of 0.05-mm. wire, having 70 meshes per linear centimeter, dry cement must not leave a residue of more than 50 per cent; or on a 30-per-centimeter mesh of 0.1-mm. wire, not more than 15 per cent. Test blocks having a sectional area of 5 sq. cm. at point of rupture must show, in the case of neat cement, a tensile strength of 20 kg. per square centimeter at the end of 7 days, and 25 kg. after 28 days. Cement in barrels must weigh 370 lb. net.

Analytical Methods.

Detection of Free Lime in Portland Cement.—A. Baikoff states[7] that upon applying an alcoholic solution of phenolphthaleïn to slag cement, Roman cement, and portland cement, the first named gave a red coloration immediately, due to the presence of free calcium hydroxide, the second after a little while, but with the portland cement no color change occurred, either in the cement or in the solution. From this difference it is assumed that Roman cement contains calcium aluminate, which undergoes hydrolysis, while in portland cement the lime is combined as silicate. Further, it was found that portland cement decolorized the alcoholic phenolphthaleïn stained red by calcium hydroxide, the color being restored by re-exposure to hydroxide after filtration. This behavior indicates the possession by anhydrous portland cement of the power of absorbing calcium hydroxide, thus reversing the process occurring when the same cement is mixed with water. This double character of portland cement is attributed to the presence of the intimate mixture of basic silicate and puzzolana, of which the cement is composed. Owing to the high fusing point of the silicate (over 1,700° C.), it could not be formed at the ordinary kiln temperature (1,500° C.) without a flux, such as is afforded by the presence of oxides of alumina, iron and alkalis in the clay. This basic silicate is slightly less soluble than lime; and being formed in the presence of an excess of lime is strongly basic, and resembles blast-furnace slag.

Rapid Method for the Determination of Lime in Cement.—B. Enright has mentioned[8] a quick volumetric method for this determination. The powdered cement is agitated with hot dilute hydrochloric acid, a few drops of bromine-water are added, and the solution is boiled, rendered alkaline with ammonia, and filtered. The precipitated hydroxides are treated with hydrochloric acid, and the solution diluted. After once more adding ammonia in slight excess, boiling, filtering and washing, the united filtrates are slightly acidified with hydrochloric acid and boiled. Ammonium oxalate solution and ammonia are added to the boiling solution, the precipitate is washed with hot water, and dissolved in sulphuric acid, and the solution immediately titrated with potassium permanganate solution.

Limits of Free Silica and Calcium Oxide Allowable in Portland Cements Manufactured by the Dry Grinding Process.—A. V. Bleininger reports[9] the results of experiments made with cement mixtures consisting of varying proportions of kaolin, potters' flint and whiting, together with so much red Clinton iron ore that the cements in all cases contained about 3 per cent of ferric oxide. It was found that the ratios of combined to free silica and of silica to alumina are of great importance. The best results

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[7] *Tonindustrie Zeitung*, XXVIII, 1904, pp. 1,713 and 1,747.
[8] *Journal* of the American Chemical Society, XXVI, 1904, p. 1,003.
[9] *Transactions* of the American Ceramic Society, VI, 1904, p. 155.

are obtained when the ratio of combined to free silica is 1:2.56, and of silica to alumina 3:1. The most satisfactory ratio of lime to silica depends largely upon the fineness of grinding, but, in general, the best results are obtained with dry-ground mixtures having a silica to alumina ratio of 3:1, when the formula $(2.8CaO,SiO_2)(2CaO,Al_2O_3)$ is adhered to. These results were confirmed by tests made with a silicious clay and a hard limestone occurring in Ohio.

Formula.	Tensile Strength 1:3; 28 days.
	lb. per sq. in.
$(2.9\,CaO,SiO_2)(2\,CaO,Al_2O_3)$	290
$(2.8\,CaO,SiO_2)(2\,CaO,Al_2O_3)$	360
$(2.7\,CaO,SiO_2)(2\,CaO,Al_2O_3)$	190

Effect of Calcium Hydroxide on Natural Cements.—The same author examined the effect of adding 5% of dry slaked lime to four different specimens of ground natural cement, prepared by burning the natural cement rock till practically all carbon dioxide was expelled. It was found that the addition caused an increase in the tensile strength of the cement of from 44.4 to 170 per cent. Experiments with natural cement mortars, to which varying amounts of lime paste were added, gave these results:

Composition of Mixture.	Tensile Strength after 26 weeks, 1:2.	Gain in Tensile Strength.
	lb. per sq. in.	Per cent.
Natural cement	292	....
96% cement + 4% lime	335	14.7
92% cement + 8% lime	325	11.4
90% cement + 10% lime	325	11.4
85% cement + 5% lime	322	10.4
80% cement + 20% lime	357	22.3
75% cement + 25% lime	304	4.1

It appears, therefore, that the addition of dried calcium hydroxide during the grinding of the natural cement gives the best results.

Materials Which Retard the Setting of Portland Cement.[10]—Kniskern and Glass have recently investigated the retarding action of gypsum and calcium chloride on the setting of portland cement. With gypsum the maximum retarding effect was produced by an addition of 1.5 per cent. The retarding effect disappeared when the mixture of cement and gypsum was exposed to the air, but was restored by the addition of 2 to 4 per cent of slaked lime while gauging. Small additions of gypsum for the purpose of retarding setting did not diminish the ultimate strength of the cement, except when the latter was exposed to sea water. The maximum retarding effect of calcium chloride was produced by an addition of about 0.5 per

[10] *Engineering Record,* L, 1904, p. 769.

cent (rather less than 2 lb. per barrel of cement); this addition had no injurious action on the ultimate strength of the cement. It is preferable to add the calcium chloride in the form of a solution while gauging, rather than to add the dry salt during the grinding of the cement clinker.

Preparation and Employment of Concrete.

In view of the frequent confusion of terms relating to the use of concrete occurring even among technical writers, we would urge general adherence to the following definitions, which are those already adopted by the leaders of the profession:

Natural or Hydraulic Cement.—The finely ground product from the calcination of an argillaceous limestone at a temperature only sufficiently high to expel its carbon dioxide. Cement is understood to have hydraulic properties.

Portland Cement.—The finely ground product from the incipient fusion of an artificial mixture of calcareous and argillaceous materials.

Slag or Puzzolan Cement.—The finely ground mechanical mixture of dried slaked lime with dried pulverized blast-furnace slag, or a natural volcanic ash. Slag should preferably be water-quenched.

Cement grouting.—A thin mixture of cement and water.

Cement paste.—A thick mixture of cement and water.

Cement mortar.—A mixture of cement, sand and water.

Concrete.—A mixture of cement, sand, water and a coarser 'aggregate' of crushed stone, screened gravel, etc. Proportions vary with circumstances.

Cinder concrete.—A concrete in which the aggregate consists of furnace clinker instead of stone, for the purpose of saving weight.

Reinforced concrete.—A structure of concrete in which metal, usually steel shapes or built beams, rods, lattice, wire netting, etc., is imbedded in such a way as to add tensile strength.

The actual composition of a concrete for a particular purpose will depend upon the factors of strength, cost, weight, impermeability, etc. It is fundamentally necessary, however, to use sufficient cement to surround every grain of sand in the mortar, and enough mortar to fill the interstices between the fragments of the aggregate, or, in other words, to permit no two non-adhesive particles to be in contact.[11] A rule which has gained some currency is that, in solid blocks of concrete, the ratio of sand and stone to cement should not exceed 6:1; for hollow blocks, 4:1; and for facing composition, 2:1. Earlier practice required the screening of crushed rock intended for concrete; the advantage of using the unscreened product of the crusher is now coming to be recognized.

[11] For an exhaustive statement of tests on pastes, mortars and concretes made of various brands of cement and having a wide range of composition, see 'The Elasticity and Resistance of the Materials of Engineering,' by Wm. H. Burr.

Cinder concrete should be employed with extreme caution. Its comparatively light weight adapts it for floors and partitions in steel-framed buildings, but the inevitable sulphur is thought to have a deteriorating influence, while the presence of unburned coal is an element of weakness.

Concrete, impervious to water, can be made by adding 10 to 25 parts of dry slaked lime to 100 parts of cement, during the mixing of the concrete. In the German manufacture of artificial stone, lime paste is prepared and allowed to stand a year before being mixed with cement mortar.

The employment of concrete in building is estimated to have increased more rapidly during 1904 than in any previous year. New applications for it, alone or reinforced, are found almost weekly. Present opinion is that reinforced concrete meets more perfectly the requirements imposed by the modern city office building than anything else yet tried. It is fireproof;[12] it is durable (its history is not lengthy, but satisfactory tests of 20 years' duration are on record); it lends itself to molding into any shape; it is said to be cheaper than stone, brick, steel, or any combination of these. Even in small constructions it is replacing brick and terra cotta. The side walls of dwelling houses have been built by tamping concrete between parallel faces of rough boards, and foundation walls are quite commonly built in this way. As a pavement for streets and sidewalks it is becoming universal. In the form of railway ties, reinforced by pieces of old rail, concrete is giving satisfaction on a short line in Ohio, and also in Italy and Spain. Railway roadbeds are made of concrete also in the form of longitudinal stringers, tied at intervals by struts of the same material.

Concrete-steel bridges are rapidly gaining in favor.[13] They cost more than light steel bridges with plank floors, but in many localities they cost no more, and frequently less, than good steel bridges carrying a pavement. The advantages of a concrete-steel bridge over a concrete bridge are due not so much to diminished sections or cost as to the greatly increased security which the steel affords against settlements or other weaknesses which cannot be calculated or foreseen. Under normal conditions the steel is not strained to much more than one-quarter of its elastic limit, so that a very large reserved force is always available for emergencies. The claimed and generally recognized advantages of a concrete-steel bridge, as compared with a steel bridge, are as follows: They make handsomer structures, and architectural ornamentation can be applied to any extent desired; if properly designed and constructed, they show vastly greater durability and greater ultimate economy; they are comparatively free from vibration and noise; they are proof against tornadoes and fire, and also against floods, if properly built of good material; the cost of maintenance is confined to the pavements.

The inventor of the first concrete-metal arch ever built is generally con-

[12] See observations on the Baltimore fire in *The Cement Age*, July, 1904.
[13] Edwin Thacher in *The Cement Age*, November, 1904.

ceded to be Jean Monier, of Paris. He imbedded wire nets in mortar. Original constructions on this system had only one wire netting near the intrados of the arch, but later two nettings were used, one near the intrados and the other near the extrados. Many Monier arches have been built in Europe, and tests made on them by the Austrian Society of Engineers and Architects show their superiority over concrete alone. They have, however, some serious disadvantages. The transverse wires of the nets take proportionately but little stress, and add considerably to the cost. The nets are also flexible and difficult to manage, and the close mesh interferes seriously with the placing of the concrete, so that no coarse aggregates, like gravel and broken stone, could be used, thereby adding greatly to the cost of the concrete mass. Notwithstanding these disadvantages, various notable Monier arches have been built, for example, three spans of 128 ft. each, with 11 ft. rise, built in Switzerland in 1891.

The first concrete-steel bridge in the United States (two spans of 25⅓ ft.) was built over the Pennypack Creek, Pennsylvania, in 1893. The arches were 27 in. thick at the crown, the spandrel filling was of rammed concrete, with 1½-in. mesh wire nets distributed horizontally and vertically through the mass, as a binder rather than to aid in sustaining stress.

The Melan system, invented by Joseph Melan, of Austria-Hungary, in 1892, and patented in the United States in 1893, consists of a concrete arch in which steel beams are imbedded. For small spans the beams are usually rolled I-beams; for spans of considerable length they usually consist of four angles latticed. The first Melan arch bridge was built in the United States in 1894. Since that date there have been built, or are now in process of construction, under the Ransome, Melan, Thacher and other patents, some 300 spans of concrete-steel bridges, distributed throughout the United States. Among the most notable are the two bridges across the rapids of Niagara river a short distance above the Falls. The one from the mainland to Green island has three spans, total length, 412 ft.; width, 40 ft.; the one from Green island to Goat island has three spans, total length 198 ft., width 40 ft. At St. Sebastian, Spain, a 300-ft. concrete bridge has just been contracted for, 14 other bids for stone or steel construction having been rejected.

Concrete has allowed great economies in the building of bridge abutments and approaches, and of retaining walls, so that the railroads are doing a vast amount of such construction in their campaign to abolish grade crossings.

Hollow concrete blocks for wall building are found to be cheaper than brick. A factory 50 by 100 ft., walls 28 ft. above foundation, recently constructed at Binghamton, N. Y., cost $513 for the blocks in the wall and only 6c. per sq. ft. for the mortar and labor of laying, making the total cost $1,101, or approximately 13c. per sq. ft. of wall, the latter being 10 in. thick. The cost of a 17-in. brick wall, with brick at $13.25

per M laid, would have been $3,339, no allowance being made for openings in either case. The hollow wall was laid with blocks 12 by 24 by 10 inches.

Concrete stairs have been accepted by the New York Building Commissioners as meeting the requirements of the ordinance requiring positive fireproof construction. Shingles of cement composition are giving satisfactory service.

The brick sewers torn out in building the New York Subway were replaced by concrete work—for the reason, as stated, that thus built they were 'stronger and cheaper.' A concrete-steel sewer has also been built for the city of Harrisburg, Pa.

The Government coal-pockets at Bradford, R. I., are being made of concrete, with electrically welded fabric reinforcement; and a concrete-steel lighthouse 132.2 ft. high was recently erected by the Russian Government.

Successful installations have been made with concrete to replace wooden piles, for use under water. One method adopted was as follows: A sheet-iron slightly conical case about 20 ft. long, tapering at one end and widening at the other to about 2 ft., the axis being reinforced with a stout iron rod, was employed as a mold. This was driven into the required position, like an ordinary pile. The reinforcement was then removed, and the hollow interior filled with portland cement concrete. On hardening, this formed a pile that would sustain an appreciably greater weight than its displaced wooden prototype, with the additional value of not being subject to decay. The sheet-iron cases were left, as doing no harm and being difficult to remove. This usage, particularly, seems destined to great expansion. It would be hard to find a more promising field for the extensive use of concrete-steel piles than in the teredo-infested waters on the coast-line of the southern United States. For a valuable contribution bearing on this subject, see 'Decomposition of Cement by Sea-water,' by Henry Le Chatelier, in *Annales des Mines*, Tome VI, 1904, p. 251.

In laying the foundations of the new railway station at Hamburg, Germany, 580 reinforced concrete piles were driven. The soil on which the station is built varies considerably, but is composed chiefly of sand, marl, and clay, and it carries a great deal of water. The piles were about 14 in. square and 23 ft. long, and were each reinforced by four 1-in. diam. round bars, which were tied together at intervals by wire. After being made, the piles were permitted to remain in the molds for three days, after which they were removed and allowed to harden for two weeks before being driven. They were shod with iron and driven down by a pile-driver.

Many notable concrete-steel chimneys have been built during the past ten years. One for the Pacific Coast Borax Company, Bayonne, N. J., is 150 ft. high and 7 ft. inside diameter. Another for the Central Lard Company of New York, at Jersey City, N. J., is 108 ft. high and 8 ft. inside diameter. One for the Pacific Electric Railway Company at Los Angeles, Cal., has a height of 158 ft. above grade and 174 ft. above the foundation, and has an inside diameter of 11 ft. One recently completed at Tacoma, Wash., is 307 ft. high. Its base is 39½ ft. square, the inside diameter is 18 ft., and the largest outside diameter 21 ft. The chimney is built double to a height of 90 ft.; the outer shell is 9 in., the air space 5 in., and the inner shell 4 in. The single shell above this is 7 in. thick. The chimney was built in 3-ft. sections, with a network of T-steel in the base and vertical steel T-bars in the shell encircled by rings of the same.

The flues of brass furnaces have been made of concrete blocks. In an instance noted, the temperature reaches 3,700° F.; and the furnaces are shut down at night, and from Saturday to Monday; yet, after eight weeks, there was no damage that was perceptible. The blocks were made of crushed limestone.

The use of concrete in mining and metallurgy has been fully treated by H. W. Edwards.[14] A discussion, by Professor Hofman, of those parts of this contribution that deal with furnace flues and dust chambers, will be found on another page of this volume.[15] Experience indicates that sulphurous gases have no deteriorating effect on cement unless water also is present. The best paint for the interior of flues is composed of soluble water glass and asbestos.

In general construction, concrete has established itself in employments too numerous to mention. The New York subway, just completed, used large amounts, and the two great undertakings now in hand, the Panama canal and the Pennsylvania tunnels under the North and East rivers, passing also under New York, will call for vast quantities.

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[14] *Transactions*, American Institute of Mining Engineers, XXXV, February, 1904.
[15] See also The Engineering and Mining Journal, LXXVIII, p. 348 and p. 460.

CHROMIUM.

The amount of chrome ore mined in the United States is insignificant in comparison with the quantity imported from New Caledonia, India, Turkey and Canada. The remoteness of the deposits in California and North Carolina from the manufacturing centers where the ore is used, and the low cost of high-grade foreign ores brought to Eastern ports and entered free of duty, are the factors that retard the growth of domestic production. An organized attempt will soon be made to develop and utilize the deposits of chrome and nickel ores known to occur abundantly in Buncombe county, North Carolina.

PRODUCTION, IMPORTS AND CONSUMPTION OF CHROME ORE IN THE UNITED STATES.

Year.	Production.			Imports.			Consumption.	
	Quantity Long Tons.	Value.	Value per Ton.	Quantity Long Tons.	Value.	Value per Ton.	Quantity Long Tons.	Value.
1900....	140	$1,400	$10.00	17,542	$305,001	$17.39	17,542	$305,001
1901....	368	5,790	15.73	20,112	363,108	18.05	20,480	368,898
1902....	315	4,725	15.00	39,570	582,597	14.73	39,885	587,322
1903....	150	2,250	15.00	22,931	302,025	13.13	23,081	304,275
1904....	123	1,845	15.00	24,227	348,527	14.38	24,350	306,120

No new applications for chrome ore have developed. The principal uses are the preparation of chromium salts, employed in tanning and textile works, the manufacture of chrome brick for basic furnace linings, and of ferro-chrome alloys for the steel industry. The leading makers of chrome salts are the Kalion Chemical Company, of Philadelphia, and the Baltimore Chrome Works, of Baltimore. It was stated erroneously in Vol. XI (1902) of THE MINERAL INDUSTRY that the Kalion company had bought the Baltimore works; no absorption or partnership of business has ever existed, both companies having maintained, at the time and continuously since then, complete independence. The Willson Aluminum Company, with plants at Kanawha Falls, W. Va., and Holcomb Rock, Va., is the only producer of ferro-chrome. This company doubled its output, having made about 2,500 tons of ferro-chrome in 1904; much of this went to Sheffield, England, to be used in the manufacture of projectiles, the demand for which was increased by the Eastern war. Little can be said as to the likelihood of an increased use of chrome steel for rails, as sufficient time has not yet elapsed to determine the relative durability of the earliest rails of this steel that were laid. The alloy used for the making of rail steel carried 52% chromium and 7% titanium, the finished steel analyzing between ¾ and 1% chromium. Nickel as a constituent of rail steel has an advantage over chromium, in that it can be easily recovered from scrap, while the bond between iron and chromium cannot be broken in a simple manner.

As a refractory material, chrome ore, low in silica, and bricks made of it have long been used in the steel industry, but their employment in copper and lead smelting has only recently been attempted to any significant extent. The bricks are manufactured by the Harbison-Walker Refractories Company, of Pittsburg, which also deals in the crude, low-silica ore. It has succeeded in making a chrome brick which is not only highly refractory, but can withstand sudden extreme changes in temperature and is resistant to abrasion while highly heated. In the basic open-hearth furnace, chrome ore, in lump or pea-size, is used at nearly all the steel works where this process is employed, to bank up in front of the port-walls so as to prevent cutting away of the silica brick by the sweeping flame. It is also banked along the slag line, to protect the walls from the action of frothing slag, and on the floors of the ports to protect them from particles of slag or lime carried over in the flames. A course of chrome brick is often interlaid between the clay brick resting on the metallic bottom plate of the furnace and the magnesite brick forming the lining of the basic hearth. This prevents fusion of the acid with the basic brick, and decreases loss of heat, magnesite brick and dead-burned magnesite having a high heat conductivity. In the soaking pit, six or seven courses of chrome brick at the bottom prevent the scouring due to dripping slag, by which fire brick are rapidly cut, to the ruin of the side walls.

In copper smelting and refining furnaces, chrome ore is used in reverberatory linings. Chrome brick are also used to line the crucible of copper blast-furnaces and the side walls of matte settlers; they make a good lining from the bottom to the tapping holes of any copper reverberatories that are operated intermittently. In lead smelting, chrome brick have proved valuable along the metal and slag line, since they are much less affected than fire-clay brick by the corrosion of lead oxide.

Both its resistance to corrosion and its refractoriness vary inversely with the proportion of silica that a chrome ore contains. For this reason, to set a lining of low-silica ore will require a higher heat than is needed by an ore high in silica.

Markets.—The rapid expansion of the chrome ore industry of New Caledonia has begun to have a very noticeable influence upon general trade conditions. In fact, the competition from this source has become so sharp that some apprehension is felt that it may seriously affect the industry in other countries. So far, the most important result connected with the increased exports from New Caledonia has been a decline in the quotations of about $5 per ton for 50% ore. Freight from New Caledonia to the

United States ranges between $2.88 and $4.32 per ton. The present quotations for chrome ore at New York are $19 to $19.50 per long ton, on the basis of 50% chromic oxide. A premium of $0.40 is allowed for each unit above that limit. It remains to be seen whether the present prices, which are below the normal of previous years, will stimulate the consumption sufficiently to maintain a balance with the rapidly increasing production.

THE WORLD'S PRODUCTION OF CHROME ORE. (a)
(In Metric Tons.)

Year.	Bosnia.	Canada.	Greece.	New Caledonia. (b)	New South Wales.	Norway.	Russia.	United States.
1900....	100	2,118	5,600	10,474	3,338	165	18,233	Nil.
1901....	505	1,159	4,580	17,451	2,523	85	22,169	506
1902....	270	817	11,680	10,281	454	22	19,655	320
1903....	147	3,069	8,478	21,437	1,982	Nil.	......	152
1904....	....	5,510	......	42,197	403	.....	......	125

(a) From the official statistics of the respective countries. (b) Exports.
NOTE.—Turkey, although a notable producer, is omitted because of the lack of reliable statistics.

Australia.—New South Wales exported, in 1904, 397 long tons of chrome ore, valued at $6,340, a remarkable falling off from the 1,951 tons, worth $36,710, produced in the previous year. The mines at Gobarralong, in the Gundagai division, contributed most of this. A 20-ton lot from the Bingara division was sold with a good profit, so that the deposits here will probably be opened. The decreased export is due to the present low grade of the ore, averaging only 46% chromic oxide, whereas 50% ore is the poorest that is marketable.

Canada.—The production of chrome ore, as estimated by the Geological Survey, amounted to 6,074 short tons, valued at $67,146, showing a heavy increase over the output of the previous year, viz., 3,509 tons. Nearly all of this was mined in Quebec, which Province, according to J. Obalski, Inspector of Mines, gave 5,832 short tons, valued at $71,499,[1] as against 3,068 tons, worth $45,300, in 1903. The 1904 product consisted of 626 short tons first-class ore worth $13.10 per ton, 1,120 tons second-class ore worth $9.84, and 4,086 tons of concentrate worth $12.80 per ton. The larger part of the output is exported, mainly to the United States, with some to Europe. Exports in 1904 were 3,338 short tons ($60,336). The remainder is consumed in Canada by the Electric Reduction Company, of Buckingham, for the manufacture of ferro-chrome.

The Black Lake Chrome & Asbestos Company operated its two concentration mills throughout the year, one at Lake Caribou and one at Black Lake. Electric power is used at the former. Development has been carried on energetically and systematically, showing results that justify more extensive operations. This company is the leading producer in the district. Its first-grade concentrate ranges around 52% chromic oxide, with not more

[1] Part of the Quebec output was concentrated, and valued as such.

than 3% silica. Second-grade material carries 45% chromic oxide, and this is used for making ferro-chrome. The American Chrome Company and the Montreal Chrome Company did no mining in 1904, and the Star Chrome Company merely prospected on the Coleraine Indian reserve. The Thetford Chrome Company mined and shipped a quantity of lump ore and installed a steam plant. The property has recently changed ownership, and an electrically driven concentrator of 12-ton per day capacity is expected to be finished by June. The chromite industry employs permanently 90 men.

Cuba.—A deposit near Canjete, on the north shore of Santiago de Cuba, has been reported upon. The ore is too low-grade to find employment in the steel industry, and its character is such as to preclude concentration.

India.—Chromite is known to occur with the peridotites of the chalk hills near Salem, in Madras, southern India. Attempts were made long ago to mine it, but nothing has been done lately. In Baluchistan, the ore occurring in the Pishin and Zhob districts is being opened up for export, the output for 1903, the first year of work, having been 284 long tons. The output is now more vigorous, having been 1,816 tons in the first half of 1904. A strong vein near Khanozai carries 54% chromic oxide.

New Caledonia.—This island is advancing rapidly in the production of chrome ore and has already surpassed Turkey, which, up to 1903, had supplied about half the world's consumption. According to the *Bulletin de Commerce*, of Noumea, exports from New Caledonia were 42,197 metric tons in 1904, or nearly double the output of the previous year—21,437 tons. Of this, only 17,194 tons were shipped direct to the United States. This decided increase has been made possible by the unusual richness of the ore and extensiveness of the orebodies, and by the cheapness with which shipments can be made.

The chromite is mined principally in the northwestern and southwestern portions of the island, the mineral occurring in association with serpentine, which also yields the nickel and cobalt ores. Some of the deposits are of great size; as much as 20,000 tons of ore has been taken from a single orebody. The principal factor in the industry is the Société le Chrome, a combination of producing interests which came into existence in 1902. At present, mining is most active at Tiepaghi, where the ore is especially rich. The Société le Chrome has leased the mining rights on this property to tributers, who paid the sum of $200,000 for the privilege of working it for three years. It is said that the output for this period may reach 100,000 tons. The ore requires no mechanical concentration, and is shipped in large lots with an average content of 56% chromic oxide. The organization is also enlarging its operations at Plum and is extending its tramway from Prony to the new mines, where ore is being developed in large amounts.

Newfoundland.—No chromite was mined on the island in 1904; the mines at Port au Port are admirably situated near deep water, and in past years have afforded a good supply of ore, which, after concentrating, sold at high prices. At the expiration of the option under which they are now held, they will quite likely be re-opened under more active management.

Turkey.—For many years the trade in chrome ore has been practically controlled by the Turkish producers. The exports from this country have averaged 40,000 tons annually, which up to 1903 about equaled the aggregate output from all other countries. The mines are situated in the European provinces of Salonica, Kossovo and Monastir, and the Asiatic provinces of Aidin, Konia, Adana, Angora, Broussa and Macri. Most of the product imported into the United States comes from Macri and Broussa, and is known under the trade names of 'Macri' and 'Daghardi,' the latter being the largest mine in Broussa. The ores range in content of chromic oxide from 48 to 54%; the Macri ore carries from 48 to 51%, and the Daghardi ore up to 54%. Turkish ores are soft and unusually free from silica and impurities. Some effort has been put forth to restrict the output, as the resources of the country are extensive and could be made to yield much more than the present output. The Turkish government exacts a royalty of 20 per cent on the value of the ore mined and also imposes a duty of 1 per cent on the exports. In spite of this heavy burden, however, the cost of producing the Macri ore and delivering it at the seaboard is said to be only $8.75 per ton. The Turkish government makes no official statement of production.

Electrolytic Precipitation of Chromium.[1]—Attempts to precipitate metallic chromium from chloride and sulphate solutions have been made by H. R. Carveth and W. R. Mott. They used a diaphragm and copper cathodes, which were withdrawn from time to time for the determination of the deposited chromium, fresh cathodes being inserted in their place. The chromium was determined by dissolving the coating in hydrochloric acid, and measuring the hydrogen evolved; chromous chloride is formed quantitatively. With solutions of chromic chloride (containing 100 grams of chromium per liter), the yield rose from 9.5 to 30 per cent at 22° C., when the current density was increased from 50 to 70 amperes per sq. dcm. No increase of the yield was caused by rise of temperature, but, on the contrary, the character of the deposit was affected injuriously. On passing air through the electrolyte, the yield diminished, owing to oxidation of the chromous salt, the presence of which is necessary for the deposition of the metal. Sulphate solutions behave similarly to chloride solutions. The presence of acid in the solution causes a decrease in the yield, but an improvement in the condition of the deposited metal.

Obtaining Metallic Chromium.—C. Goldschmidt describes[2] a new and exceedingly simple way of reducing metallic chromium from solutions of its salts. Metallic chromium can be separated from solutions of its salts

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[1] *Journal of Physical Chemistry*, 1905, IX, 231. *Chemiche Centralblatt*, 1905, I, 1,364.
[2] *Chemiker-Zeitung*, 1905, XXIX, 56.

by contact with metallic zinc or its alloys. Thus if a solution of chromium nitrate be allowed to stand in the cold in a zinc vessel, chromium is deposited partly in the amorphous and partly in the crystalline form, in the course of a day. The chromium hydroxide simultaneously deposited can be removed by treatment with alkali in excess. The best results are obtained with crystalline chromium nitrate, other chromium salts not being so suitable for the purpose.

Volumetric Determination of Chromium.—A simple volumetric method for the determination of chromium in the presence of iron, taking advantage of the difference in reducibility of their sesquioxides, is presented by R. Glasmann.[8] The solution containing a mixture of ferric and chromic salts (but not more than 0.5 gram of chromic oxide on account of its color) is treated in a flask, provided with a Bunsen's valve, with sulphurous acid, which reduces the ferric salt, leaving the chromic salt unaltered. The excess of sulphur dioxide is expelled by boiling, accompanied by the passage of a current of carbon dioxide, and the ferrous solution after cooling is titrated with permanganate. The oxidized solution is again reduced by heating with sulphuric acid and zinc according to Zimmermann's method, until it assumes an azure-blue color. The ferrous and chromous salts are then again titrated with permanganate, the percentage of chromium being calculated from the difference between the two titrations.

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[8] *Zeitschrift für Analytische Chemie*, 1904, XLIII, 506.

COAL AND COKE.

BY FREDERICK HOBART.

The production of coal in the United States in 1904, as compared with 1903, was nearly stationary. The total reported in THE MINERAL INDUSTRY for the earlier year was 351,733,872 short tons; for 1904, as shown in the table below, it was 350,740,062 tons.

PRODUCTION OF COAL IN THE UNITED STATES. (Short tons.)

State.	1903.			1904.		
	Short Tons.	Value at Mines.		Short Tons.	Value at Mines.	
		Total.	Per ton.		Total.	Per ton
BITUMINOUS:						
Alabama	11,700,753	$14,625,941	$1.25	11,273,151	14,091,439	$1.25
Arkansas	2,300,000	2,960,000	1.30	2,009,451	2,612,286	1.30
Colorado	7,726,338	9,271,605	1.20	6,721,147	8,401,434	1.25
Georgia and N. Carolina.	430,000	537,500	1.25	400,191	480,229	1.20
Illinois (f)	34,955,073	36,442,917	1.04	37,077,897	40,774,223	1.10
Indiana	11,191,659	12,310,825	1.10	9,872,404	10,859,644	1.10
Indian Territory (f)	3,320,057	5,644,097	1.70	3,011,972	1,957,782	1.65
Iowa	5,900,000	9,322,000	1.58	6,542,005	9,813,007	1.50
Kansas	5,540,637	8,310,955	1.50	6,322,875	8,852,025	1.40
Kentucky	7,075,000	7,075,000	1.00	7,167,324	7,095,651	0.99
Maryland	4,400,000	5,500,000	1.25	4,277,196	5,346,495	1.25
Michigan	1,581,346	2,482,713	1.57	1,414,834	2,292,031	1.62
Missouri	4,265,328	6,739,218	1.58	4,115,695	6,749,381	1.64
Montana	1,500,000	2,175,000	1.45	1,359,409	2,039,113	1.50
New Mexico (f)	1,323,907	1,681,364	1.27	1,613,334	2,484,534	1 54
North Dakota	300,000	420,000	1.40	269,297	336,621	1.25
Ohio	24,573,266	29,487,912	1.20	24,583,815	27,042,197	1.10
Oregon	80,000	200,000	2.50	111,540	278,850	2.50
Pennsylvania	103,713,982	116,159,660	1.12	99,660,167	108,564,182	1.09
Tennessee	4,810,758	6,253,985	1.30	4,782,302	5,977,877	1.25
Texas	(e)900,000	1,330,000	1.70	1,195,944	2,033,105	1.70
Utah	1,762,178	2,114,614	1.20	1,563,274	2,345,061	1.50
Virginia	3,500,000	3,675,000	1.05	3,576,092	6,515,770	1.85
Washington	3,190,477	6,380,954	2.00	2,905,689	5,520,809	1.90
West Virginia	25,663,342	26,946,508	1.05	30,222,881	30,222,881	1.00
Wyoming	4,602,929	8,056,876	1.75	4,996,828	8,744,449	1.75
Alaska, California, Utah and Nevada	109,670	314,568	2.87	78,868	236,604	3.00
Total Bituminous.	276,416,702	$326,419,212	$1.19	277,065,582	$311,667,680	$1.12
ANTHRACITE:						
Colorado	48,964	146,892	3.00	55,404	166,212	3.00
New Mexico	35,621	105,794	2.94	24,707	78,074	3.16
Pennsylvania	57,232,585	157,988,428	2.10	73,594,369	161,907,612	2.20
Total Anthracite.	75,317,170	158,241,114	2.10	73,674,480	162,151,898	2.20
Total Coal { Sh. Tons.	351,733,872	$484,660,336	$1.38	350,740,062	$473,819,578	$1.35
Total Coal { Met. Tons	319,177,385	....	1.52	318,275,562	....	1.49

(e) Estimated.
(f) Fiscal year, ending June 30.

The production of coal received a great impetus during the prosperous years from 1901 to 1903, and in the last named year it reached a record which showed in some degree the capacity of our coal mines, with their present equipment. During this period many new mines were opened, including a number of large operations equipped with the latest machinery, and with every facility for a great production. To this fact it is probably due that the total in 1904 showed so very small a decrease, in the face of a lessened demand in many parts of the country, at least during the first six or eight months of the year. In the closing months there was a strong reaction, and an enlarged demand which increased requisitions upon the mines to a point almost as high as in the boom time of 1903. Nevertheless, it is quite probable that there was a certain amount of over-production last year, which was at times reflected in competition among mines and among different districts, and in resulting low prices. This was especially the case in some of the central States of the West, such as Indiana, Illinois, Iowa and Missouri; also to some extent in Ohio and West Virginia.

It may be said that the great production made last year could probably be increased by 20 or 25%, without much enlarging the number of mines, or their equipment, in case of an intensified demand. Few large mines—and indeed not many small ones—are worked to their full capacity. The returns of the States where careful reports are made show that averages of from 210 to 225 working days in the year are general. It would appear, therefore, that the increase named—of 20 or 25%—could be obtained simply through more continuous working with only such stoppages as are absolutely necessary. Such an increase, however, would involve improvements in railroad facilities and equipment for handling coal, since at different times during the year the coal trade of important sections was embarrassed by delays in shipment and the failure of the railroads to respond fully to the demands upon them.

The decrease in the case of the great majority of States was not large, and in some there was an actual increase. The most marked falling off, perhaps, was in Pennsylvania, where the great production of 1903 was reached under the stimulus of extreme activity in the iron and steel trades. In Illinois, which is the second State as a producer, there was, on the other hand, a considerable gain; the same was the case in West Virginia, which is the third on the list; while in Ohio, the fourth State, production was about the same.

In several of the western States slight decreases were due to the greater consumption in the large cities of the higher grade coals shipped from Ohio, Pennsylvania and West Virginia, and also to the better supplies of anthracite which were obtainable.

Pennsylvania continues to be by far the most important producer, supplying about one-half of all the coal mined in the country. It produces practically all of the anthracite, and about 27% of the bituminous coal, and therefore remains the leading factor in the coal trade of the country.

While there were some local labor troubles in various districts during the year, especially in southern Illinois, and a general strike in Alabama, the year was measurably free from labor troubles in the coal regions. The western bituminous schedule was settled by a compromise, and a two years' agreement was made covering several important fields. The anthracite mines were free from strikes or labor troubles of consequence.

The money return received for the coal mined by the operators was somewhat less than in the previous year. On anthracite the amount received per ton must have been very nearly the same, the falling off being proportionate, of course, to the decrease in production. Owing to a complete organization of the trade, and the steady demand, there is very little variation in the values received for this class of fuel. In the western markets, however, as shown by the reports which follow, there was a pressure to sell, and a reduction in prices, which was not favorable to the producers.

In one respect the record of the year has not been a good one. So far as returns are made, they indicate an increase in the number of accidents, the loss of life, and injury to person in coal mining. This is probably due to the intensified working of the past two years, the opening of new mines, and the employment of new men. In some States, the returns of accident are incomplete, while a few make no returns at all.

The tendency during the year was to introduce improvements for the purpose especially of increasing production and cheapening the handling of coal. The use of electricity for haulage, in and about mines, has made steady progress. The use of mechanical coal cutters made comparatively little gain. This is chiefly due to the fact that the agreements in force in the West provide for differentials between pick-mining and machine-mining rates so small that no considerable economy is secured by the use of machines.

Several large mines were opened during the year, notably in Western Pennsylvania. The consolidation of bituminous mining interests, which was a notable feature of the period from 1901 to 1903, made little progress in 1904. Since the close of that year, however, this movement has been renewed.

The coal-testing plant established by the Geological Survey at the Louisiana Purchase Exposition, at St. Louis, came into use during the later months of the Exposition. Some valuable results were secured, a part of them being published in a special report. The more important experiments were in the use of inferior coals in gas producers. The testing plant was not closed with the Exposition, but is still in operation. Some experiments have also been made in the use of coke-oven gases for the production of power, directly in gas engines, and through the use of the gases as fuel in steam boilers.

Production of Coal in the United States.

Alabama.—Output was somewhat restricted by a strike of the union mine workers; according to the chief mine inspector, it amounted to 11,273,151 tons, a decrease of only 3.6 per cent from the 11,700,753 tons produced in

1903. A few counties, notably DeKalb, in which the mines at Batelle made their first large-scale output, and Walker, where non-resident miners alone are employed, and which for this reason was not affected by the strike, showed substantial increases. Jefferson county, embracing the operations of the Tennessee Coal, Iron & Railroad Company, the Sloss-Sheffield Steel & Iron Company, and the Pratt Coal Company, contributed the largest output—5,834,490 tons. A total of 17,850 workmen was employed in and around the coal mines, of whom 12,375 were miners. Fatalities numbered 84, the largest death list yet reported, being in the ratio of 4.7 per 1,000 employees. Coal-cutting machines to the number of 155 were in use, mainly air-driven punchers of the Harrison, Ingersoll-Sargent and the Sullivan types. A few Jeffrey chain cutters were used also.

The strike was dictated purely by the desire of the United Mine Workers for recognition of their union, although the nominal occasion was a reduction in wages. A scale of wages had been adjusted by an arbitration board, of which Judge Gray was chairman, after a one month's strike in the summer of 1903, and had ranged from 47½c. to 57½c. per ton of coal, according to the fluctuations of the pig-iron market quotations. At the termination of this agreement, July 1, 1904, the Furnace Operators' Association, whose members owned the largest coal mines in the State, offered a sliding scale of 40c. to 55c. per ton, pig iron being quoted at $6 less than in the previous summer; the union workers thereupon suspended work. Within a few weeks all but one of the commercial operators, those whose product is used elsewhere than in the coke and iron industries, had made temporary arrangements with their men to continue the old wages until a new basis should be generally adopted, and these, with the operators in non-union territory, and the few mines in which State convicts were regularly employed, maintained a heavy and uninterrupted output, disposing of it at prices which soon rose to 15c. to 25c. above normal. The furnace operators began at once to import non-union laborers from Kentucky and Tennessee, so that by the end of September they had restored their coal supplies to nearly normal size, in the meantime covering their shortage by imports of coal and coke from West Virginia. In October, the operators raised the wages of their non-union workers to the regular scale; in November the commercial operators raised the wages of their union workers, under temporary contracts, by 2½c. per ton, in view of the rising pig-iron quotations, and in December wages were raised 5c. per ton for all miners, the non-union men receiving 52½c. and the union men 55c. per ton. Conditions remained unchanged at the end of the year, the contention of the workers having degenerated into a fight for recognition, while the operators had resumed a normal activity at their mines.

Coke production amounted to 2,284,095 tons, 9,000 ovens having contributed. None of the coal seams of the State affords a coal entirely suitable for coking, although by washing, and by adjusting a mixture of several coals, excellent coke can be made.* Thus a mixture of three parts of Milldale with one part of Brookwood coal gives a coke low in sulphur, moderate in ash, of dense texture and in large pieces, and equal to the standard Connellsville.

Colorado.—The coal industry during 1904 was greatly hampered by labor troubles which both diminished production and augmented the number of serious casualties, among which the fatal accident at Tercio, when 19 men were killed, was the most disastrous. This explosion appears almost certainly to have been the result of flying dust. The total production of the State in 1904, according to the State coal mine inspector, was 6,776,551 tons, of which 5,352,960 tons were bituminous, 1,238,187 tons were lignite, and 54,404 tons were anthracite. The above total includes also 130,000 tons estimated as the output of small mines and others not reported. The mines in operation during that year numbered 175, and 10,769 workmen were employed in mining. There were 89 fatal accidents during the year (40 in 1903), which gives a ratio of 8.3 per 1,000 employees. The number of coke ovens in operation was 3,376 and the output was 591,351 tons. About half the output of coal comes from Las Animas county, and all of the anthracite is mined at two points in Gunnison county.

Illinois.—David Ross, Secretary of the Bureau of Labor, reports for the fiscal year 1904 that coal mined in the State amounted to 37,077,897 short tons, valued at $40,774,223, an increase of 2,122,497 tons over the output of the preceding year. A distinction is made between the commercial, or shipping mines, and those which are worked sporadically, thus:

	No.	Tons Mined.	Average.
Commercial mines	380	35,779,517	94,157
Small mines	552	1,298,380	2,352
Total	932	37,077,897	96,509

The large mines supplied 96.5% of the whole production. The disposition of the output was this:

	Tons.	Per Cent.
Sold and shipped from mines	31,778,260	85.7
Supplied to locomotives	1,223,099	3.3
Sold to local trade	2,521,612	6.8
Used, or wasted, at mines	1,554,926	4.2

The amount and average value per ton of the grades into which the output was sized were as follows:

	Tons.	Per Cent.	Value.
Run of mine	10,627,904	28.6	$1.03
Lump	16,888,010	45.6	1.37
Egg	1,014,700	2.8	1.39
Nut	1,602,383	4.3	1.05
Pea	5,751,570	15.5	0.56
Slack	1,193,330	3.2	0.33
Total	37,077,897	100.0	$1.10

* The Engineering and Mining Journal, October 27, 1904, p. 667.

In 66 mines, 609 coal-cutting machines were in use, giving 7,400,343 tons, or 20% of the whole output, a decrease of about 2% from the previous year. The average price paid per gross ton for machine-cut coal was 46.6c.; for pick-mined, 59.3c. The total number of miners employed was 37,987, assisted by 11,374 men and boys working underground, and 5,413 on surface.

The number of accidents reported is as follows, non-fatal accidents including only those cases where men were disabled from working for a month or more:

	1903.	1904.	Changes.	
Fatal accidents	156	157	I.	1
Non-fatal	410	507	I.	97
Total casualties	566	664	I.	98
Deaths per 1,000 employees	3.13	2.87	D.	0.26
Injuries per 1,000 employees	8.23	9.26	I.	1.03
Total	11.36	12.13	I.	0.77

There was a large increase in the number injured. Of the fatal accidents in 1904, there were 148 underground and 9 on the surface, showing averages of 3.00 and 1.64 per 1,000 employees respectively. The total number of men reported in 1903 was 49,814, or 4,960 less than in 1904.

Indiana.—The report of James Epperson, State inspector of mines, shows that in 1904 there was mined in that State a total of 9,872,404 short tons of coal, a decrease of 120,149 tons, or 1.3%, as compared with 1903. Of the coal mined last year, 9,145,332 tons were bituminous coal, and 727,072 tons of the grade known as block coal, which is mined in the Brazil and adjoining districts. At the close of the year there were 137 companies or firms operating 210 mines; an increase of 23 companies and 32 mines. There were 42 new mines opened during the year, and 10 old mines abandoned. The list does not include any pit or opening wherein less than 10 men are employed.

Of the coal mined, it is estimated that 5,304,906 tons, or 53.7%, were consumed in Indiana, while 4,567,498 tons, or 46.3%, were shipped to points outside the State. The total number of machines reported in 1904 was 395, of which 291 were electric chain-cutting machines and 104 were compressed-air punchers. There were 30 electric motors, 67 dynamos and 28 air-compressors reported in use. The coal mined by pick and machine is reported as follows:

	—Machine—		——Pick——	
	Tons.	%	Tons.	%
Block coal	86,505	11.9	640,567	88.1
Bituminous	3,499,669	38.3	5,645,663	61.7
Total	3,586,174	36.3	6,286,230	63.7

The total number of days mines were worked was 29,441; this would give an approximate average of 140 days for all mines. There were 1,421 mules used in underground haulage.

The number of employees in the mines is reported as follows: Pick miners, 8,806; machine runners, 380; machine helpers, 380; loaders, 3,046; inside day-men, 3,449; outside day-men, 1,777; total, 17,838 men. The figures given above show that for the year the average coal mined per machine employee was 942 tons; per pick miner, 714 tons. The average per man, including all employees, was 553 tons.

Accidents reported and averages per 1,000 employees are as follows:

	Number.	Per 1,000.
Fatal	34	1.91
Serious	132	7.40
Minor	81	4.54
Total non-fatal	213	11.94
Total casualties	247	13.85

The causes of these casualties are given in considerable detail; they are shown in the following table:

	Fatal.	Serious.	Minor.	Total.
Falls of slate	13	38	25	76
Falls of coal	..	15	20	35
Smoke explosion	1	2	..	3
Powder explosion	3	5	..	8
Dust explosion	..	3	..	3
Delayed shots	5	3	..	8
Premature shots	..	5	..	5
Blown-out shots	..	1	..	1
Misplaced shots	..	1	..	1
Mine cars	7	40	20	67
Mine cages	..	9	4	13
Mining machine	..	3	2	5
Electric shock	1	1	..	2
Shaft accidents	4	3	..	7
Miscellaneous	..	3	10	13
Total	34	132	81	247

Falls of slate and coal were the chief cause of accident, resulting in 38.2% of the deaths and 44.9% of the total casualties. The movement of mine and railroad cars came next, causing 20.6% of the deaths, and 27.1% of the casualties. Bad shots were the occasion of 14.7% of the deaths, and 6.1% of the total casualties.

Kansas.—The latest report of the State mine inspector, James A. Orr, covers a period of six months only, Jan. 1 to June 30, 1904. The reason for this is that the fiscal year of the State has been changed from the calendar year to that ending June 30. During the six months the output of coal was 2,732,499 short tons, from mines in six counties. In the full year 1903, the production was 5,540,637 tons.

The total number of men employed in the mines during the half year was 10,347. This includes 376 convicts, who work in the State mine in Leavenworth county. The average number of days worked was 92 during the half year. The number of accidents reported is as follows:

	Killed.	Injured.	Total.
No. of casualties	16	50	66
Per 1,000 employees	1.546	4.832	6.378
Per 1,000 days' work	0.017	0.053	0.070

The list of deaths includes 9 miners, 5 shot-firers, 1 driver and one day-man. The injured were 32 miners, 7 shot-firers, 6 drivers and 5 day-men.

Kentucky.—The report of the State inspector of mines gives the coal production of Kentucky for the year 1904 as follows: Western district, 4,121,564; southeastern, 3,431,125; northeastern, 614,635; total, 7,167,324 tons. This is a decrease of 30,927 tons, or 0.4%, as compared with 1903, when the total was 7,198,251 tons. The disposition of the coal mined in 1904 was as follows:

	Tons.	Per Cent.
Used at mines	162,423	2.3
Sold locally	201,006	2.8
Made into coke	135,973	1.9
Shipped from mines	6,667,922	93.0
Total	7,167,324	100.0

Of the coal shipped from the mines, 3,453,151 tons, or 51.8%, were sold at points within the State; while 3,216,173 tons, or 48.2%, were sent to points beyond the State limits. The average price realized at mines was $2.03 per ton for cannel coal and 98.51c. for other coal; giving a general average of 99.37c. per ton.

The output for 1904 was produced by 141 companies, operating 172 mines, and employing 13,906 persons, of whom 10,991 worked underground. The average number of 10-hour days worked in each district was as follows: Western, 174; southeastern, 184; northeastern, 173. The number of hours constituting a working day varies. The average coal mined per employee was 515 tons. Machines are largely used in the Kentucky mines. The coal mined by machine in 1904 was 3,768,183 tons, or 52.6% of the total.

The coke made in 1904 was 62,722 tons, a decrease of 56,876 tons, or 47.6%, from 1903. The coal used in making coke was 135,973 tons; showing the high average of 2.17 tons to the ton of coke.

Michigan.—The coal-mining industry is centered in Saginaw county, with Bay and Eaton counties showing a lesser activity. According to the commissioner of labor, production in 1904, with 28 mines in operation, was 1,414,834 tons, at a cost of $1.62 per ton, as compared with an output of 1,581,346 tons from 30 active mines in 1903, at a cost of $1.57 per ton. Employees numbered 2,714 in 1904, as against 3,149 in the preceding year; they received wages of $3.01 for 7.7 hours' work per day in 1904, as compared with $2.91 for the same hours in the previous year, but were busy for only 18.3 days out of the month during 1904. No coke is made from coal mined in Michigan.

Missouri.—The secretary of the State Bureau of Mines states that coal was mined in 35 counties of the State, the more important being Macon, 899,963 tons; Lafayette, 713,677; Adair, 658,558; Randolph, 578,895; and Ray, 225,485 tons. The total production at the 299 mines of the State was 4,115,695 tons (4,265,328 tons in 1903), and the value of this product at the mines was $6,749,381; an average of $1.64 per ton.

The total number of men employed was 10,881 in the winter, and 8,868 in the summer, a number of the small mines being operated only during the winter season. The number of deaths from accident in the mines was 11, an average of 1.114 per 1,000 men. The number injured by accident in the mines was 16, an average of 1.63 injured per 1,000 men employed.

Montana.—The output of this State during 1904 was 1,359,409, as compared with 1,514,438 tons in the previous year. Montana coal is almost entirely lignitic, showing an average fuel ratio of 1.27. At three localities in Cascade and Park counties, a good coking coal is found, and at Horr a semi-anthracite (fuel ratio 4.04) is being mined. Mine equipment throughout the State is up to date; 87 cutting machines are in use and large, thoroughly equipped plants have been installed at all of the principal producing mines. The number of men employed in coal mines in 1904 was 2,214 and 9 fatal accidents occurred; an average of 4.07 per 1,000 men employed.

New Mexico.—The production during the fiscal year ending June 30, 1904, according to the United States mine inspector, aggregated 1,638,041 tons, of which 1,075,522 tons was bituminous (mostly coking), 537,812 tons was lignite and 24,707 tons was anthracite. The net product, after deducting the 43,457 tons used at the mines, had a total value of $2,185,780, and showed an increase of 267,971 tons, or 20.2%, over the net output of the previous year. There were 1,972 men and boys employed in coal mining, and 15 fatal accidents occurred. Colfax county, in the Raton field, contributes most of the bituminous, McKinley county comes next with lignite, and all the anthracite is mined in Santa Fé county.

Ohio.—The report of the chief inspector of mines shows that 24,583,815 tons of coal were mined in 1904, as compared with 24,573,266 in the preceding year, and that of this, 67.3% was mined by machine, a decided increase over the the 59.3% mined thus in 1903. There was a large decrease in lump coal shipped, and a corresponding increase in fine coal, due to the system, in practice in some of the districts of the State, of blasting coal off the solid. The total number of mines reported was 1,018, of which 959 were in operation during the year. There were 101 new mines opened, while 57 suspended operations and 37 were abandoned. At the close of 1904, 243 mines used machines, and the total number of machines employed was 975; this is an increase of 55 mines and 201 machines over the preceding year. The quantity of powder consumed in mining was 284,714 kegs; an increase of 41,006 kegs over the preceding year.

Accidents were: Deaths, 118; serious injuries, 316; slight injuries, 121; a total of 555, or 12.1 per 1,000 employees. In 1903 the number of deaths was 124, or 2.99 per 1,000 employees; of injuries, 436. The total number of men employed in Ohio coal mines in 1904 was 45,834, of whom 13,346 were pick-miners; 2,297 machine operators; 17,432 drillers, shooters and loaders; 12,759 day hands. The average number of days worked by pick-miners was 159; by machine-miners, 169 days.

The coal trade for 1904, while showing a slight increase in tonnage, was not marked by prosperity; a strike on the Great Lakes, car shortage, long continued drought during the latter part of the year, and other trade conditions caused serious embarrassment to the industry. The tonnage increased only 10,549 tons, while the miners increased 4,438 in numbers, showing a loss of efficiency in the latter year; the average yearly tonnage per man in 1903 was 593; in 1904, it was only 536 tons of coal. A revision of the mining laws is urgently needed, owing to the growth in the use of machinery since the date of the existing statutes.

Pennsylvania.—The production of anthracite coal in Pennsylvania is given by James E. Roderick, chief of the Bureau of Mines, at 65,709,258 long tons (73,594,369 short tons), which is a decrease of only 1,462,693 tons from the great output which was made in 1903, following the strike year. The disposition of this coal is shown in the following table:

Anthracite.	Tons.	Per Cent.
Shipped to market	58,158,288	88.5
Sold to employees and local trade	1,379,222	2.1
Used in working colleries	6,171,748	9.4
Total	65,709,258	100.0

The highest production ever reached in the anthracite region was in 1903. The extraordinary output of that year was in considerable part due to the necessity of extensive working in its earlier months, so as to make up the deficiencies caused by the strike of the previous year.

The explosives used included 1,791,192 kegs of powder, and 6,519,312 lb. of dynamite; an increase of 90,016 kegs of powder, and of 1,201,890 lb. of dynamite. The average was 36.7 tons of coal mined to each keg of powder. The dynamite is chiefly used in dead work, and not in breaking down the coal. The number of horses and mules employed was 17,085, showing an increase of 213 over the previous year. This indicates that there has been no special increase in the movement to utilize mechanical means of haulage to the replacement of animals.

The number of employees and the number of casualties in the anthracite fields during the year is shown in the following table:

Anthracite Fields.	Killed.	Injured.	Total.
No. of employees	....	....	161,330
Average days worked	....	....	213
Approximate days worked	....	....	34,363,290
No. of casualties	595	1,047	1,642
No. per 1,000 employees	3.688	6.490	10,178
No. per 1,000 days' work	0.017	0.031	0.048

The number of deaths, as compared with 1903, showed an increase of 82; while the number of injured decreased 278, so that there was a decrease of

196 in the total number of casualties. The average coal mined per employee for the year was 407 tons; per day, 1.91 tons.

The same authority reports that the total bituminous coal mined was 99,600,167 tons, a decrease of 4,113,815 tons, or 4%, from the previous year.

The total output of bituminous coal for the year 1904, and its disposition, are given below, in short tons:

Bituminous.	Tons.	Per Cent.
Shipped from mines	76,543,529	76.9
Sold to employees and local trade	943,237	0.9
Used in making coke	19,670,754	19.7
Used in operating mines	2,442,647	2.5
Total coal mined	99,600,167	100.0

The proportion used in operating the mines was less than in the anthracite regions, as might be expected from the general conditions in the two regions.

The maximum output was reached in 1903, the total in that year being more than double the production of 10 years ago.

The accident report for the bituminous mines is as follows:

Bituminous Fields.	Killed.	Injured.	Total.
No. of employees	....	....	155,569
Average days worked	....	....	190
Approximate days worked	....	....	29,558,110
No. of casualties	536	917	1,453
Casualties per 1,000 employees	3.445	5.894	9.339
Casualties per 1,000 days' work	0.018	0.031	0.049

The number of employees in 1904 increased over that reported in the previous year by 4,824, but the average days worked fell from 216 to 190, a decrease of 26. The number of fatal accidents increased by 134, but there was a decrease of 129 in the number injured, showing a decrease of 5 in the total casualties. The average coal mined per employee was 640 tons; per day's work, 3.37 tons.

Miscellaneous statistics show that the explosives used were 505,051 kegs of powder and 1,360,161 lb. of dynamite. This gives an average of 197 tons of coal mined to the keg of powder. The dynamite is used chiefly in rock-work, opening galleries and similar classes of work. The number of horses and mules employed in the mines was 12,849, a decrease of 50 from the previous year.

Utah.—Labor troubles during 1904 interfered seriously with coal mining in this State, fully two-thirds of the men employed after the close of the difficulties never having had any previous experience in mines. The production in 1904 was 1,563,274 tons, valued at $2,345,061, showing a decrease of 185,000 tons, as compared with the output of the previous year. Employees in the coal mines numbered 2,215, and the number of fatal accidents was in the proportion of 4 per 1,000.

Washington.—The production of coal in this State during 1904 was 2,905,689 tons, as compared with 3,190,477 tons in the previous year. Of the total production, 838,298 tons were exported from the coast, showing a decrease of 120,000 tons from 1903. This decreased export trade is explained by the Russian-Japanese war and by the rapid advance in the use of petroleum fuel in California. Local consumption also has been affected by the rapid inauguration of water-driven electric generator installations, but the demand for domestic fuel is rapidly growing. Coke amounting to 46,175 tons was made in 1904, showing a slight decrease from the production of the previous year—47,916 tons. This coke is all made in Pierce county. A disastrous explosion occurred at Burnett, toward the end of the year, which has been with certainty designated as a coal-dust explosion.

West Virginia.—The report of James W. Paul, chief mine inspector, shows that the mines of the State during the fiscal year 1904 produced a total of 26,984,715 long tons of coal, which was an increase over the previous year of 4,071,017 tons. The disposition of the tonnage reported was as follows:

Shipped from the mines	22,922,574
Sold to local trade	400,858
Used in making coke	3,333,861
Used in operating mines	327,422
Total	26,984,715

The tonnage of coal by districts was as follows: Potomac, 1,619,340; Monongahela, 7,396,161; Wheeling, 553,984; Kanawha-New River, 9,293,-771; Norfolk & Western, 7,951,459; small mines, 170,000. Each geographical district, except the Potomac, shows an increase, but the production of small mines fell a little short of that for the previous year.

Of the total coal mined, 18,667,023 tons were pick-mined, and 8,317,692 tons were machine-mined. Mechanical coal cutters were in use at 248 mines, and 988 machines in all were employed. The average tonnage produced by each machine was 9,052 tons for the year, or 40.4 tons per day worked, the average day's run being 224. The coal produced per employee on the machines was 990.7 tons for the year. In the pick mines the average output per year for each miner, not counting for employees, was 979.7 tons.

It is estimated that during the year coal was worked out from under 3,968 acres of surface.

The total number of inside or underground employees was 36,316, and the average number of days worked was 209, giving, approximately, 7,590,044 days' labor. Using these totals, the following averages are obtained:

	Killed.	Injured.	Total.
No. of employess	123	191	314
No. per 1,000 employed	3.3869	5.2594	8.6463
No. per 1,000 days' work	0.0162	0.0251	0.0413

The accident figures are as follows for 1904 and 1897-1904 inclusive:

	1904 No.	1904 %	Eight Yrs. No.	Eight Yrs. %
Falls of roof or coal	95	11.2	585	68.9
Mine cars	12	9.8	78	9.2
Gas explosions	3	2.4	88	10.4
All other	13	10.6	98	11.5
Total	123	100.0	849	100.0

By far the greater proportion of the West Virginia coal is handled by rail. The total rail shipments from the mines included 24,033,424 tons of coal, and 2,467,368 tons of coke. Shipments by water on the Great Kanawha river amounted to 1,332,430 tons of coal and 1,500 tons of coke.

Wyoming.—The production of coal in this State during 1904 was 4,996,-828 tons, showing a slight increase over the output of the previous year—4,602,929 tons. Employees in coal mines numbered 9,177, an increase of 3,454 men over the number employed in the previous year.

Foreign Coal Trade of the United States.

The coal trade between the United States and other countries was:

UNITED STATES EXPORTS AND IMPORTS OF COAL CLASSIFIED AS TO COUNTRIES.

Country.	Exports. 1902.	Exports. 1903.	Exports. 1904.	Imports. 1902.	Imports. 1903.	Imports. 1904.
Australasia	....	....	....	324,543	448,193	235,069
Canada	4,468,953	6,535,863	6,577,954	1,678,919	1,613,426	1,211,304
Europe	186,695	85,189	144,354	456,938	1,171,270	63,367
Hawaii and Philippine Islands	67,673	66,198	....	....	....	....
Japan	....	....	....	9,556	61,466	45,429
Mexico	537,708	846,412	880,747	8,037	5	221
West Indies	679,988	660,255	772,812	....	....	....
Others	186,289	118,181	197,651	382	1,019	759
Totals	6,126,946	8,312,098	8,573,518	2,478,375	3,295,379	1,556,149

Beginning with 1904, shipments to Hawaii and the Philippine Islands are considered as domestic trade, and are not reported among the exports.

IMPORTS OF COAL AND COKE INTO THE UNITED STATES. (In long tons.)

Yr.	Coal. Anthra. Long. tons.	Coal. Bit. Long tons.	Coal. Totals. Long tons.	Coal. Totals. Metric tons.	Coal. Totals. Value.	Coke. Long Tons.	Coke. Metric tons.	Coke. Value.
1900..	118	1,909,258	1,909,376	1,939,926	$5,020,102	103,175	104,826	$371,341
1901..	286	1,919,962	1,920,248	1,950,972	5,293,273	72,729	73,883	266,078
1902..	73,006	2,478,375	2,551,381	2,592,203	7,339,791	107,437	109,156	423,774
1903..	151,023	3,295,379	3,446,402	3,501,544	10,004,844	127,479	129,519	437,625
1904..	72,526	1,556,149	1,628,675	1,654,734	4,136,278	161,476	164,060	648,520

EXPORTS OF COAL AND COKE OF DOMESTIC PRODUCTION. (In long tons.)

Year.	Anthracite.		Bituminous.		Totals.		Coke.	
	Quantity.	Value. $	Quantity.	Value. $	Quantity.	Value. $	Quantity.	Value. $
1900....	1,654,610	7,092,489	6,262,909	14,431,590	7,917,519	21,524,079	376,999	1,358,968
1901....	1,993,307	8,937,147	5,390,086	13,085,763	7,383,393	22,022,910	384,330	1,516,898
1902....	907,977	4,301,946	5,218,969	13,927,063	6,126,946	18,229,009	392,491	1,785,188
1003....	2,008,857	9,780,044	6,303,241	17,410,385	8,312,098	27,190,429	416,385	2,091,875
1994....	2,228,392	11,077,470	6,345,126	17,160,538	8,573,518	28,238,008	523,100	2,286,401

The imports of coal are chiefly on the Pacific Coast. Some coal—chiefly from Japan—is received at Manila.

Returns from the custom houses show that the bunker coal supplied to steamships at United States ports during 1904 was as follows, in net tons:

	Coastwise.	Foreign.	Total.
Atlantic ports	1,834,270	3,597,354	5,431,624
Pacific ports	79,076	478,954	558,030
Gulf ports	411,065	177,739	588,804
Great Lakes	1,321,619	821,536	2,143,155
Totals	3,646,030	5,075,583	8,721,613

The total shows an increase of 546,446 tons over the year 1903. Of the total coal bunkered in 1904, coastwise vessels took 41.8%, and only the remaining 58.2% can be counted as exported. Adding the coal exported in 1904, we find that only 13,649,101 tons of coal mined in the United States were consumed beyond its limits.

The Coal Markets.

Anthracite.—The shipments of commercial anthracite in 1903 and 1904 were as follows, in long tons:

	1903		1904		Changes.	
	Tons.	Pr ct.	Tons.	Pr. ct.	Tons.	Pr. ct.
Reading....................	11,490,963	19.4	11,399,622	19.8	D. 91,341	I. 0.4
Lehigh Valley..............	9,737,160	16.4	9,611,426	16.7	D. 125,734	I. 0.3
N. J. Central..............	7,404,612	12.5	7,201,276	12.5	D. 203,336	.. ...
Lackawanna.................	9,575,657	16.1	9,333,069	16.3	D. 242,588	I. 0.2
Delaware & Hudson..........	5,927,283	10.0	5,276,797	9.2	D. 650,486	D. 0.8
Pennsylvania...............	4,555,459	7.7	4,765.953	8.3	I. 210,494	I. 0.6
Erie.......................	6,343,852	10.7	5,711,173	9.9	D. 632,679	D. 0.8
Ontario & Western..........	2,693,462	4.5	2,646,460	4.6	D. 47,002	I. 0.1
Delaware, Susquehanna & Sch.	1,634,489	2.7	1,546,746	2.7	D. 87,743	.. ...
Total..................	59,362,937	100.0	57,492,522	100.0	D. 1,870,415	.. ..

The principal increases in proportion were on the Pennsylvania, which last year was the only company showing an actual gain in tonnage. The important decreases were on the Erie and the Delaware & Hudson. The decrease in the total shipments was 3.1%.

The shipments from the three regions, into which the anthracite country is generally divided, were as follows:

	1903.	1904.	Changes.
Schuylkill	16,474,790	16,612,055	I. 137,265
Lehigh	7,164,783	6,988,182	D. 176,601
Wyoming	35,723,364	33,892,285	D. 1,831,079
Total	59,362,937	57,492,522	D. 1,870,415

The greater part of last year's decrease was in the Wyoming region, the northern and northwestern section of the field. That region produces about 60% of the coal, the Schuylkill supplying about 28, and the Lehigh 12 per cent.

The New York harbor trade, so far as the domestic sizes were concerned, continued very even throughout the year, demand being steady, and deliveries generally good. Parallel conditions obtained in Philadelphia, which is, next to New York, the most important delivery point on the coast. Schedule prices were generally maintained at these points. The plan of offering a discount of 50c. per ton from the schedule price on all purchases during the month of April, gradually decreasing the discount by 10c. each month, until it disappeared in September, was again adopted. It was found to work well, as in the preceding year. The object of this discount is, of course, to promote the purchase and storing of coal by retail dealers and by householders through the spring and summer months, and so maintain the tonnage, which would normally be lower during those months, and even up as far as possible the demands on the railroads. To a very large extent this was found to be the case; though with householders early purchases were less the rule than in 1903, when the memory of the strike year and its coal famine was still fresh. Moreover, there seemed to be a general feeling that the very severe winter of 1903-4 would be followed by a milder season—an anticipation which has so far proved fairly correct.

The demand for the small or steam sizes was not as even as for domestic coal. The business depression of the early part of the year, and the extremely low prices at which bituminous coal was for some time sold at tidewater points, caused a smaller demand for these sizes, and in many cases they were sold at considerable discounts, while large quantities had to be stocked for a time. It must be remembered that the production of a certain proportion of the small sizes is a necessary accompaniment to the preparation of the larger sizes, so that the output cannot be reduced, when demand falls off. At this period of the year pea coal was in the best demand, probably from the fact—which is not generally alluded to in public—that many retail dealers are in the habit of buying a certain proportion of pea, which they mix with the chestnut coal sold to householders. The other sizes, buckwheat, rice and barley, felt the depression very considerably. Later in the year, however, when business began to improve, and manufacturing establishments extended their purchases of coal, there was a marked betterment in trade. Prices improved, stocks were worked off, and long before December the small coal trade was in good condition, with prices well up to the companies' schedules. This movement was assisted, in some degree, by the stricter enforcement of the ordinances against smoke and the consumption of bituminous coal in New York, Boston and other large coast cities. There had been a considerable relaxation during the anthracite strike, and apparently it took a year or more for city officials to realize that the emergency was entirely over. When they did, however, they made up for lost time by greater strictness than had ever been known before.

Transportation was generally good throughout the year after the first quarter. The hard winter lasted until well on in March, with the necessary accompaniments of delays in traffic, the enforced haulage of smaller trains, and similar difficulties. From March on, however, there was very little complaint, and coal moved freely and steadily.

The coastwise trade was generally good. The only interruption was some controversy over the bill of lading and demurrage question. The supply of vessels was, for the most part, good, so that New England ports found little difficulty in securing their full supplies. All-rail trade with New England points was not quite as satisfactory; especially in the later months of the year, there were annoying difficulties and delays in delivering coal to points in central and western New England which are dependent upon the New York, New Haven & Hartford and the Boston & Maine railroads for their supplies. In December the connecting lines west of the Hudson were obliged to declare an embargo against the New Haven road on account of the great delays on the part of that road in returning cars. This was enforced for several weeks, when the transfer of coal cars to that road at New York harbor and at Newburgh was either stopped altogether or very much restricted. These delays, however, applied only to points east of the Hudson river. It may be said that the New Haven road is now making considerable improvements in the way of increased trackage facilities and more motive power, so that it is hoped there will be no recurrence of these troubles.

With reference to anthracite coal in Chicago and other Western territory, some falling off from the extraordinary shipments of the previous year was natural; but the loss was less than had been expected. Buffalo is the chief shipping port for the anthracite which goes up the Lakes; and its total for the year was 2,855,000 tons, a decrease of 345,000 tons, or 10.8%. This is a moderate falling off when the circumstances of the two seasons are considered. It may also be noted that toward the close of the season, when the shipments were heaviest, there was some interruption, due to shortage of cars, and to congestion in the receiving yards. The reports from the upper ports reflect this decrease also. Thus receipts by lake at Chicago were 950,000 tons, a decrease of 226,000 tons, or 19.2%. Those at Milwaukee were better, having been 865,000 tons, a decrease of 94,000 tons, or

9.8%. The anthracite passing the Sault for Lake Superior ports reached a total of 991,228 tons, a decrease of 157,777 tons, or 13.7%.

Some of this decrease was possibly due to the fact that many consumers were forced to turn from anthracite to bituminous during the strike; some of them continued its use, finding it quite available for their purposes. This has promoted the use of the better grades of bituminous coal in many western cities.

The most important incident of the year was undoubtedly the purchase of a controlling interest in the New York, Ontario & Western Railroad Company by the New York, New Haven & Hartford Railroad Company. The Ontario & Western, taking into consideration its coal line only, and not considering the line to Oswego, or the western connections, has an important interest in the upper or Wyoming district of the anthracite region. Its shipments amount to about 2,800,000 tons of anthracite yearly, or 4.6% of the total. Its line reaches tidewater at Cornwall, on the Hudson river, and from that point its trains run to Weehawken over the West Shore division of the New York Central, its delivery point for tidewater trade being at Weehawken, though it has also a shipping dock at Cornwall which is available, except for three or four months in the winter. The important point, however, is its connection at Maybrook and Campbell Hall with the Poughkeepsie Bridge line, the control of which was acquired by the New Haven company a year and a half ago. Two motives seem to have been prominent in this purchase; the first being a desire to secure business for the Poughkeepsie line, which has never been very prosperous; the second, and possibly the stronger, was the desire to control, as far as possible, the coal supply of the large district in western and southern New England served by its line. The policy of the New Haven road has always been the absolute control of traffic, and the coal trade is no exception. Heretofore, the coal supply of western Connecticut and Massachusetts has been received principally by water, to some of the Long Island sound ports, and thence by rail, giving only a short haul to the railroad lines.

This incident also derives considerable importance from the fact that it is the first time a New England company has acquired any direct ownership in the anthracite fields. The New York, Ontario & Western was an independent company, in so far that it was not controlled in any way by the dominant interests which have in recent years practically unified the management of the anthracite coal business. While independent, however, it always found its interest in acting with the other companies.

Near the close of the year an arrangement was made under the leadership of a Philadelphia banking house to pool the stock of the old Lehigh Coal & Navigation Company, and it was said that an option on the property had been given to a prominent company which was not named. This movement was successful, so far as securing the deposit of a large part of the stock was concerned, but before the transaction was closed, it was announced that the whole matter had been postponed. The then recent purchase of the Ontario & Western gave rise to rumors that the New Haven company was the prospective purchaser in this case also. The Lehigh Coal & Navigation lands are in the Lehigh field, and to connect them with the Ontario & Western would have required the construction of 35 or 40 miles of road through a rather difficult country. The coal property of the company is valuable, and it is one of the few surviving anthracite companies which bought their land at low prices and at an early date, and has been able to pay dividends on their mining operations throughout. It was also reported that the control had been taken by some of the older anthracite companies in order to prevent a further extension of the New Haven interests. Neither story has been confirmed, however, and the whole matter rests for the present.

The Hearst complaint to the Interstate Commerce Commission against the anthracite carrying roads came forward again. The courts finally decided that the representatives of the companies must answer certain questions and give certain information, which they had refused to furnish the commission at the original hearings. Some sessions of the commission were held in New York to receive this information; but it added little, or nothing, of importance to the evidence previously taken. The commission has not yet rendered its decision in the case.

The conciliation board, provided for in the settlement of the anthracite strike, has had a number of minor cases before it. The most important one, at least that which caused the most feeling and was most strongly contested, was that relating to the payment of check-weighmen, which was fully discussed in the columns of The Engineering and Mining Journal. In this, as in several other cases, the board failed to agree, and the final decision had to be made by the arbitrator, Carroll D. Wright.

It may be said that the anthracite trade was generally free from local strikes and small labor troubles. At one time a strike seemed imminent over the check-weighman question, but the matter was finally settled.

The division of anthracite coal shipped, by sizes, was as follows for two years past:

	1903		1904	
	Tons.	Per ct.	Tons.	Per ct.
Lump	2,303,116	3.9	1,447,549	2.5
Broken	4,825,497	8.1	3,979,062	6.9
Egg	7,977,689	13.4	7,600,002	13.2
Stove	11,531,573	19.4	11,282,077	19.6
Chestnut	11,200,635	18.8	11,327,971	19.7
Total large	37,838,510	63.6	35,636,661	61.9
Pea	7,929,715	13.3	8,057,268	14.0
Buckwheat	8,180,880	13.8	7,894,145	13.9
Rice and barley	5,513,726	9.3	5,904,448	10.2
Total steam	21,624,321	36.4	21,855,861	38.1
Total	59,462,831	100.0	57,492,522	100.0

The year 1904 showed an increase in the proportion of steam sizes, a continuation of the movement which has been going on for several years. A notable point also was that the shipments of chestnut exceeded those of stove coal for the year. The more important decreases in proportion were in lump and broken; the larger gains were in chestnut, rice and barley and in pea coal.

The Seaboard Bituminous Coal Trade.—If one should draw on the map a line from Baltimore to the head of the Cumberland valley, from thence to Hornellsville in New York, and thence to Buffalo or Dunkirk on Lake Erie, the region included between that line and the sea-coast would form the district in which anthracite coal may be considered a necessity of life. More than 90% of the anthracite mined is consumed in that section of the country; less than 10% goes west or south of the line above given, and the greater part of that small proportion follows the line of the Lakes and is consumed in the larger cities and towns, either directly on the lake, or within a short distance of some port. Everywhere else, bituminous coal is supreme. Even in the district so delineated, it is only as domestic fuel that anthracite has an exclusive hold. For steam coal and for manufacturing purposes, except in a few large cities where it is prohibited by law, a very large proportion of the fuel used is bituminous. The same may be said of the considerable quantities which are furnished to steamships engaged in foreign trade and in coastwise navigation. Even the steamboats employed in local trade use bituminous coal with the sole exception of the passenger boats plying on the Hudson river, on Long Island Sound and in Boston Harbor. The result is a large and important trade in coal of the bituminous variety to seaboard points, which comes mainly from the Clearfield, the Beech Creek, and the Broad Top regions in central Pennsylvania, the Georges Creek and Cumberland districts in Maryland and West Virginia, and the New River and Pocahontas fields, also in West Virginia. Comparatively little coal reaches the seaboard from the Pittsburg district or from Western Pennsylvania, with the exception that mines of the Berwind-White company, in the western Pennsylvania district, supply a considerable share of the bunker coal which is sold to steamers in the port of New York.

In former years the seaboard bituminous market resembled a battlefield, in which the contending forces were not arrayed in orderly lines, but were fighting, every man for his own hand. In the past three or four years much of this has disappeared, due principally to the control which Pennsylvania railroad interests have obtained over some of the more important competing lines, such as the Baltimore & Ohio and the Norfolk & Western; nevertheless, there are still strong independent interests, especially in the Clearfield and the West Virginia districts, and among these occasionally there is active competition. The year just closed saw one of those periods of competition and consequent low prices, to get at the causes of which it is necessary to go back a little. There is no question that the anthracite strike of 1902 unduly stimulated production throughout the district which supplies the seaboard trade. There was a large increase in the production of coal in the districts serving the seaboard, and some of the producers seem to have formed the idea that this increase would be permanent. The result in 1903 was an over-production of coal, and considerable competition, in the course of which some of the Clearfield operators managed to secure large contracts by cutting under the prices upon which they had previously agreed with the West Virginia interests. In the early part of 1904, when long contracts for the delivery of coal to manufacturers and consumers were generally made, it was understood that the price on the basis of good average Clearfield should be $1.25 at the mines. The West Virginia operators, however, embittered at the results of the previous year, and seeing also that demand was declining instead of increasing, promptly cut prices, and offered coal on the basis of 90c. at the mine, when the Clearfield operators were looking for $1.25. The result was that they got the best orders, and the Clearfield men had to cut prices to the lowest figures since the famine year of 1899. Sales were made as low as 60c. a ton at the mines, a price which was certainly not remunerative. This unsatisfactory condition of affairs continued through a large part of the year, and in fact it was well on towards August before there was any improvement. At the close of July, average Clearfield was selling at $2.25 to $2.35 per ton f. o. b. New York harbor points, and at corresponding rates all along the coast.

In August, however, business began to improve, and with it the demand for coal. Many manufacturers found that their contracts, made when prospects did not appear good, were below their requirements. Moreover, production had been in some degree restricted, partly by the enforced closing down of some smaller operations, partly from the long drought, which interfered with the work at the mines, and partly from inadequate transportation. The consequence was an advance which began in September, and which continued through the later months. The year closed with the lower grades of Clearfield selling at $2.75 to $3, and the better class of steam coals at $3 to $3.50 f. o. b. New York harbor; with corresponding prices on Baltimore and Philadelphia deliveries. Operators are feeling much better, and are looking forward to another period of prosperity in 1905. Whether this feeling will obliterate the old enmities remains to be seen.

This competition did not materially affect the Cumberland and Georges Creek operators. The quantity of that coal upon the market is necessarily limited, and its quality is such that it commands a special trade of its own, which is not subject to much competition.

The drought above referred to proved a considerable hindrance to shipments of bituminous coal in all of the last third of the year. An almost unprecedented period elapsed without rain. In some sections of Pennsylvania and West Virginia the supply of water for the mine boilers could not be had. Attempts were made to run with water pumped from the mine. These were occasionally disastrous, as the mine water was so impure that scale and corrosion were found to be weakening the boilers to a dangerous point, and the attempt had to be abandoned. On the railroad lines also, transportation was restricted because it was impossible to get water enough to run the full complement of locomotives. The first sign of relief came with a snowfall in December, which was very general throughout the region. This gave little help at first, but fortunately it was followed by a general thaw, and by rain which filled the streams and furnished the much needed supplies.

In the early and middle part of the year, when the trade was on a lower basis, there was little trouble with transportation from the mines to tide-water, and to points in what is known as the all-rail trade. In the latter part of the year, however, many delays occurred, some caused by the drought, or by short car supply on the railroad lines. These delays hampered the trade a good deal, and caused much annoyance both to operators and consumers.

The coastwise trade was generally good, and vessels were in good supply throughout the year. Vessel freight rates were low throughout the year. In late November and early December, there was a period of stormy weather, as a result of which many wrecks and losses were reported.

Export trade is not an important feature in the market. Apart from the export trade proper, there were considerable sales, chiefly of West Virginia coal for shipment to the Philippines, for local supply and for the use of Government transports.

Upon the whole, in the competition between anthracite and bituminous for the manufacturing trade of the East, neither gained nor lost materially during the year. Delays in transportation and delivery of bituminous undoubtedly assisted the trade in the anthracite steam sizes to some extent, but with this exception the two fuels stood at the close of 1904 about where they did at the opening of the year.

Chicago (E. Morrison).—Through the stimulus given to the consumption of bituminous coal by the great strike in the anthracite region in 1902, new mines were opened throughout the bituminous fields. These mines have since been in operation and their products flooded the Chicago market. A large number of new selling firms and agents were created by this influx of new producers, some of them without the necessary capital for doing business in competition with older firms. Through the operation of the law of the survival of the fittest, the weaker firms were eliminated or changed the nature of their business.

In anthracite business there was comparative stability. The wholesale trade is in the hands of a few firms. But to these the inertia of the consumers of anthracite has been a preventive of good business. Dock stores were large at the beginning of the new year, because, although about 190,000 tons less anthracite was received in 1904 than in 1903, it was not drawn upon to any considerable extent for the wholesale trade.

Total receipts of coal by lake at Chicago were 1,074,853 tons in 1904, against 1,250,615 tons in 1903. In the records of the United States Treasury Department, no division of anthracite and bituminous coal received is made, but it is estimated that about 85,000 tons in 1903 and 100,000 tons in 1904, of these totals, were bituminous. The receipts of anthracite, on the basis of these figures, were about 975,000 in 1904 and 1,165,000 tons in 1903.

Business in Eastern bituminous was better than in Western throughout 1904. Smokeless, especially, gained in popularity and, from being weak at the beginning of the year, became strong. Shipments of smokeless were much hampered by the railroads, and the same, though in a less degree, is true of Hocking, which has been in steady and good demand. Gas coals were quiet for most of the year.

Prices were uniformly low throughout the year, on bituminous. The packing-house strike, in the summer, sent the price of screening below the cost of the freight on coal to Chicago. Eastern bituminous in this respect was better off than Western, but prices of Eastern were not high at any time. Anthracite continued the same as in 1903—$6.50 base price, with a discount ranging, by 10c. gradations per month, from 50c. in April to nothing in September and the following months. Shipments of anthracite from Chicago to the West were about 250,000 tons less than the shipments of the previous year.

Pittsburg (S. F. Luty).—The production of the Pittsburg district in 1904 was about the same as in 1903. While the business was not as profitable as in 1903, under the conditions that prevailed it was a very satisfactory year.

The Pittsburg Coal Co. had more competition than formerly, and in the early part of the year the demand was light, owing to depression in the iron and steel trade. The company also was greatly handicapped by the strike of the masters and pilots, by which it lost the first 50 days of the lake shipping season.

The New York & Cleveland Gas Coal Co. and the Mansfield Coal Co. both are controlled by the Pittsburg company. It also controls the Monongahela River Consolidated Coal & Coke Co., the river coal combination. Production of this company fell off heavily, as the Ohio river was not navigable during the second half of the year. Some shipments were made to the lower markets on July 12, but the next rise did not come until December 26, when a good tonnage was shipped.

The Pittsburg Terminal Railroad & Coal Co., which was formed in 1903 and opened seven mines, became an active competitor of the leading producer for the lake coal trade in June. The production of these mines in 1903 amounted to 400,000 tons, which was increased to nearly 2,000,000 tons in 1904. Early in September the Wabash Railroad bought the entire properties of the Pittsburg Terminal company, including 15,000 acres of coal, seven mines and 36 miles of Terminal railroad. The former transfer was made in October, and a month later the Pittsburg Coal Co. obtained possession of the mines and coal land. The terms of the deal were not made public, but it was given out that the company got a straight lease for 40 years and will pay the Wabash a royalty for the coal mined. Another important deal was made by the Pittsburg Coal Co., which greatly strengthened its position in the Pittsburg district. Early in December it bought the Rachel and Blanche mines of the Pittsburg-Buffalo company, and entered into a contract with that company to handle all of its lake coal for a period of three years. The Pittsburg-Buffalo company also agreed to make no further new developments of coal property for a term of years. This deal removed a formidable competitor, as the company was preparing to engage in the lake trade. The Pittsburg Coal Co. made a number of contracts with independent operators for coal for the 1905 lake season. The Pittsburg-Buffalo company continues to be the largest independent producer in the Pittsburg district, but will not double its capacity, as had been intended.

Prices in 1904 were much lower than in the previous year. A fair average for the year is about as follows: Run-of-mine, $1.05 per ton; ¾-in., $1.15; 1¼-in., $1.25, all f. o. b. at mine. Some sales were made at a higher figure, but several large contracts for run-of-mine coal were made as low as 90c. Better prices were obtained for all coal shipped to the northwestern markets and to river points below Pittsburg.

A strike was threatened early in the year in the four large bituminous coal mining States, Pennsylvania, Ohio, Indiana and Illinois, parties to the inter-State agreement. At the joint convention held in Indianapolis in January, the operators demanded the 1902 scale, which was based on an 80c. pick-mining rate, and the miners insisted on a continuation of the 1903 scale, which was based on a rate of 90c. a ton for pick-mining. The question was left to a special joint committee and the convention adjourned. The committee could not agree and the joint convention was reconvened on February 29. The operators receded from their demand and offered to compromise at 85c., or a general reduction of 5.55%, and to enter into a contract covering a period of two years from April 1, 1904. The convention of miners decided to submit the question to a referendum vote of the membership. The vote was taken on March 15, and all the mines were closed on that date in order to give all miners an opportunity to vote. The compromise proposition of the operators was accepted, the vote being 98,514 for, and 67,373 against.

The Lake Coal Trade.—The movement of the two staple products of lake commerce, coal and ore, during the season of 1904 has been beset with numerous difficulties. Greatest of these has been the strike of the masters and pilots on the lake boats, which kept commerce on the lakes tied up until well on toward the middle of June. By dint of steady plodding the coal movement was almost brought up to that of 1903. The total tonnage of coal passed through the Sault Ste. Marie canals during the season, with the changes from the preceding year, were as follows:

	1904.	Changes.
Anthracite	991,228	D. 157,777
Bituminous	5,463,641	D. 324,987
Total	6,454,869	D. 482,764

In part this decrease was to be expected, as the opening of 1903 found the northwestern docks bare, and coal had to be rushed up the lakes to supply immediate needs; the consequence being a very heavy record for the season. In 1904 the late opening of navigation interfered with the traffic, and it shows the capacity of the lake fleet, which was able, in a little more than five months, to handle a tonnage only 7% less than the extraordinary shipment of the previous year.

Production of Coal in the World.

The coal production of the world in 1904 was close to nine hundred million metric tons, and shows a steady increase. There is a search everywhere, especially in Europe, for new coal-fields. Even the barren wastes of Spitzbergen, in the Arctic Ocean, are being explored.

The details of the foreign production are given in the following table:

COAL PRODUCTION IN THE CHIEF COUNTRIES OF THE WORLD. (In metric tons.)

Countries.	1900.	1901.	1902.	1903.	1904.
Asia:					
India	6,216,591	6,741,899	7,543,272	7,557,400	7,682,319
Japan	7,429,457	8,945,939	9,701,682	10,088,845	11,600,000
Australasia:					
New South Wales	5,595,617	6,063,921	6,037,083	6,456,524	6,116,126
New Zealand	1,111,494	1,259,521	1,386,881	1,442,916	(e)1,400,000
Other Australia	892,158	926,188	931,148	771,536	769,723
Europe:					
Austria Hungary (c)	39,027,929	40,746,704	39,479,560	40,160,823	(e)40,650,000
Belgium	23,462,817	22,213,410	22,877,470	23,913,240	23,380,025
France	33,404,298	32,325,302	29,997,470	34,906,418	34,502,289
Germany (c)	149,788,256	153,019,414	150,600,214	162,457,253	169,448,272
Italy	479,896	425,614	413,810	346,887	(e)332,000
Russia	14,759,866	16,526,636	16,465,836	(f)17,500 000	(f)18,600,000
Spain (c)	2,582,972	2,651,857	2,807,550	2,800,843	(e)2,800,000
Sweden	252,320	271,509	304,733	320,390	320,984
United Kingdom	228,772,886	222,614,981	230,728,563	233,419,821	236,147,125
North America:					
Canada—					
Western	1,791,826	1,861,248	1,826,221	1,791,798	2,619,816
Eastern	3,296,322	3,788,168	4,699,396	4,700,645	4,194,939
United States	243,414,164	266,078,668	273,600,961	317,272,110	318,275,920
South Africa (a)	759,362	1,388,205	2,213,275	2,957,736	3,015,000
All Other Countries (e).	2,500,000	2,500,000	3,500,000	4,000,000	4,250,000
Totals	765,138,033	790,349,184	804,115,125	882,865,185	866,104,538

(a) Transvaal, Natal and Cape of Good Hope. (c) Includes lignite. (e) Estimated. (f) Estimated by Minister of Finance.

Some details in relation to foreign coal production are given herewith:

Australia.—The production of coal in New South Wales during 1904 was 6,019,809 tons, valued at $9,575,770, as compared with 6,354,856 tons, valued at $11,134,368, in the previous year. Two-thirds of the output comes from the northern district, but the southern district is the only one that recorded an increased production during the year. Of the total output, 2,846,942 tons was consumed in the State; 1,880,545 tons was shipped to other Australasian ports, and 1,292,322 tons was exported to foreign countries. As compared with the previous year, these figures show that the domestic consumption is increasing at the expense of exports.

The production in Victoria in 1903, the latest official figures obtainable, was 64,200 long tons of bituminous and 5,661 tons of lignite.

Queensland produced in 1904, 512,015 tons, as against 507,801 tons in 1903. The Ipswich district is the principal producer. The Callide field is being developed, and at the Dawson field, in the interior, anthracite is being exploited.

Belgium.—The report for 1904 shows a decrease of 2.2% in production, as compared with the previous year. The output by districts was as follows, in metric tons:

	1903.	1904.	Changes.
Borinage	4,705,110	4,599,640	D. 105,470
Center	3,741,250	3,655,810	D. 85,440
Charleroi	8,276,000	8,092,800	D. 183,200
Namur	774,000	729,020	D. 44,980
Liege	6,416,880	6,302,755	D. 114,125
Total	23,913,240	23,380,025	D. 533,215

A decrease was shown in every district. At the close of 1903, nearly all the collieries had large surplus stocks on hand, and most of them curtailed the output to some extent, until these stocks were, at least partially, worked off. The consumption in 1904 was equal to that of the previous year, and work has been active since the opening of the current year, except during the miners' strike, which covered parts of February and March.

Exports of fuel from Belgium for the year were as follows, in metric tons:

	1903.	1904.	Changes.
Coal	4,923,367	5,066,390	I. 143,023
Coke	841,143	879,798	I. 38,655
Totals	5,764,510	5,946,188	I. 181,678

The coke exported went chiefly to France and Luxemburg. Coal exports were to France, Germany and Holland, chiefly.

Imports of coke into Belgium were 308,877 tons in 1903, and 338,791 tons in 1904, an increase of 29,914 tons. Most of this coke was from Germany.

Canada.—The total production of coal in Canada in 1904 was 7,509,860 long tons. Of this, 4,622,823 tons were mined in Nova Scotia; 1,685,698 tons in British Columbia, and 1,201,339 tons in the Northwest Territories. The most notable feature of the year was the active development of the new coalfields in Alberta.

The report of the Minister of Mines of British Columbia for 1904 says that the producing collieries of the province are located on Vancouver Island and on the western slope of the Rockies, near Crow's Nest Pass, in the extreme southeastern portion. The former are operated by two companies, the Western Fuel Co., at Nanaimo, and the Wellington Colliery Co., at Ladysmith and Union (Comox), while the eastern collieries are all operated by one company, the Crows's Nest Pass Coal Co. The conditions surrounding these two coalfields are so different that they must be considered separately. The production and disposition of the coal are shown in the table below:

	Vancouver.	Crow's Nest.	Total.
Sold as coal	784,169	287,168	1,072,337
Made into coke	81,170	350,900	432,070
Used at mines	135,034	24,617	159,651
Added to stock	22,640	......	22,640
Total mined	1,023,013	662,685	1,685,698
Coke made	19,371	218,857	238,428

The disposition, or place of consumption, of the coal and coke sold is reported as follows:

	Coal.	Coke.
In Canada	537,744	129,337
United States	532,436	100,281
Other countries	1,157	......
Total	1,171,339	229,618

The tons given in these tables are long tons of 2,240 lb. each. As compared with 1903, there was an increase of 85,434 tons of coal—excluding that used in making coke—and an increase of 72,885 tons of coke.

The Vancouver Island collieries mined 1,023,013 tons of coal, as shown in the table above. The coke produced amounted to 19,371 tons, of which 12,934 tons were sold, and 6,647 tons were added to stock. Of the coal sold, 53% was exported to the United States, practically all to California, while 20% of the coke sold found the same market. The local market is slow of growth, so the export market must be looked to for any expansion of business. In 1902, 75% of Vancouver Island coal went to California, in 1903 about 45%, and in 1904 about 53%, which would indicate that the worst is already known of the competition of the California fuel oil.

The coal production of Nova Scotia during 1904 was 4,622,823 tons, showing only a slight increase over the record of the previous year—4,586,649 tons. A large increase had been confidently expected, but the discouraging result is attributable to the severe weather that prevailed early in the spring, by which shipments were curtailed 300,000 tons from the shipments during the same season of the previous year, and to the lighter demand from the United States ports. The Dominion Coal Co.'s output—2,780,038 tons—was more than five times that of its closest competitor. All the companies are in good condition to increase their outputs as soon as new markets can be found. The Dominion company is instituting a search for these in distant foreign countries.

France.—The total production of coal in France for the full year is reported as follows, in metric tons:

	1903.	1904.	Changes.
Coal	34,217,661	33,838,130	D. 379,531
Lignite	688,757	664,159	D. 24,598
Totals	34,906,418	34,502,289	D. 404,129

There was a decrease of 1.2% in the total production in 1904.

A new coal deposit, the value of which is not yet known, has been discovered in the east of France. For more than 50 years geologists have supposed that the Saar coal field continued to the old department of the Moselle. Explorations, commenced in 1859 by Jacquot, were abandoned and then resumed in 1899 in Meurthe-et-Moselle. Acting on the advice of Professors Marcel Bertrand, Bergeron and Nicklès, the ironmasters of the district put down more than 30 bore-holes, and on March 19 last one of them struck coal at the depth of 2,046 ft., and passed through several seams, together 47 ft. thick, a great deal of water being encountered. This is the first new discovery reported in France for a number of years.

Imports and exports of fuel into France for the full year were as follows, in metric tons:

	Imports		Exports	
	1903.	1904.	1903.	1904.
Coal	11,208,283	10,888,370	938,530	1,120,140
Coke	1,521,646	1,656,250	106,341	160,580
Briquettes	611,771	528,030	72,650	66,960
Totals	13,341,700	13,072,650	1,117,521	1,347,680

The more important receipts of coal were from Great Britain, Belgium and Germany; of coke from Germany and Belgium. The exports in 1904 included 137,050 tons of coal and 50,470 tons of briquettes sent abroad for the use of French steamships; an increase of 6,680 tons of coal and a decrease of 7,730 tons of briquettes, as compared with the previous year.

Germany.—The production in Germany in 1904 was as follows, in metric tons:

	1903.	1904.	Changes.
Coal	116,637,765	120,694,098	I. 4,056,333
Brown coal	45,819,488	48,500,222	I. 2,680,734
Total mined	162,457,253	169,194,320	I. 6,737,067
Coke made	11,509,259	12,331,163	I. 821,904
Briquettes made	10,476,170	11,413,469	I. 937,299

Of the coal mined in 1904, 112,808,409 tons of coal, and 41,126,856 tons of brown coal, or lignite, were from the mines of Prussia.

The foreign coal trade of Germany is shown in the following table:

	Imports 1903.	Imports 1904.	Exports 1903.	Exports 1904.
Bituminous	6,766,513	7,299,042	17,389,934	17,996,726
Lignite	7,962,123	7,669,099	22,499	22,135
Coke	432,812	550,302	2,523,351	2,716,855
Totals	15,161,448	15,518,443	19,935,784	20,735,716

The largest imports of bituminous came from Great Britain, while practically all the lignite came from Austria, and the coke from Belgium. The largest exports were to Austria, Holland, Belgium, France and Switzerland; the coke went to France and Russia, but 27,901 tons was shipped to the United States.

Great Britain.—The production of coal had only a moderate increase in 1904. The total, as given by the official report, recently published, was 232,411,784 long tons, and the gain over 1903 was 2,087,489 tons, or 0.9%. There were no serious strikes or other interruptions to the working of the mines, so that the slight extent of the change was due to a moderate increase in demand, which was to be expected from business conditions during the year. In 1904 there were 48,250,280 tons of coal exported to foreign countries, while 17,190,900 tons were sent abroad for the use of steamers engaged in foreign trade, so that a total of 65,441,180 tons, or 28.2% of the coal mined, was consumed beyond the limits of the United Kingdom.

Exports of fuel from Great Britain for 1904 were as follows, in long tons:

	1903.	1904.	Changes.
Coal	44,950,057	46,255,547	I. 1,305,490
Coke	717,477	756,949	I. 39,472
Briquettes	955,166	1,237,784	I. 282,618
Total	46,622,700	48,250,280	I. 1,627,580

In addition to these exports there were 16,799,848 tons of coal sent abroad for the use of ships engaged in foreign trade in 1903, and 17,190,900 tons in 1904; an increase of 391,052 tons.

The coal shipped to the United States, included above, was as follows:

	1903.	1904.	Changes.
Atlantic ports	1,070,230	33,394	D. 1,036,836
Pacific ports	72,373	75,700	I. 3,327
Total	1,142,603	109,094	D. 1,033,509

This year's returns show that no part of the trade secured during the strike period in the United States has been retained.

Forty years ago some excitement was caused in Great Britain by the assertions of Professor Jevons that the coal supply of Great Britain would not last a hundred years. The result was the appointment of a commission, which, in 1871, submitted an elaborate report, putting the available coal in the country at 90,207,000,000 tons. Two years ago, another commission was appointed, which last year made a preliminary report, estimating the quantity of unmined coal, in seams 1 ft. thick, or over, at depths less than 4,000 ft., at 100,914,000,000 tons, in round figures. In addition to this, the Geological Committee reports that there are certain large quantities of coal existing at depths greater than 4,000 ft., and certain other deposits in areas outside of the coal fields now worked. The commission's estimate is based entirely upon the fields now yielding coal.

Summing up all the supplies referred to above, we have the following estimate of coal in existence in the United Kingdom:

Commission's estimate	100,914,000,000
Under 4,000 feet depth	5,239,000,000
In areas outside present fields	39,483,000,000
Total tons	145,636,000,000

If we assume that all this coal is available, it would last, at the rate of consumption shown in 1904, for somewhat over 600 years. But the average rate of increase in consumption for 30 years past has been 2.5% yearly; and if this increase should continue, the supply will be sufficient for less than 300 years. Three centuries is a long time in the life of a nation, and it would be easy to assume, therefore, that Great Britain has no cause for apprehension as to the future of her industries, on the score of fuel supply.

We must remember, however, that not all the coal expressed in the figures given will be available. The estimates include all seams known, or supposed to be, 1 ft. in thickness, or over. But, without considering quality, there must be some part of this coal which cannot be considered available. It is easily apparent, for instance, that a seam 1 ft. thick cannot be worked commercially at a depth of 3,000 to 4,000 ft., except under very exceptional conditions; while only thick seams can be regarded as promising profit at depths of over 4,000 ft. Moreover, the estimate makes no allowances for waste and loss in mining, which are inevitable, as every operator knows. Fifteen years ago the Pennsylvania Anthracite Commission put the loss of coal at one ton for each ton actually sold and consumed. For British mines—or for our own at the present time—this is too high; but the waste is an amount entirely too large to be neglected in any estimate for the future.

On the other hand, there are opportunities for many savings in consumption. The Commission thinks that 50% of the coal used in manufacturing could be saved, if all engines and boilers were of the highest degree of efficiency. Of course, this is too much to expect; but there is room for great improvement. The extended use of the gas engine may be an important factor in economizing fuel. Another feature is the recent establishment in the coal country of large central stations, where slack and waste are converted into electric power, through the medium of the gas producer and gas engine. These not only save the consumption of much good coal, but also utilize a part of the waste from mining.

Japan.—The production in 1904 increased, notwithstanding the industrial disturbances due to the war. There was a greater demand for coal for naval and other war purposes; but the exports show only a slight decline.

Russia.—Coal production declined, as labor was scarce, owing to the drain of men for the army. Moreover, there were serious labor troubles in Poland and in the Donetz basin. Imports of coal into Russia for the full year were 2,937,637 long tons in 1903, and 3,106,901 tons in 1904; an increase of 169,-264 tons. Imports of coke were 487,104 tons in 1903, and 574,147 tons in 1904; an increase of 87,043 tons.

Coke.

The production and use of coke is so directly connected with the iron and steel trades that any depression in the latter is immediately felt by the coke-makers. The first part of 1904 having been marked by a decrease in the demand for steel and iron, as was to be expected, the total output of coke was less than in 1903. In that year 23,910,344 tons were reported; in 1904 the total was 22,035,292 tons, showing a decrease of 1,875,052 tons, or 7.8% for the year.

The production by States is shown in the following table:

PRODUCTION OF COKE IN THE UNITED STATES. (Short tons.)

States.	1903.			1904.		
	Tons.	Value at Mine.		Tons.	Value at Mine.	
		Total.	Per ton.		Total.	Per ton.
Alabama	2,693,497	$7,622,528	$2.83	2,340,219	$5,686,132	$2.43
Colorado and Utah	1,053,840	3,089,783	2.93	789,060	2,461,867	3.12
Georgia and N. Carolina	85,546	368,351	4.31	75,812	235,017	3.10
Indian Territory	49,818	227,542	4.57	44,808	205,669	4.59
Kansas	14,194	50,221	3.54	9,460	28,853	3.05
Kentucky	115,362	305,327	2.65	64,112	153,869	2.40
Missouri	1,839	5,797	3.15	2,446	6,482	2.65
Montana	45,107	310,882	6.89	41,497	208,935	6.77
New Mexico	11,050	31,539	2.85	10,150	28,927	2.85
Ohio	143,913	528,143	3.67	109,284	333,316	3.05
Pennslyvania	14,286,995	34,574,619	2.49	13,281,475	30,680,207	2.31
Tennessee	546,875	1,706,722	3.12	379,240	1,133,927	2.99
Virginia	1,176,439	2,724,047	2.32	1,101,716	2,478,861	2.25
Washington	45,623	214,776	4.71	45,432	211,713	4.66
West Virginia	2,707,818	7,115,842	2.63	2,276,451	5,645,598	2.48
Other States	932,428	3,228,064	3.46	1,464,130	4,978,042	3.40
Total Coke { Short tons	23,910,344	$62,074,162	$2.63	22,035,292	$54,178,015	$2.46
Total Coke { Metric tons	21,697,227	....	2.90	19,995,732	....	2.71

Pennsylvania continues to be, as for many years past, far in advance of all the other States in coke-making. Close to 60% of the total comes from that State. West Virginia is second, and Alabama a close third, each reporting about 10% of the total. In 1904, the Alabama output was affected by the strike of the coal miners, which was most felt at the mines owned by the iron companies, where coke is chiefly made. At several times during the second half of the year, it was found necessary to bring coke from West Virginia to keep up the supply at the blast furnaces.

In the United States, the average yield of coke to a ton of coal is from 60 to 66⅔% ; that is, it takes from 1.5 to 1.67 tons of coal to make a ton of coke. Taking the average at 62.5%, the total coal consumed in coke-making in 1904 was 35,256,467 tons.

These figures do not include the coke produced in making gas, of which no definite statistics can be obtained. This gas coke is a by-product, and is not used as a metallurgical fuel, being generally sold in the cities where it is made as a household fuel, or to bakers and other manufacturers.

The use of by-product coke ovens made some progress during the year, and work was begun on several new plants, which will be in use during 1905. Notwithstanding the decrease in the total output, the quantity of coke made in by-product ovens increased. This coke, which was estimated at 1,870,000 tons, or 7.8% of the total in 1903, was 2,608,000 tons, or 11.8% of the total in 1904. A considerable part of this gain was from the large new plant of the Lackawanna Steel Co. The Semet-Solvay and the Otto-Hoffman are the types of by-product ovens chiefly in use. The bee-hive oven, however, continues to be the staple coke-maker of this country.

There was an increase last year in the proportion of slack, or fine coal, used in making coke. There was also an increase in the practice of washing coal intended for use in the coke oven. The use of washed slack is extending, especially among the coke-makers in Alabama and other parts of the South.

The consolidation of coke interests made some progress in 1904. The H. C. Frick Coke Co.—a subsidiary of the United States Steel Corporation—enlarged its holdings in the Connellsville district. The Steel corporation is also increasing its facilities for coke-making in West Virginia. No new coking-coal deposits of much importance have been opened; but new workings have been started in the Southern or Lower Connellsville district, where the coal is said to be equal in quality to the original Connellsville.

The coke trade was generally disappointing to producers during the first half of the year; but this was partly made up by the activity of the later months.

COPPER.

The production of copper in the United States in 1904 was 833,802,147 lb., the largest output yet recorded, exceeding that of the previous year by nearly 119,150,000 lb., or 16.7%. The year 1903 exceeded its predecessor by about 7%, and this approximate ratio of increase in production had been maintained for several years. The States suffered no change in relative importance, although California shows the largest proportional increase over 1903, 56%; Michigan's increase was 8.3%, and Montana, contributing nearly 37% of the country's 1904 output of metallic copper, increased nearly 20% over its 1903 output. Arizona showed an increase amounting to 22%; Utah's increase was normal.

PRODUCTION AND OTHER STATISTICS OF COPPER IN THE UNITED STATES.

States.	1901.		1902.		1903.		1904.	
	Pounds.	Long Tons.	Pounds.	Long Tons.	Pounds.	Long Tons.	Pounds.	Long Tons.
Arizona.	126,183,744	56,332	119,841,285	53,501	153,591,417	68,567	191,602,958	85,536
California. . . .	33,667,456	15,030	25,038,724	11,178	19,113,861	8,533	29,974,154	13,381
Colorado.	7,872,529	3,515	8,463,938	3,779	7,809,920	3,487	9,401,913	4,197
Michigan. . . .	155,511,513	69,425	170,194,996	75,979	192,299,485	85,848	208,329 248	93,003
Montana.	229,870,415	102,621	266,500,000	118,973	272,555,854	121,676	298,314,804	133,181
Utah.	20,116,979	8,981	23,939,901	10,687	38,302,602	17,100	47,062,889	21,009
Eastern and Southern States.	6,860,039	3,063	13,599,047	6,071	13,855,612	6,186	15,211,086	6,790
All others. . . .	17,360,537	7,750	9,154,753	4,087	10,846,477	4,842	17,817,953	7,954
Copper in sulphate (b). .	11,730,000	5,232	9,154,753	4,087	6,281,113	2,804	16,087,142	7,182
Total domestic produc'n	609,173,212	271,949	645,887,447	288,342	714,656,341	319,043	833,802,147	372,233
Stock Jan'y 1	93,050,230	41,541	209,587,698	93,566	162,935,439	72,739	230,111,792	102,729
Imports, bars, ingots, old, and ores(a)	176,472,369	78,782	161,551,040	72,121	167,161,720	74,626	182,292,205	81,380
Total supply.	878,695,811	392,275	1,017,026,185	454,029	1,044,753,500	466,408	1,246,206,144	556,342
Deduct exp'ts	227,194,184	101,426	376,298,726	167,991	312,822,627	139,653	555,638,552	248,053
Deduct consumption. .	440,913,929	196,837	477,792,000	213,030	501,819,081	224,026	482,190,920	215,264
Stock Dec. 31	209,587,698	94,009	162,935,439	72,738	230,111,792	102,729	208,376,672	93,025

(a) This includes copper imported in low-grade Spanish and other pyrites, chiefly for sulphur, and the copper imported from Canada in copper-nickel matte, in which the nickel is the metal of chief value; also the copper in certain gold and silver ores. These items, until 1898, did not appear in the United States statistics of imports. (b) Including only the copper in sulphate obtained as a by-product and by leaching copper ores.

In spite of this great enlargement of production, domestic consumption showed a decline from around 224,000 long tons in 1903 to 186,400 long tons in 1904, but this was overbalanced by greatly increased exports—139,653 long tons in 1903 and 248,053 long tons in 1904. Trade conditions were thus exactly the reverse of those during 1903. Europe showed a heavily augmented demand for our copper, mainly for immediate consumption, and China, for the first time, drew extensively upon our supplies, importing 4,622 tons of raw copper. For some months stocks on hand have been no larger than the normal amount in transit and in refiners' hands, approximating two months' output from the mines.

Prices during 1904 ruled below the average of 1903, although towards the end of the year an improved domestic demand gave them an upward tendency which continued well into 1905. The price of Lake copper in New York averaged 12.990c. as against 13.417c. in 1903 and 11.887c. in 1902; electrolytic averaged, at New York, 12.823c. as against 13.243c. in 1903 and 11.626c. in 1902. Average monthly quotations are:

Review of Copper Mining in the United States in 1904.

Alaska.—Copper occurs over a wide area in Alaska, and many large lodes have been discovered, but in most cases they are too remote from present communication to be worked profitably. During the year a promising copper mine was developed at Niblack Anchorage, on the east side of Prince of Wales island. A 400-ton smelter was erected at a group of copper mines on the Kassan peninsula, and the Copper Mountain company completed a new 250-ton smelter to treat the ore from Prince of Wales island mines. The Gladhaugh mine, on Prince William sound, was worked throughout the year. The Apollo mine, on Unga island, after several years of small production, suddenly took a new lease of life, and now promises to become a regular producer.

Arizona. (By James Douglas.)—The activity in the southeastern section of Arizona, which was a conspicuous feature of the copper trade of 1903, has been fully maintained in 1904.

A new producer has entered the field in the Imperial Copper Company, which has re-opened the Old Boot mine in the Silver Bell district to the southwest of Tucson, and has already brought its output up to 200 tons of ore per day. None of the old mines shows any signs of decay or decrepitude, but only the Old Dominion mine and the Copper Queen have notably increased their outputs. Development is being prosecuted as actively as it was last year by the group of Lake Superior and Pittsburg companies in the Warren district (Bisbee) with, in some cases, positively favorable results, and, in most, with promising prospects. Although the Calumet & Arizona smelter is being enlarged to meet future exigencies, none of the newly developed properties has yet turned out any copper. Nor in the Clinton district has the New England Company, which is a consolidation of the old Copper King with other claims, nor any other of the recent organizations, contributed independently to the production, which still depends on the works of the Arizona Copper Company, the Detroit Copper Company and the Shannon Copper Company.

Northern Sonora, whose copper passes to the market, whether as ore or as bar, through Arizona, has not during the year added any new source of supply to its already large output, though the Transvaal Company is erecting works near Cumpas to the south of Nacozari, to treat copper and lead ores. The Greene Company reduces most of its ore to copper at Cananea, but ships a notable quantity of its mineral and furnace by-products to smelter at El Paso. The total output of the Nacozari mines is shipped as concentrate for reduction by the works of the Copper Queen Company at Douglas, Ariz. These works also treat the ores of the Imperial mine. The Old Dominion Company, which heretofore has not averaged from its smelter a million pounds of copper per month, is now turning out 2,000,000 lb., partly from its own mines and partly from the United Globe mines and from purchased ores. This new activity is primarily due to the erection and operation of a new smelter with its converter department, but the advantages of smelting and bessemerizing over the old and wasteful practice of direct reduction to black copper in the cupola could not have been secured had not the railroads so reduced their freight rates as to make possible the interchange of low-grade ores. At present, the Globe finds a profitable market for its infusible lean oxidized ores as converter lining in the Bisbee district, and receives back from the Copper Queen and other mines tributary to the Southern Pacific the sulphur ores, which are as yet scarce in, and near, Globe. The more liberal policy of the public carriers will undoubtedly help to develop the resources of the Southwest by bringing together at profitable rates refractory ores from distant points to centers where their mixture will make a smelting charge. Incidentally, one wonders whether a law endowing a central bureau in Washington with rate-making power will aid or retard such a movement, which, as is apparent, depends for its helpful application upon intimate knowledge of local conditions.

The output for the past year from Southern Arizona has been approximately:

From the Warren (Bisbee) district, 45,000 tons; this includes copper from ores produced by the mines of the Copper Queen, the Calumet & Arizona and the Imperial, smelted at Douglas.

The Clifton district has yielded, approximately, 28,000 tons; and the Globe district, 7,500 tons of copper.

Sonora has shipped about 35,000 tons through Arizona, but in estimating the total output of Northwestern Mexico, the production of the Boleo mines must be added, and a certain amount of low-grade ore forwarded in small shipments.

During the coming year Bisbee will probably turn out somewhat more copper from both the Copper Queen works and the Calumet & Arizona smelter at Douglas. The new reduction works of the Copper Queen Consolidated Mining Company at Douglas, when additions are completed in the fall of 1905, will consist of a boiler plant with 4,000-h. p. water-tube boilers; four No. 10 and five No. 9 rotary blowers, direct connected to compound condensing engines; six cross-compound condensing blowing-engines with total displacement of 45,000 cu. ft. per minute; four 650-h. p. cross-compound condensing engines, direct connected to 400-kw. generators, which deliver current at 250 volts to operate the trolley system and the various motors about the works.

The ore from the Copper Queen mines is received in side-dump steel cars, which discharge into stone-lined pits. This and other ores are bedded in layers and flux is added in proper amount to make the smelting mixture. This mixture is loaded by steam shovels into charge cars, trains of which then run up an incline direct to the furnaces. These cars are of rolling side-dump type, and discharge directly into the furnaces. Three 60-ft. electric cranes of 60 tons capacity transfer the matte from furnaces to converters and the converter shells from the re-lining floor to the converter stands. The furnace and converter building, which is 650 by 150 ft., contains eight blast-furnaces and seven stands of converters of the trough type, with space for two more furnaces and two more converters. There is a re-lining plant at each end with stands for re-lining and drying 30 shells. All the buildings are of steel frame with brick walls.

The Clifton district is not making prepartions for an increased output in 1905. The ores of that district are so lean that a large capital expenditure and much time are needed to prepare for a larger production, and none of the dominant companies expects that plans for contemplated extension will become operative in 1905. The Old Dominion concentrator will, it is hoped, commence active work during the coming summer, and the Old Dominion smelter will probably increase its output from its own and purchased ores to 3,000,000 lb. per month.

Fortunately, mining in the Southwest has been relieved from the destructive drains which litigation has made on this industry in Montana. Both in the Clifton and the Bisbee districts the large companies work harmoniously side by side, and by giving their agents access to one another's underground workings, aid each other in the development of their adjacent properties. This application of the golden rule is the result of abrogation by agreement of the law of the apex.

The year's production of Calumet & Arizona was 31,700,000 lb. copper, and about $200,000 in gold. The mine is now making copper at the rate of 2,650,000 lb. per month. Discoveries at the Oliver shaft have been of great importance, and on the 1,050-ft. level, as well as above and below, there is blocked out a large tonnage of sulphide ores of high grade.

The Arizona Copper Company concentrates 700 tons of sulphide and oxidized ores per day at its Clifton mills. The product is 120 tons of concentrate. The sulphide ores run about 3% copper, the jig concentrate from them running 17½ to 18% copper. The Hancock jig, in use here, has a capacity of 35 tons of ore per hour. The tailing from this jig passes through a Huntington mill, thence to vanners. The Hancock does the work of 16 Hartz jigs and uses only the same amount of water as two of the latter. The oxidized ores are concentrated separately, the tailing from them passing to the leaching plant. The company's concentrator, located near Longfellow, is handling 350 tons of ore per day and is making a product of 50 tons per day of concentrate.

The prospects of the Arizona copper mines are excellent, and when the extensive mining and metallurgical works now being carried out are completed the Territory will undoubtedly dispute with Michigan for second position as a copper producer.

California.—Copper occurs in nearly every county in California, but the chief producers are at present confined to Shasta and Calaveras counties.

In Shasta county the Mountain Copper Co. is a large, regular producer. The next largest producer is the Bully Hill property.

The prospective re-opening and extensive working of the old copper mines at Copperopolis, Calaveras county, in the lower foothills of the Sierra slope, is of interest, both because of the history of the old Union and Keystone mines and the importance of the projected development.

Colorado.—The Commissioner of Mines reports the copper production of Colorado in 1904 as 9,401,913 lb. All but 11 counties contributed to this output, Lake county leading, with 3,734,593 lb., but followed closely by San Juan county. Developments near Salida succeeded in re-opening the old Sedalia mine, and steps were taken to treat the low-grade ore by hydrometallurgical processes. At Apex, in Gilpin county, copper has been exposed, and several car-loads of good ore have been shipped. In the northwest part of the State, where the Encampment district of Wyoming extends over the line, copper has been developed and a small matte-smelting furnace was erected at Pearl. In general, the prospects of a notable copper production in Colorado have not been encouraging. Search has been and continues active, however, for, with a supply of even low-grade copper ore available as a collector of gold in matte smelting, an economy estimated at $1 per ton of ore could be attained over the present cost of smelting on a lead basis.

Georgia.—The gold veins in the Dahlonega district have long been known to contain occasional bunches of copper ore. About six miles east of Dahlonega, however, there is a well-marked vein containing a large mass of pyrite, carrying an average of 3% copper. This property is now being worked. It is proposed to use the pyrite in making sulphuric acid and to extract copper from the residues. Mining has also begun on a deposit of copper-bearing pyrite at Villa Rica, in Carroll county. An old gold property in Lincoln county, known as the Seminole, is now being worked for copper.

Idaho.—The State Inspector of Mines puts the copper production of this State in 1904 at 5,422,007 lb., or more than double the output of the previous year, viz., 2,524,000 lb.

In the vicinity of Pocatello, Bannock county, development has progressed actively on more than a dozen properties, some of which have begun shipments of selected ores. An electric company is exploiting the river power at American Falls; it is already supplying Pocatello and Blackfoot with light and power, and will be a factor in the mineral development of the region.

In Custer county, the White Knob Copper Co. employed 300 to 400 men for eight months and then went under receivership. It was soon reorganized and development was resumed. An expensive matte smelter of 600 tons daily capacity had been erected at Mackay, but for 700 ft. of depth nothing but carbonate ore has been found, wholly unsuited to matte treatment. Recent developments below the lowest level show improved tenors in copper and sulphur, so that, as soon as rich sulphides become available, the large reserves of carbonates, carrying 50 lb. bullion per ton, can be utilized. At Loon creek, the Lost Packer mine has been steadily developed, with excellent success. The company intends to erect concentrator and smelter.

In Washington county, the Ladd Metals Co. operated a smelter at Mineral and made several shipments of rich matte. In the Seven Devils district the same company made an unsuccessful attempt to run a furnace at Landore with wood gas. They are now using coke in their 40-ton stack, and have already turned out a gross value of $300,000. Ore carrying 30 to 40% copper, 5 oz. silver and $3 in gold is obtainable in considerable quantity, mainly from leasers.

The Cœur d'Alene district shows the greatest activity, although its copper resources have been overlooked in the attention given to lead. The Snowstorm mine at Larson Siding has been developing for several years on a strong, readily exposed shoot of silicious carbonate, 430 ft. long, 10 to 35 ft. wide, and already opened to a depth of 1,200 ft. below outcrop. It averages 5% copper, disseminated as carbonate through sandy vein filling, and experiments are being made on a leaching process.

Michigan. (By C. E. L. Thomas.)—The year 1904 was a highly successful one for the Lake Superior copper mining industry. Dividends have shown an increase of more than a half a million. Mining companies have been benefited by the advance in the copper market, and net earnings have shown great improvement. The list of dividend-paying mines is now the largest since 1901, and the prospects are auspicious for the addition of at least two more in 1905. Several of the newer mines are demonstrating their capacity by making more copper and larger profits; the outlook for the younger enterprises is good, while the old mines are developing new ground, improving their plants and devising new methods of winning the metal at a minimum cost. The prosperity of the past year has not been confined to the owners; it has been shared by the laboring men. Wages have remained good, and, while some discontent was manifested at certain properties early in the year, resulting in the curtailment of output and earnings, labor, as a whole, has been satisfied, as well it had a right to be. Everything considered, the outlook for 1905 is excellent. The towns and cities, collectively, have shown no diminution in population, and more men are employed than ever before in the history of the district.

It was just 62 years ago that the first copper mine was opened in the Lake Superior district, yet this continues to be one of the largest and most profitable copper-producing regions in the world; it enjoys the unique distinction of having yielded dividends continuously for 56 years, the first one having been paid in 1849, two years after the opening of the Cliff, the first successful mine. The production for the last five years is given in the following table:

COPPER PRODUCTION IN MICHIGAN. (Pounds of fine copper.)

Mines.	1900.	1901.	1902.	1903.	1904.
Adventure	....	....	606,211	2,182,608	1,380,480
Ahmeek	....	....	....	....	350,000
Atlantic	4,930,149	4,666,889	4,949,368	5,505,598	5,321,859
Baltic	1,735.060	2,641,432	6,284,819	10,580,997	12,177,729
Calumet and Hecla	81,403,041	82,519.676	81,248,739	(f)76,490,869	80,341,019
Centennial	....	806,400	....	....	641,294
Champion	....	....	4,165,784	10,564,147	12,212,954
Franklin	3,663,710	3,757,419	5,259,140	5,309,030	4,771,050
Isle Royale	Nil.	2,171,955	3,569,748	3,134,601	2,442,905
Mass	Nil.	837,277	2,345,805	2,576,447	2,182,931
Michigan	....	....	166,898	275,708	2,746,127
Mohawk	....	160,897	226,824	6,284,327	8,149,515
Osceola Consolidated	11,200,000	13,723,571	13,416,398	16,059,636	20,472,439
Phoenix	....	93,643	....	202,823	1,162,201
Quincy	14,116,551	20,540,720	18,988,491	18,498,288	18,343,160
Tamarack	18,400,000	18,000,852	15,961,528	15,286,093	14,961,885
Trimountain	....	....	5,730,807	9,237,051	10,211,230
Winona	....	....	101,188	1,036,944	646,025
Wolverine	4,778,829	4,946,126	6,473,181	8,999,318	9,764,455
All other mines	4,000,000	640,591	700,067	75,000	50,000
Totals	144,227,340	155,507,465	170,194,996	192,299,485	208,329,248

The output shows over 8% more refined copper in 1904 than during the preceding year. With the exception of two or three million pounds, the entire gain was made by the mines opened on the Baltic lode and the Kearsarge amygdaloid. Had it not been for the labor strikes which caused loss of time at the Quincy, Atlantic, Baltic, Trimountain and Champion mines, the district would have shown a greater increase in output. It will be noted that the mines opened on the Baltic lode, which owe their inception to the high price of the metal five years ago, made approximately 35,650,000 lb. fine copper. These three properties, the Baltic, Trimountain and Champion, are destined to make great progress in the next few years, and eventually will rank close to the Calumet & Hecla in point of production. The Baltic and Trimountain are owned outright by the Copper Range Consolidated Co., which also owns a half interest in the Champion. Crediting it with the output of the first two properties and one-half the latter's, its production last year was 29,525,000 lb., which makes it second only to the Calumet & Hecla company. The most notable gain has been made by the Osceola, which increased its production about 25 per cent.

As the product of the mines is disposed of through various channels, it is extremely hard to arrive at the valuation of the output. Valued at the average selling price of the metal, the Lake mines have received something over $27,000,000 for their product this year. Dividend disbursements amounted to nearly 20% of the gross yield. Lake Superior mines have produced approximately 3,388,600,000 lb. fine copper up to the end of 1904, and realized from the sale of same, about $514,200,000. Upward of 25% of the latter amount has been returned to shareholders in dividends.

The output during the last ten years, according to Stevens, is shown in the appended table:

	Lb. Copper.	Value.		Lb. Copper.	Value.
1895	129,330,749	$13,877,109	1900	142,151,571	$23,691,928
1896	142,057,500	15,758,935	1901	155,716,848	26,038,857
1897	142,702,586	16,530,843	1902	170,325,598	20,711,502
1898	147,965,738	17,829,871	1903	192,299,191	26,383,449
1899	146,950,338	26,098,382	1904	208,329,248	26,713,469

Production depends so much on factors of an uncertain nature that it is difficult to forecast the output in 1905. It is safe to say that the advance made this year will not only be held, but there will be further growth. Among the older mines the Osceola and Quincy should both do better. The three South Range properties and the Mohawk should make good gains, while the Tamarack will likely recover some of its lost ground. Franklin is ripe for an increase, and the Mass should make more copper as a result of its enlarged working force. Adventure, too, will show a better yield. Centennial and Ahmeek, two new producers on the Kearsarge lode, should take rank among the moderate sized shippers.

The dividends have been as follows:

Mine.	1903.	1904.
Calumet & Hecla	$3,500,000	$4,000,000
Champion	300,000	200,000
Osceola	......	192,300
Quincy	550,000	500,000
Tamarack	......	90,000
Trimountain	300,000	......
Wolverine	330,000	450,000
Total	$4,980,000	$5,432,300

The force of men employed in the mines, mills and smelters of the district numbers 16,000; it has never before been so large.

The present status of the active mines, beginning at the extreme northeast, is briefly stated herewith:

At the Phœnix, work on the West vein has been abandoned, to be concentrated on the St. Clair vein, which makes a favorable showing. The latter cannot keep the mill supplied, however, and the Ashbed may be opened in order to make up the deficiency. The Mohawk, which suffered from the burning of a rock-house, is in excellent condition now. The work of furnishing its four producing shafts with modern equipment is well along. About the middle of the year work on a new shaft, No. 5, was started and down to the present depth—60 ft.—the showing is excellent; sinking has been suspended pending the completion of a shaft-house. The average depth of this mine is 900 ft., the deepest level being at 1,100 ft. South of the Mohawk, the Ahmeek is proving a valuable mine and promises to surpass the record of the other mines on the same—the Kearsarge—lode. It has two shafts, one down 400 ft. and the other 600 ft. Shipments average 160 tons daily from the extension of drift stopes. This mine has been a producer for the last six months and the mill runs give good promise for its future.

A second shaft is being started by the Allouez to tap the Kearsarge lode. The first will cut the bed in February, at a depth of 1,500 ft., the present depth being 1,300 ft. This mine should be producing about the middle of 1905.

The Osceola now ranks second among individual producers. Its North and South Kearsarge mines are proving highly profitable, while the old Osceola branch is making a fair showing at the present copper prices. Great improvements have been made at the stamp mills, and an additional expenditure of $75,000 will be made at the plant in 1905, for the conversion of more of the stamps to the steeple-compound type, which has proved so successful.

Wolverine shows little change. It is making the cheapest copper on Lake Superior, pays good dividends and maintains its production. Construction work has ceased for the present, so that production is uninterrupted; an uneventful history is the best for a mine of this high type.

Centennial has practically cleaned up its stockpile and should be in a position to know the average yield. Production began a few months ago, but has been small owing to the treatment of the surface accumulation. The work of getting the second shaft in shape for production will be completed next summer. The Arcadian mill, of three stamps, was purchased last January.

North of the Mohawk, the Miskwabik and Bohemian Range companies are exploring. The former is prospecting a formation believed to be the Kearsarge lode. The Mayflower and Old Colony companies are employing small forces and are still engaged in a search for paying lodes, east of the Kearsarge. Nothing of value has been found by either.

At the Calumet & Hecla a large amount of new work is being done. At No. 13 shaft stoping on the Osceola amygdaloid has been resumed, and a regular production is being maintained. The work of remodeling the stamp-mills is going forward steadily, and the plant will be brought up to date in every department. Two shafts have been sunk on the Kearsarge lode, and a third is located on the southeastern corner of the property for exploration purposes. No. 19, the northernmost opening, is shipping rock regularly, and No. 20 will begin in a short time. The general outlook at this bonanza mine is bright indeed. A large electric power plant is being built at Lake Linden to furnish operative power for the mines, mills, etc., and a great saving should result. Some exploratory work has been done a couple of miles west of the mine on lands it owns in that section, but nothing authentic is known regarding the results.

Tamarack has recovered from the effects of the shutdown at No. 2 shaft, which has been repaired , and is now making copper on a good scale. Openings in the ground adjacent to No. 5 shaft are better and the outlook is much improved, as compared to a year ago.

Diamond drilling on the Laurium has been promising, and more vigorous steps may be taken to prove the property next summer. Two borings have been completed and a third is now in progress. Tecumseh shows no signs of becoming active, many reports to the contrary notwithstanding. The Rhode Island is still exploring, with indifferent results. Franklin is in excellent shape. Its new shaft at the Junior mine (on the Allouez conglomerate) is penetrating good ground and furnishes an increasing output. The old mine has not done so well as formerly and its days are numbered. Developments at the Junior, however, make it reasonably certain that the company will do better this year.

Nearly everything of value has been disposed of by the Arcadian, and it will be a long time before it again receives attention, if ever. Quincy has made many improvements in its equipment, at mine, mills and smelter, and should decrease its copper cost henceforth. No. 8 shaft, on the Mesnard property, will be in a position to furnish a good product toward the close of 1905, as No. 4 shaft is greatly improved.

Isle Royale's prospects have been greatly improved by the openings on Section 11, where a new shaft has been opened to a depth of 130 ft. Production at that point begins shortly, but will not be large for a year or more.

Atlantic has confined its work to the more profitable stretches of ground and is not making so much copper as a consequence, though the yield per ton treated has improved. The prospects are that the Atlantic has a good mine in Section 16, which should receive attention next summer. Development work on all sides of this property is encouraging.

The Superior Copper Co., a new concern, is down about 90 ft. It is the purpose of the management to cross-cut the formation in both directions to ascertain whether the shaft is on the east or west vein of the Baltic lode.

Baltic is now operating normally and is making its copper as cheap as the majority of the mines in the district. Trimountain is improving perceptibly and its outlook is very encouraging; work has been retarded by the change in mining methods. Champion has ample drill capacity now and is pushing the development of its ground. It is enlarging its mill and the addition should be completed next summer.

The St. Mary's Mineral Land Co. has become active in exploration work and is sinking a drop shaft on the Challenge property, south of the Globe. After a good depth is reached, cross-cuts will be extended to cut the lodes which were located with the diamond drill, one of which is thought to be the Baltic.

The Elm River is still exploring, work being confined to No. 1 shaft. There have been efforts made to float the Kaukauna, adjoining, but no active work has resulted as yet. Wyandot is investigating a new bed uncovered in the Misery river; a shaft is being opened on this formation with good promise.

The Winona management has conducted a careful mill-test, and is satisfied that the property has promises of making a valuable mine.

Adventure is making a better showing. Its output has been increased gradually during the past six months and it is now making a profit. Attention is being given to the Evergreen lode, which heretofore has not been opened much, though it is prolific in mass copper and good stamp rock at the Mass.

New life seems to have been given the Mass, which is prosecuting a vigorous campaign of development in the two older shafts, and at the third shaft, where work was resumed recently. Openings in the third shaft are particularly inviting and promise well.

The Michigan is utilizing one head at the Mass mill and developing its ground in good shape. The Branch vein and Calico lode are doing nicely and the property is making a good profit. The Victoria is confined to surface work, the development of the mine having reached a point which will enable rock shipments for five years without another foot of exploration. A stamp-mill is being constructed out of the salvage of the old Belt mill, which was purchased last summer. The Copper Crown Mining Co., of St. Louis, Mo., has a number of men at work on the Hamilton, where the prospect is said to be hopeful.

Montana. (By B. E. St. Charles.)—The mining companies and individuals owning mines in Montana had a prosperous year in 1904. Except the Gagnon, Pennsylvania and Parrot, all the large properties in the Butte district were operated continuously, and the copper-silver mines extensively. The Gagnon was closed three months, the Pennsylvania five weeks, and the Parrot three weeks, to permit of needed repairs in the shafts. Some changes in the ownership of property took place; the Amalgamated company bought the Taylor & Brunton sampling works at Butte, and the Indian Queen group of mines and smelter, in Beaverhead county; the Speculator bought the Jesse from the Lewisohn estate for $300,000; the Butte Copper & Zinc Co.

acquired the Emma mine; and the United Copper, or Heinze interest, took an 18 months' lease-and-bond on a portion of the Lexington. Several new companies were organized, among them Butte Copper & Zinc, Raven and Ada. The Amalgamated closed its Colorado smelter, but operated the Washoe, Butte & Boston, and Great Falls plants continuously.

Omitting the product of the mines worked by lessees and small companies, which aggregated 250 tons per day, the total quantity of ore shipped by the Amalgamated, United Copper, Speculator and Clark mines aggregated 4,106,650 tons, of which the Amalgamated is credited with 3,217,400; United Copper, 438,000; Clark, 360,000; and the Speculator, 91,000.

Amalgamated, which comprises the Anaconda, Boston & Montana, Butte & Boston, Parrot, Colorado, and Washoe, used 53,000,000 ft. of lumber, exclusive of round timbers and lagging poles. The shaft of the Anaconda was sunk 200 ft., making it 2,400; the Parrot, 100 ft., giving it a depth of 1,700 ft.; and the Never Sweat 200, making it 2,200 ft. The Mountain View was equipped with a hoisting engine to work to 3,000 ft. The orebodies in the lower workings of all the Amalgamated mines open up well and promise a very large yield during 1905. The company employs 6,870 men in Silver Bow county, paying them $1,000,000 per month in wages.

The United Copper, comprising the Montana Ore Purchasing, Johnstown, Cora-Rock Island, Hypocka, and Basin Reduction companies, made average monthly shipments of 30,000 to 35,000 tons. By assignment from Adolph Victor, of New York, this company secured a lease-and-bond on part of the Lexington property; but the workings will have to be unwatered below the 550-ft. level before work can begin. The shaft on the Lexington is 1,465 ft. deep; and the openings below the 550-ft. level are very extensive. The Lexington company has been mining its copper vein and will continue to do so during the life of the bond; it is now extracting 50 tons of ore per day.

W. A. Clark mined and treated 30,000 tons per month, producing 21,000,000 lb. copper. He has employed 1,000 men, to whom he paid $100,000 per month. At the smelter, the blister-copper furnace was closed several months ago, but three converters will take its place in the spring. The larger part of the ore came from the Original and West Steward mines. The vein of the former is 27 ft. wide at 1,800 ft.—the deepest workings.

The shaft of the Reins Copper Co. was sunk 400 ft. and opened up an 8-ft. body of copper-silver ore at the 800-ft. level. This property is likely to be a heavy producer in 1905. The Speculator maintained an average output of 250 tons of ore per day with 250 men. The shaft was deepened 200 ft., making the total 1,600 ft.; the Jesse vein was cut by a crosscut at the bottom. The product was sold to the Amalgamated. The Raven company, organized a few months ago, has struck a new shoot of copper-silver ore in the 700-ft. east level. Shipments for the year averaged 60 tons per week.

The Pittsburg & Montana Co. has pushed development work; 300 ft. was added to shaft No. 3, making it 1,200, and a cross-cut on this level 2,150 ft.

long connected shafts 2 and 3, intersecting several of the Amalgamated's large copper-silver veins. The smelter was given a test run of two weeks and many surface improvements were made. The company expects to commence making copper April 1. The smelter will have a capacity of 400 tons of raw ore per day.

The Indian Queen Co. shipped matte from which 576,000 lb. copper was extracted. The Amalgamated now owns this property and intends to develop the mining claims on an extensive scale; but the smelter will not be utilized, as it has a capacity of only 30 tons per day. The purchase price was $125,000. The property includes, besides the blast furnace and water rights, three mining claims on Birch creek, Beaverhead county, 50 miles southwest of Butte. The ore carries copper, silver and gold, the copper value predominating. With the exception of about three months, the Indian Queen had been operating the mines and smelter continuously since July, 1903, turning out about $120,000 worth of matte, assaying on an average 54% copper.

The Cataract Copper Co., owning property on Jack creek, Jefferson county, completed its smelter, but did not operate more than two months on account of the expense attached to securing supplies from the railroad, eight miles distant.

A new copper district is being opened up in the main range of the Rocky mountains, seven miles southeast of Butte. Prospecting has been in progress there for years, but it was not until recently that substantial discoveries were made. Shipments of ore carrying a small percentage of copper, and from $20 to $30 in gold per ton have been made.

The Amalgamated Copper Co. has, for the first time in its existence, made public a statement of its standing, withholding, however, all information as to its current earnings. Its balance sheet on April 29, 1905, stood thus:

ASSETS.		LIABILITIES.	
Investment in securities, etc.	$154,281,303	Capital stock outstanding	$153,887,900
Office furniture	2,500	Acounts payable	21,070
Loans to Washoe Copper Co.	7,350,000	Dividends payable May 29, 1905	1,538,879
Cash and cash assets	2,756,759	Surplus and reserve	8,942,712
Total assets	$164,390,562	Total liabilities	$164,390,562

The following is an abstract of the report:

The Amalgamated Copper Co. was organized in April, 1899, with a capital stock of $75,000,000. For three months prior thereto copper was selling at between 16c. and 17c. per lb., and there was no accumulation of stocks in the hands of the producers. Scarcely any new discoveries of copper had been made in the United States for several years, and the most experienced observers of the market were of the opinion that the price of the metal would not again fall under 14c. per lb. until new and extensive sources of supply were developed.

During the last eight months of 1899 and throughout 1900 the company was able to sell its product at over 16c. per lb. Dividends at the rate of 1.5% regular and 0.5% extra were paid quarterly from October, 1899, to October, 1901, when the rate was made 1.5% for the quarter. In January, 1902, a dividend of 1% for the previous quarter was paid, and from May, 1902, to January, 1905, quarterly dividends of 0.5% were paid. In January, 1905, the dividend rate was increased to 1%. The average rate of dividends for the total period from October, 1899, to June, 1905, has been 3.875% per annum.

In 1901 the authorized capital stock of the company was increased to $155,000,000, and the new stock was issued for that of the Boston & Montana and the Butte & Boston companies. This has proved to be a very advantageous investment.

In 1901 and 1902, in order to reduce to a minimum the cost of production, a new concentrating and smelting plant was erected at Anaconda, at a cost of over $8,000,000. This is now the most complete and up-to-date copper reduction works in existence, and has been the means of effecting great savings in the cost of production. At these works are treated the ores of the Anaconda, Washoe, Parrot, Colorado and the Butte & Boston mining companies. The ores of the Boston & Montana Co. are treated in its own smelter at Great Falls.

What is known as the law of the apex has given rise to a vast amount of litigation, by which the Amalgamated company has been harassed on an enormous scale, having had to contend constantly with this and other litigation to preserve its existence. The heavy expenses incurred in this litigation and the cost of building the new reduction works, opening and developing new coal mines and making settlements for damage claims, have been paid entirely out of earnings.

The company owns the entire stock of the Washoe Copper Co., the Colorado Smelting (now the Trenton Mining & Development) Co. and the Big Blackfoot Milling Co., all but a few shares of the Boston & Montana and Butte & Boston companies, and a majority interest in the Anaconda and Parrot companies. The Big Blackfoot Milling Co. owns more than 1,000,000 acres of timber lands (upon which there is estimated to be over 4,000,000,000 feet of standing timber) and saw-mills turning out 5,000,000 feet of lumber per annum.

The company also owns all the stock of the Diamondville Coal & Coke Co., which mines and ships 600,000 tons of coal per annum, and its mines in Wyoming are estimated to contain an available supply of 73,500,000 tons. Through its ownership of all the Washoe Copper Co. stock, the company holds 1,900 acres of the Bear Creek coal lands in the vicinity of Red Lodge, Mont., and also all the coking coal property at Storrs, Mont., now under development, as well as a controlling interest in the Cokedale Coal Co., owning coal lands and a plant which is equipped with 100 coking ovens. From the Anaconda company's coal lands at Belt, Mont., are mined and shipped

375,000 tons of coal per annum. It also owns 27,000 acres of timber lands. Its saw-mills in Hamilton, Mont., turn out 30,000,000 ft. of lumber annually.

The principal asset of the company consists in the ownership, through the companies above mentioned, of copper mines, the value of which is largely dependent upon the duration of their productiveness. The mines look as well at the present time as at any period of the company's existence, and there are no indications that they have not a long productive life before them.

The companies, owned wholly or in part by the Amalgamated company, in 1904 produced 252,000,000 lb. of refined copper (including only a small amount of custom ore). Of this amount the Amalgamated company received the benefit from 202,000,000 lb., which is about 25% of the total production of the United States. As the outstanding capital stock of the company is $153,887,900, each pound of copper produced is capitalized at 76c. per pound, without taking into consideration any earnings from other sources than mining. By comparison with the oldest and most conservative copper companies, it will be found that the Calumet & Hecla company's stock, selling at a market valuation of about $64,000,000, and producing annually 80,000,000 lb. of copper, has a market capitalization of 80c. per pound of copper produced; and that the Rio Tinto company, having a market valuation of about $125,000,000 (including stock and bonds) and producing annually refined copper and copper in pyrites amounting to 80,000,000 lb., has a market capitalization of $1.56 per pound produced.

New Mexico.—No important copper-producing district has yet been developed in this territory, but there is a production from many small mines, which in the aggregate is considerable. The mines of the Santa Fé Gold & Copper Co., at San Pedro, Santa Fé county, were idle in 1904, being incapable of profitable operation except at a high price for copper.

Tennessee.—The Ducktown district is the producing center of Tennessee and is occupied by two large companies, the Tennessee Copper Co. and Ducktown Sulphur, Iron & Copper Co. The Tennessee Copper Co. is changing its reduction process from heap roasting to pyrite smelting, and this disorganization caused a diminution in the output for 1904, as well as a temporary increase in the cost of production. When finished, the new plant will consist of seven furnaces, affording a capacity of 600,000 tons of ore a year. The furnace gases may be utilized in making sulphuric acid, a plant for which, having an initial capacity of 400 tons of acid a day, is now under consideration.

In order to clear up the accumulation of roasted ore in the heaps, mining was allowed to relapse to the actual daily needs of the new process, and yard roasting was definitely discontinued on April 1. Development, however, was pushed actively, and resulted in the enlargement of ore reserves by 650,000 tons. The average number of men employed throughout the entire year was 721, of which number 261 worked in the smelter and 162 in the mines.

The amount of ore raised from the three mines was 144,799 tons, three-fifths of which came from the Burra Burra mine, as compared with 287,465 tons, the total for the previous year. This was drawn mainly from old stopes and was distributed as follows: 63,784 tons to roast heaps prior to April 1; 57,559 tons raw ore direct to smelter; 23,456 tons stored as reserve of raw ore for smelter.

Two furnaces were in blast up to April 1, when the third was blown in and all three continued for the rest of the year. The charge smelted during the year was as follows:

	Tons.
Roasted ore, equivalent to 185,446 tons of raw ore	166,901
Raw ore	54,870
Silicious ore	1,539
Custom ore	2,695
Converter slag	21,119
Blast-furnace by-products	22,567
Blast-furnace flue-dust briquettes	7,150
Quartz flux	32,972
Matte re-smelted	5,350
Total	315,163
Coke used	34,053

This comparatively small tonnage, as compared with 284,202 tons of raw ore put through by two furnaces in the previous year, was accounted for by a slightly increasing refractoriness of the ore, by a preponderance of fine stuff from the clean-up of the roast yards, and by the fact that the capacity of a furnace is less when running on raw ore than when on roasted ore.

Utah. (By L. H. Beason.)—Bingham continued to be the only important copper-producing district of this State. It produced during the year close to 1,000,000 tons of ore. The Utah Consolidated, which owns the original Highland Boy mine, leads in output and in dividends. Up to July this company sent to its smelter, near Murray, about 500 tons per day, but since that date, owing to an enlargement of the smelter, the output has been 700 tons per day. The year's output is about 15,000,000 lb. copper bullion; but, with additional facilities, the production is now 50,000 lb. daily. At the mine the policy has been to keep development far in advance of extraction. The United States Mining Company has turned out between 11,000,000 and 12,000,000 lb. copper from the smelting of its own and custom ores. Difficulties in operating the smelter at Bingham Junction have been practically overcome; plans, outlined some time ago, to enter the lead smelting business in competition with the American Smelting and Refining Company are about to be carried into execution. A lead smelter of 400 tons capacity has been completed. Developments in the mines owned by the company have been most satisfactory. Heavy shipments have been made from the Centennial-Eureka mine, the control of which is in the hands of this company. The main shaft is being sunk to open up the orebodies under the present lowest workings. An equally energetic campaign is being pushed in the Bingham properties. A case involving title to the Kempton lode was decided in favor of the company by the United States Court of Appeals in November. If sustained by the United States Supreme Court, possession to valuable territory will be obtained. The Mammoth mine, in Shasta county, California, was purchased; it is to be provided with a smelter. The Yampa mine, situated in Upper Carr fork of Bingham, near the Highland Boy, has been vigorously developed, with results so satisfactory as to warrant the manager, Walter S. Kelley, in enlarging the smelter at Lower Bingham. This is the only smelting plant operated in the Bingham district. As originally planned, the plant was to consist of one roaster and one blast-furnace; but it was found that the ore was not suited to blast-furnace treatment, by reason of the fine. Therefore, the plant was completely overhauled and, at great expense, new equipment has been installed. This consists of a second blast-furnace, a reverberatory, also a roasting furnace of large capacity. When the new equipment is ready (in February) the capacity will be 600 tons of ore per day.

The Utah Copper Company has achieved success with the low-grade ore of the Bingham 'porphyry' belt. In April a new 400-ton concentrating mill, of very efficient design, was placed in commission. It has proved so successful that additional equipment was provided, increasing the capacity to 700 tons per day; the enlarged plant was started in October. Concentration is in the ratio of 22 to 1, making a 33 to 35 per cent copper product, besides $5 in gold and a little silver. Another mill is to be built, with four units of 600 tons each, so that the company will be able to treat 3,000 tons of ore daily. The Utah copper mine is now the largest in the State. New workings aggregate 22,000 ft. The surface is being stripped over a large area, preparatory to quarrying ore on an extensive scale. The output for 1904 was 126,000 tons of ore.

The Bingham Consolidated increased its output of copper by 3,000,000 lb., making 11,500,000 lb. A new furnace has been added to the smelter. By an arrangement with the American Smelting and Refining Company, a part of its copper ore is secured; the smelter trust, in return, receives the Bingham's lead-silver ore. The Dalton & Lark mine, owned by this company, has made a fine showing. On the 1,150-ft. level an ore-body has been cut, averaging 7 per cent copper and 60 oz. silver; at present the output is 200 tons per day. Another property, the Eagle and Blue Bell mine, in the Tintic district, supplies the smelter with 75 tons of ore daily, while the Commercial mine, at Bingham, contributes 200 tons. From the company's own properties the smelter is supplied with 15,000 tons monthly, besides 5,000 tons of custom ore.

Adjoining the Utah Copper is the Ohio Copper Company, which purchased the holdings of the Columbia Copper Mining Company at Bingham. Developments have demonstrated that this property will soon become one of Bingham's most important producers. The company leased the old Winnemuck mill, remodeled it, and now treats 120 tons of ore per day. In November the Winnemuck mill and mine were purchased by the Ohio Company; additional equipment has been put in, so that an output of 200 tons per day can be handled. The erection of an entirely new plant is contemplated, with a capacity of 500 tons. The Ohio properties are capable of furnishing a big tonnage, the ore averaging 5 per cent copper. This company also owns a large area of the copper-bearing porphyry which is being worked so successfully by the Utah Copper Company.

The Boston Consolidated sent 40,000 tons to the Bingham Consolidated smelter. This company also owns a large slice of the porphyry belt, and a concentrating mill is under consideration. The output from the Boston will be greatly increased during 1905. It has been estimated that there are over 2,000,000 tons of ore available, carrying from 3 to 6 per cent copper, $3.50 in gold and some silver. The Bingham-New Haven is a new enterprise. The Utah-Apex is conducting an extensive campaign of development. An adit 3,000 ft. long will tap the orebodies at a depth of 1,000 ft. The New England Gold and Copper Company has operated a 50-ton concentrator with success, and the development of the mine justifies further enlargement, which is contemplated.

Bingham's ore deposits will inevitably give Utah an increasing importance as a copper producer. They are large, and although of low grade, they are capable of advantageous treatment in connection with the higher grade silicious ores, so abundant in neighboring regions, particularly at Tintic. Smelted by themselves, Bingham ores will never be profitable.

In Beaver county the Newhouse Mines & Smelters Corporation has expended $2,000,000 on the Cactus mine. The first 800-ton unit of a concentrating mill is nearing completion. An extension (7½ miles long) of the San Pedro, Los Angeles and Salt Lake Railroad from Frisco was completed in September. A model town has been built; it is supplied with water through a large pipe line from Wah Wah springs, 9 miles distant. An adit 5,980 ft. long is nearly finished; this will connect with the 600-ft. level of the mine and will serve as the exit for all ore going to the mill. The Cactus milling ore carries from 3 to 6 per cent copper, the concentration being about 6 to 1. The Majestic Copper Mining & Smelting Company has survived its financial troubles and is pushing exploration with satisfactory result. A concentrator for the output of the O. K. mine is also likely to be built shortly.

Wyoming.—There was a marked improvement in copper production in Wyoming in 1904; the yield, amounting to 4,220,000 lb., is the greatest ever recorded. Nearly the whole of the copper ore produced in the State is now smelted locally. The North American Copper Co., in the Encampment district, has been the chief producer. Its mine, the Ferris-Haggerty, has being extensively developed, but has never given financial success, owing to mismanagement. In the spring of 1905, the company was reorganized as the Penn-Wyoming Copper Co., additional capital was secured, and extensive plant and equipment were installed. Promising copper mines are being opened at Hecla, near Cheyenne, and the erection of a small matte furnace in this locality is under consideration. The copper resources of the State have been described by H. C. Beeler, State Geologist.

THE WORLD'S COPPER PRODUCTION, 1901-1904. (a)

Countries.	1901.		1902.		1903.		1904.	
	Tons of 2240 Lb.	Metric Tons.	Tons of 2240 Lb.	Metric Tons.	Tons of 2240 Lb.	Metric Tons.	Tons of 2240 Lb.	Metric Tons.
Argentina	780	793	240	244	135	137	155	157
Australasia	30,875	31,371	26,640	29,098	29,000	29,464	34,160	34,706
Austria-Hungary	1,335	1,356	1,600	1,626	1,385	1,407	1,450	1,473
Bolivia	2,000	2,032	2,000	2,032	2,000	2,032	2,000	2,032
Canada	18,282	18,575	17,485	17,765	19,055	19.360	19,183	19,490
Cape of Good Hope — Cape Co.	4,000	4,064	2,750	2,794	4,630	4,704	5,475	5,563
Cape of Good Hope — Namaqua	2,400	2,439	1,700	1,727	600	610	2,300	2,337
Chile	30,805	31 299	28,930	29,373	30,930	31,424	30,110	30,592
Germany—Total	21,720	22,069	21,605	21,951	30,714	31,214	29,778	30,262
(Mansfield)	(18,780)	(19,082)	(18,750)	(19,050)	(19,593)	(19,810)	(19,265)	(19,578)
Italy	3,000	3,048	3,370	3,424	3,100	3,150	3,335	3,388
Japan	27,475	27,916	29,775	30,251	31,360	31,861	34,850	35,408
Mexico—Total	33,813	33,943	35,785	36,357	45,315	46,040	50,945	51,760
(Boleo)	(10,783)	(10,956)	(10,785)	(10,958)	(10,315)	(10,480)	(10,945)	(11,120)
Newfoundland	2,756	2,800	2,860	2,906	2 710	2 753	2,200	2,235
Norway	3,375	3,429	4,565	4,638	5,915	6,010	5,415	5,502
Peru	9,520	9,673	7,580	7,701	7,800	7,925	6,755	6,863
Russia	8,000	8,129	8,675	8,814	10,320	10,485	10,700	10,871
Spain-Portugal—Total	53,621	54,482	49,790	50,587	49,740	50,536	47,035	47,788
Rio Tinto	35,348	35,916	34,480	35,032	35,810	36,382	33,480	34,016
Tharsis	7,427	7,546	6,710	6,817	6,320	6,421	5,620	5,710
Mason & Barry	3,729	3,789	3,330	3,383	2,430	2,469	2,950	2,997
Sevilla	1,292	1,313	1,545	1,570	1,105	1,123	1,330	1,351
Sweden	450	457	455	462	455	462	533	542
Turkey	1,639	1,665	1,100	1,118	1,400	1,422	950	965
United Kingdom	532	541	480	488	500	508	500	508
United States	271,949	276,300	288,342	292,955	319,043	324,148	372,233	378,189
Totals	528,327	537,381	537,727	546,331	596,107	605,645	660,062	670,631

(a) The figures in this table are taken from the annual metal circular of Henry R. Merton & Co. except where returns have been received by THE MINERAL INDUSTRY direct from official sources.

COPPER MINING IN FOREIGN COUNTRIES IN 1904.

Africa.

Algeria.—A rich vein of copper has been discovered in Algeria, near Aïn-Sefra. Researches have shown that 600,000 tons of ore are available. The great drawback to successful working is the price of coal in this district—viz., 75 frs. ($15) per ton. To the north and west of Aïn-Sefra, copper, iron and lead have been discovered, and there are indications of the existence of zinc. The discovery of this mineral wealth may lead to the early construction of a railway from the port of Bône to Aïn-Sefra.

Congo Free State.—Copper has been worked by the natives of the Congo Free State since an early period. Their chief workings are at Katanga, Yambingo, and Mboko-Songo. The most promising deposits are at Katanga, which is situated in the extreme southern part of the State, and about 200 miles west of Lake Bongweolo. Some of the ore from this district assays up to 20% copper.

German Southwest Africa.—The existence of valuable copper deposits in the Otavi district has been disclosed by the prospecting operations carried out by the Otavi Mining Co. The unsettled condition of the country and the absence of suitable labor prevent any extensive mining operations.

Natal.—Development was continued during 1904 on the Goodricke mine in the Umsinga district, but did not result in disclosing any orebodies of importance. Promising deposits containing native copper were located on the Buffalo river, in Zululand.

Rhodesia.—Copper deposits occur in many parts of Rhodesia. In the north, the Northern Copper Co. and the Rhodesia Copper Co. own extensive deposits. Promising showings occur in Le Mogundi, Umtali and Victoria districts of Southern Rhodesia. The South Africa Chartered Co. proposes to operate its copper mines in the Victoria district, a short distance north of the Victoria Falls of the Zambesi river, by electric power obtained at the falls from a plant similar to the one at Niagara.

South Africa.—The copper production of South Africa comes from the mines in Little Namaqualand. These are owned by two English companies, and yield about 7,000 tons of copper per year. They are situated 100 miles from the west coast, and 300 miles north of Cape Town. A railroad connects them with Port Nolloth, a seaport a few miles south of the mouth of the Orange river. The ore consists mainly of chalcopyrite and bornite. The Ookiep mine is the richest, its ore averaging 21% Cu. The Nababeep mine yields 7% ore.

The ores occur[1] in a region of old gneisses and schists, crossed by two series of fractures, running in an easterly direction and dipping gently to the north. One set of fractures is barren; the other is in the form of diorite dykes, carrying copper as a constituent. At the intersection of the two systems the ore has been concentrated as irregular replacement orebodies, often of great size, composed of bornite and chalcopyrite.

Australasia.

New South Wales produced in 1904, from its own mines, 6,549 long tons of ingot copper, besides 2,358 tons of ore, having a total value of $2,101,935. This diminished value, as compared with the $2,313,200 copper output of 1903, was due to suspension of operations by the Lloyd Copper Co. at Burraga, from July to December, owing to its inability to make a profit out of its increasingly low-grade ore. Development was continued, however, during these five months, with such success that mining was resumed in 1905. During the year ending June 30, 1904, the company treated 56,820 tons of

[1] Walter Harvey Weed, 'The Copper Deposits of Cape Colony.' The Engineering and Mining Journal, February 9, 1905, p. 272.

ore, by concentrating, roasting, and smelting, then roasting the matte to blister copper, to recover 1,596 tons refined copper, at a cost of $6.90 per ton. The Cobar district produced 3,825 tons, mainly from the Cobar and Nymagee divisions, a slight excess over its previous year's output. The Great Cobar mine, which contributed the larger part of the output, during the year installed a new crushing plant, having a capacity of 120 tons per hour; a new furnace, 17.33 by 3.75 ft. at the tuyeres, and additional plant. The shaft was deepened to 1,050 ft. The Great Cobar Copper Syndicate has bought the Chesney mine, and is extracting 650 tons per week, with the ready possibility of doubling this output. The successful development of the Queen Bee mine, 16 miles from Cobar, is the most striking feature of the year. The shaft has reached 350 ft., and ore has been proved to this depth for a distance of 400 ft. From the 1,291 tons of ore raised, 206 tons of copper were recovered. In the Nymagee division, the Crowl Creek Co., at Shuttleton, erected a plant and refinery during the year. A depth of 450 ft. in good ore has been reached, and copper to the value of $174,000 was obtained.

An attempt was made recently to reopen the Woolgarlo copper mine in the Yass district, but the condition of the financial market was unfavorable. The mine has the distinction of being the first copper property opened in Australia, and was worked in 1867 by an English company; it is now owned in Sydney. The mine has an area of several thousand acres. Numerous copper lodes have been opened on it, and one of them is over a mile long, with an average width of six feet. It carries 3.5 to 12% copper, with a little silver and gold, its gangue being chiefly quartz, with large pockets of fluorspar carrying rich copper carbonates, besides lead and silver. The Yass river runs through the center of the mining area and affords a permanent supply of water. The Woolgarlo mine is considered one of the largest and most valuable copper properties in Australia, and when reopened it will quickly become a producer.

Queensland showed a slight falling off in copper production in 1904. This was largely due to an unfavorable financial attitude toward the development of new fields. The Walsh and Tinaroo field is the chief producer The Chillagoe company carried on a considerable amount of development work, and benefited by its policy of leasing areas of its mineral ground. By this means, supplies of ore for the furnaces were augmented, and a large amount of effective prospecting was done with small expenditure. The company's Redcap, Ruddygore and Zillmanton mines were the largest contributors to the smelters, which produced 1,313 long tons of copper, valued at $387,415 (£77,483).

The O. K. mine is opening up well, and its owners, toward the end of the year, completed the erection of a 100-ton water-jacket smelter. This property promises to yield well during 1905. A new 80-ton smelter has been installed at the Mount Malloy mine. During the year it produced 132 tons of copper from 1,200 tons of ore. It has been decided to treat the Tartana orebody as a whole, without selection, and it is proposed to mine 150 tons of pyritic ore weekly, rejecting 100 tons for atmospheric oxidation, and to quarry 1,000 tons of oxidized ore per week for leaching in vats. The New Moonta mine, at Mount Perry, is yielding ore assaying 11% copper, besides gold and silver. The returns for 1904 were 1,447 tons of copper, 73,788 oz. of silver and 1,604 oz. of gold, from 9,805 tons of ore.

The raising of ore rich enough to bear the cost of conveyance to the smelters on the coast still constitutes all the mining attempted at Cloncurry. In 1904 the field's output was reported as 1,336 tons, valued at $117,800 (£23,560).

The smelter at the Mount Morgan mine yielded 290 tons of copper, and 167 tons were obtained by precipitation from mine water. During the year diamond drill bores in the lower levels disclosed large auriferous copper orebodies estimated to contain upward of a million tons averaging 3½% copper and 8 dwt. of gold; also an equal quantity of lower grade ore containing a pay margin.

Tasmania has widely distributed copper deposits, and in the northwest about a dozen small mines are being developed. The chief producer, however, is the Mount Lyell Co., whose operations are an excellent indication of the way in which careful management can earn profits with a low-grade property. Its smelting operations are exemplary in their economy and efficiency.

The ore supply is derived from two mines, Mount Lyell and North Lyell, the former yielding 140,113, and the latter 51,584 tons during the six months ending September 30, 1904. No exploration is being done in Mount Lyell, but in the newer mine 1,759 ft. of drifts, 353 ft. of shafts and raises, and 435 ft. of diamond drill holes were accomplished during that period. The entire output from the older mine is won by open-cut work, at a cost which is a potent factor in the profitable handling of the ore. The cost of mining, handling and treatment has been reduced to $3.35 per ton.

The reduction method employed is the outcome of Mr. Robert Sticht's experience with pyrite smelting, and is fully described in THE MINERAL INDUSTRY, Vol. XII, pp. 117-118. The pyrite analyzes: Fe, 40.3; SiO_2, 4.4; $BaSO_4$, 2.5; Al_2O_3, 2.0; S, 46.5%, and carries about 2.1 oz. silver, less than 0.1 oz. gold, and of copper, 1% in Mount Lyell and 6.2% in North Lyell, averaging, when mixed, ready for charging, about 2.4%. Small amounts of silicious fluxing ores, carrying low values, are obtained from other sources, and a little copper-bearing clay for briquetting the flue dust. The mine produces between 9,000 and 10,000 tons of copper per annum, in addition to large quantities of silver and gold.

During the year the company purchased the Lyell Tharsis mine, and commenced the erection of a sulphuric acid and fertilizer plant near Melbourne, Victoria.

Europe.

Germany.—The center of the copper mining industry for 700 years has been Mansfeld. The mines in the early days were worked by the counts of Mansfeld, but in 1852 they were acquired by the present owner, the Mansfeld Kuperschieferbauenden Gewerkschaft. This company's mines and works now give employment to 20,000 men. The ore occurs in a bituminous, black marl-shale. Copper and silver sulphides are distributed in finely divided particles throughout the ore. The average tenor is 2 to 3% copper.

In 1904, the production of copper ore in Germany amounted to 798,214 metric tons, and of copper bullion, 30,262 tons, worth $9,076,000, besides black copper and matte to the value of $76,250. Of copper sulphate, 6,584 tons were made. The corresponding figures for 1903 were: Ore, 772,695 tons; bullion, 31,214 tons ($9,460,250); black copper and matte, $63,750; sulphate, 5,200 metric tons.

Imports and exports of copper in Germany in the last two years were as follows, in metric tons:

	1903.	1904.
Imports	83,261	110,231
Exports	4,333	4,223
Exccss, imports	78,928	106,008

Imports of copper ore were 13,914 tons in 1903 and 7,949 tons in 1904. Exports of copper ore were 15,986 tons in 1903 and 19,235 tons in 1904, an increase in exports, but a decrease in imports.

Norway.—Many of the Norwegian copper mines are within the Arctic circle. The Sulitjelma mine is the largest, giving employment to 1,500 men and yielding about 60,000 tons of 4% ore annually. An English company is operating several mines at Kjoli and Röros.

In 1903 Norway mined 35,417 metric tons of copper ore, averaging about 5% copper, and made 1,383 tons of copper, worth $391,500, showing a decrease in ore, but an increase in metal as compared with previous years. Exports of copper ore in 1903 decreased to 3,448 tons, while metal increased to 1,930 tons, showing a decided growth of the copper smelting industry. Norway imports no copper ore, and only about 1,000 tons of metal per year.

Spain.—The copper mining industry is chiefly confined to the famous Huelva district, where the Tharsis and Río Tinto companies are operating on an extensive scale. The Huelva deposits consist in the main of pyrite and chalcopyrite, occurring in lenticular masses ranging up to a mile and a half long and from 65 to 500 ft. wide. They are estimated by Gonzalo[2] to contain over one billion tons of ore. The mineral belt is about 20 miles

[2] Gonzalo y Tarin, "Descripcion Fisica de La Provincia de Huelva," *Descripcion Minera*, Vol. I, 1886; Vol. II, 1888. See also J. Gregory, "Rio Tinto," THE ENGINEERING AND MINING JOURNAL, February 23, 1905.

wide, and crosses the northern part of Huelva from east to west. It consists of Silurian and Carboniferous rocks traversed by many parallel intrusions. The Tharsis orebodies are contained wholly within the Silurian strata, and those of Rio Tinto are in a quartz-porphyrite.

The ore in the Tharsis mine averages 3% copper, 45% iron and about 50% sulphur. It is chiefly treated by leaching with water and precipitating with pig iron in creosoted timber sluices after the sulphide has been oxidized to sulphate by exposure to the atmosphere. In 1904, the mine produced 5,620 tons of fine copper.

The Rio Tinto company, of London, owns the Rio Tinto mines, and gives employment to more than 1,100 men. It is the largest and most important copper mining company outside of the United States. The company reports that during 1904 gross profit from the sale of produce amounted to £1,667,530. After allowing for expenses of administration, taxes, debenture interest, depreciation, etc., the net divisible profit was £1,242,252. Out of this £77,000 went to preference shareholders, and £1,170,000 as ordinary dividend, being at the rate of 70%. Nothing is placed to reserve fund this year, but as this fund now stands at half a million pounds, and as the heaps of ore are sufficient for five years' supply at the present rate, it is hardly necessary to augment it. The produce of pyrites during the year was 1,948,819 tons, of which 1,276,475 tons were treated locally for copper, and 672,344 tons were sold to chemical manufacturers in England, Germany and America. It is interesting to note that 144,484 tons went to America. The average copper contents of all the ore was 2.34%. In addition to this copper-bearing ore, 157,810 tons of barren ores were sold for their sulphur contents alone. The production of copper during the year was 21,218 tons locally, and the ore shipped to chemical manufacturers contained 12,260 tons of copper. The company is starting to make superphosphates on the spot, and is now erecting a sulphuric acid plant in which it will employ its barren ores.

Sweden.—The principal copper mines in Sweden are near Falun. The ore is chiefly chalcopyrite, which occurs in lenticular veins in schist. The Falun mines are celebrated, and have been worked for more than 600 years. In 1904 Sweden mined 36,834 metric tons of copper ore, a slight increase over 1903; and made 533.4 tons of copper, worth $158,552, and 1,248.3 tons of copper sulphate, worth $109,539. During 1904, 383 new licenses were granted for copper mining.

Asia.

Japan.—The copper resources of Japan are important. In 1904 production amounted to 34,850 tons, which was exceeded only by the United States, Mexico and Spain. The ancient mines of Ashio and Besshi are now equipped with first-class mining and smelting plants. During the year a number of the small producers were concentrated in a few hands. Japan is usually an exporter of copper, especially to China, but the war caused such a demand for copper goods that last year the whole production was absorbed by home needs. The expected commercial revival after the war will probably attract greater attention to the development of copper mines.

The Ashio mine, owned by the Furukawa Copper Co., of Tokio, is now down 1,200 ft., and its ores give a smelter return of about 4% copper, with a little silver. Two 3-mile aerial tramways, powered by a Pelton plant, give exit. There are five hydro-electric plants furnishing power. Electric haulage is usual; power drills are used exclusively. The crude ore is put through a dressing works, and concentrated about 4 into 1, the product sent to the smelter having about 15% copper. The smelter, completed in 1904, with 750 tons daily capacity, comprises three water-jacket furnaces, two converter stands, traveling crane and all modern devices. Employees number 12,000. The output in 1904 was 14,622,000 lb. bessemer copper.

The Besshi mine, owned by the Sumitomo Copper Co., of Osaka, is situated in the Ehimé district of Iyo province, in the northwest part of Shikoku, and is the second largest producer in Japan. Its output in 1904 was about 11,000,000 lb., and it gave employment to over 5,000 persons. A 200-ton smelter and electrical equipment are of modern design. The ore is chalcopyrite, with a great amount of pyrite and lesser proportions of lead, cobalt, manganese and arsenic, the ore averaging about 6% copper.

The total production of the empire, in long tons, has been: 1900, 23,928; 1901, 26,954; 1902, 28,569; 1903, 32,713; 1904, 34,850.

Java has been known for many years as possessing some valuable copper deposits, but few efforts have been made to turn them to commercial account. In 1904, a Dutch company did some development in Poronogo, with satisfactory results. Poronogo is near Soerabaia, in eastern Java. The copper occurs in a fissure vein 6 ft. wide. It has been opened by tunnels which expose about 500,000 tons of ore. A trial shipment to Europe amounting to 200 tons assayed: Iron, 12 to 22%; lead, 4 to 22%; zinc, 14 to 20%; copper, 1 to 5%; silver, 1 to 2 oz., and a trace of gold. The facilities for mining the ore are good, but the company is troubled by the metallurgical problem presented.

Canada and Mexico.

Canada.—The development of the Canadian copper fields resulted in a fair increase in production. The Ontario mines showed a falling off; but this was overbalanced by the increased output of the Pacific Coast mines. The smelters at Sudbury shipped 10,154 tons of matte containing 2,455 tons of copper.

The Quebec mines yielded 23,729 tons of copper ore, valued at $95,000. The Eustis company worked its properties throughout the year, and installed a new electric plant on the Coaticooke river. Both mining and concentrating machinery is now driven by electricity. A promising copper deposit was found on the shore of lake Chibogomo, near Paint mountain. The geological conditions in this district resemble those at Sudbury, and there is a possibility of valuable nickel deposits being found.

In British Columbia there was an increase both in the Boundary District and on Vancouver Island. The increase in the former was not proportionate to the larger tonnage of ore smelted, showing that the low costs of mining and smelting there are admitting ores of lower grade than heretofore. Production in the whole province in 1904 was 36,688,500 lb., valued at $4,600,000. On Vancouver Island the Tyce Copper company's works were kept going nearly all the year; but those at Crofton were shut down early in the spring, for lack of ore. During the year the big copper mines at Phœnix and near Greenwood were worked on an extensive scale, while new orebodies were developed and important additions were made to mine and smelting equipments. In this connection it is to be noted in passing that Americans have now secured controlling interests in many mining undertakings in the district. During the summer a consolidation of several copper mines in Phœnix and Deadwood camps was effected.

The copper deposits of Mt. Sicker, Vancouver Island, are being regularly worked by the Tyee Copper Co.[3] They occur near the summit of the mountain, 2,000 ft. above sea-level, in a wide band of crystalline schist that is frequently obscured by unconformably overlying Cretaceous shale. The ore is chalcopyrite associated with pyrite, blende and galena, in a gangue consisting mainly of barite, with some quartz and calcite. An average assay from the Tyee mine yielded: Copper, 4.56%; iron, 11.94%; zinc, 6.60%; silica, 13.50%; alumina, 3.95%; barium sulphate, 37.30%; lime, 2.20%; sulphur, 16.62%; silver, 3.87 oz. and gold, 0.14 oz. per ton. The gold is not visible, but is very constant. The orebodies are irregularly lenticular in form, both vertically and horizontally. They have been developed to a depth of 600 feet.

Newfoundland, during 1904, produced 107,839 long tons of ore, containing $466,739 worth of copper. The chief producer is the Union mine, at Tilt Cove. During the year its yield was 73,082 tons of cupriferous pyrite, which was shipped without any treatment, about equally to Swansea and New York. The Terra Nova mine produced 19,312 tons of ore, and the Pilley Island mine is credited with an output of 165 tons. About 300 tons of high-grade chalcopyrite were raised from the newly discovered St. Julien mine, on the northeast coast. The mine at York Bay Harbor, Bay of Islands, owned by the Humber Consolidated Mining Co., developed well. A body of ore 57 ft. thick, the full extent of which has not been determined, was opened in the lower levels. The ore averages about 7% copper and carries appreciable quantities of silver and gold.

Cuba's copper mines have the distinction of having been the first of the

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[3] See 'Copper Deposits of Mt. Sicker,' by R. Musgrave, in The Engineering and Mining Journal, October 27, 1904.

kind opened by Europeans in America. El Cobre mines, about 30 miles north of Santiago, were worked by the Spaniards in the sixteenth century, and have made an unenviable record of financial failures. Under an English company their ore was sent to Swansea for smelting; they are now owned by the Spanish-American Iron Company.

At the Minas de Cobre, near Havana, the ore occurs in well-defined lenticular bodies.[4] The largest lens is about 20 ft. wide in the middle; they vary in length from 20 to 200 ft., and extend downward with a northeast dip. They all occur along well marked fracture planes in serpentine. The ore is pyrrhotite, with or without chalcopyrite, and appears to have originated from the native metal originally disseminated in the peridotite rock from which the serpentine was derived. The principal mines are now owned by American companies, and are being developed on modern lines.

Mexico.—Copper mining on a large scale is a comparatively new industry in Mexico, but the vigorous manner in which it is pursued has placed the republic's annual copper production above that of Spain and Portugal, and ranks Mexico the second largest of the world's producers. The output in 1904 amounted to 50,945 long tons. Copper deposits occur throughout the country, and copper mines are found in nearly every State. The most important producers are in Sonora, Lower California, Chihuahua, Michoacan and Durango.

The Greene Consolidated Copper Co.'s mine at Cananea, Sonora, is now the largest mine in Mexico. It also ranks fourth among the world's producers. The company's property includes thoroughly equipped concentrating and reduction plants of the latest design.

During the fiscal year ending July 31, 1904, a policy of retrenchment in expenditure was enforced, the most economical method either of management or of technical detail being now ascertainable. As a result, the cost of the output during the second half of the year, as compared with the first, showed a reduction of 1.217c. per lb. and this in the face of a growing effort to utilize second-class and low-grade ores, involving additional activity in the concentrating department. The total cost is now less than 8c. per lb. Among the elements contributing to this economy may be mentioned the scheme of 'selective mining.' A little expeditiousness among the surveying and the assaying corps makes it possible to classify the product of any particular stope according to its commercial value and its treatment requirements, before the ore has to be removed from the working place. By thus adjusting the output to the momentary needs of the reduction plant, the use of barren fluxes is obviated, with an attending increase of efficiency. Concessions covering a railroad, a waterpower and a smelter have recently been acquired. The proposed railroad will run east from the Sonora to the Mexican Central Railway, passing through, or close to, Cananea. By tap-

[4] W. H. Weed, 'Copper Mines near Havana,' THE ENGINEERING AND MINING JOURNAL, January 26, 1905.

ping the Aros river, it is estimated that 30,000 h.p. can be generated electrically, with great economy over the steam plant now in use. The smelter concession carries valuable privileges. A railway is projected to reach the pine forests of the Sierra Madre, which, at the present rate of consumption of timber, 2,000,000 ft. per month, would be an economical source of supply.

The output of the mines during the year was 489,352 tons of ore and 147,099 tons of fluxing materials, limestone and iron. Development work comprised 7,483 ft. in the vertical direction and 27,207 ft. of drifting and tunneling. The most recent feature is the discovery, at the deepest point yet reached, of a body of hard sulphide ore of exceptional richness. As one of the chief embarrassments has been the superabundance of soft ores, necessitating the re-treatment of large amounts of flue-dust, this latest find holds out great promise. Nothing has been made public as to the size of ore reserves.

A large part of the mill was remodeled during the early months of the year, so that nearly two-thirds of the year's output was made in the latter half. The ore treatment amounted to 207,224 tons net, and the output of concentrate was 59,065 tons, showing a ratio of 3.51 to 1. Since full operations were resumed, the daily capacity has averaged 900 tons, at a cost of $0.78 per ton.

The smelter treated 308,215 tons of ore and concentrate, an increase of 33.8% over the preceding year, at a cost of $1.40 per ton less than the average for that year, but without any additions to the equipment. This result was accomplished by more careful attention to the details of the process, one outcome of which was to reduce the proportion of coke in the charge by 26.7%. The average blast furnace charge during the year was:

Copper-bearing ore and concentrate	52.38 %
Coke	11.49 "
Iron ore	11.63 "
Limestone	9.84 "
Chips and slag	5.30 "
Flue dust	9.36 "
	100.00

The output from the smelter during the year was:

Copper (electrolytic assay)	52,915,947 lb.
Silver	505,702 oz.
Gold	3,569 oz.

This was all in bullion, except the contents of 11,606 tons of flue dust shipped, or in stock.

Roasters and reverberatories are being built as rapidly as possible for the purpose of treating the increasing volumes of flue dust, of which the dust chambers are collecting 280 tons a day, in spite of every precaution in feeding. This will also give the plant an elasticity highly favorable to the treatment of such varied ores.

The net profit for the year was $1,075,315, in which the value of stocks on hand was estimated at cost. From this an appropriation of $107,988 was made, to cover depreciation of plant, leaving a balance of $967,327 for distribution. The total capitalization is $8,640,000. Two 3% dividends, aggregating $518,000, were paid during the year, the balance being applied to betterments.

Other Copper Districts of Mexico. (By James W. Malcolmson.)—In the Nacozari, Sonora, mine of the Moctezuma Copper Co. a new orebody of importance has been found, and production will be increased materially. On the completion of the railroad from Douglas to Nacozari, the smelter at the latter point was shut down, and the concentrate shipped to the Copper Queen smelter, at Douglas. An enlargement of the Nacozari concentrator is under consideration.

Lower California.—At Boleo satisfactory developments have been made, and the mine is in a prosperous condition. The output of metallic copper for the year was nearly 11,000 tons. Much searching for copper has been carried on in the Yaqui river district of Sonora, and some prospects are being exploited. At Triunfo, the Progreso mine, one of the oldest in Mexico, has resumed the payment of dividends, and, in addition to an output of silver, there have been developments of gold ore, which promise well.

Chihuahua.—Las Vegas copper mine, near the Conchos river, has now been rendered more accessible by the building of the Kansas City, Mexico & Orient Railway to Las Trancas. At Los Reyes, near Jiminez, the Gibosa mine has kept up its usual production, and extensive development work is being carried on. The Jesus Maria copper mines, at Baguerachic, on the line of the Kansas City, Mexico & Orient Railroad, has been explored by an American company; this property was operated in 1864 by Baron Necker, and trouble regarding ownership was an excuse for French intervention. The mine is still handicapped by its distance from a railroad; but as the main line of the Stilwell road, now building, passes over the claims, it will in time become a producer of importance. This railroad between Urique and Choix passes through a district in which other large copper deposits have been discovered. Northwest of Ahumada, on the Mexican Central, San Antonio capitalists are opening a new district, and have already found some oxidized ore assaying 10% copper.

Coahuila.—A light railroad has been built from Otto station, on the Mexican Central Railroad, to the mines of the Jimulco Mining Co. The line is operated by a Shay locomotive, 60 tons of ore being shipped daily to Aguascalientes, containing 0.15 oz. gold, 15 oz. silver and 16% copper.

Durango.—At Avino, irregular shipments of copper ore have been made to Aguascalientes. The Descubridora mine, at Conejos, has been worked intermittently, but it is now closed down. In Guanacevi some promising copper ores, carrying gold and silver, have been opened up near the town. At Velardeña the copper deposits of the Velardeña Mining and Smelting Co. have proved to be extensive. Gas producers and engines of large capacity are being installed, and the enterprise is being developed rapidly. Plans have been prepared for the construction of a new smelting plant, but work has not yet been started. Large bodies of silicious ore are also being opened on the Teneres mine, and on account of the successful result of the tests made on the San Nicholas lead sulphide ores, a mill is to be built at once to handle a large tonnage. Improvements and development work for 1905 will entail the expenditure of $2,000,000.

Michoacan.—Development is again being carried forward energetically by the French company operating the Inguaran mine, the orebodies being of great size; they assay approximately 5% copper, but better railroad facilities are required for the final success of the enterprise. Surveys have been made with the object of securing an outlet to the coast at Sihuatenejo, in Guerrero.

Puebla.—The principal copper property in operation in the southern part of the republic is the Tezuitlan; the railroad has been completed to the smelter, and additional machinery installed.

Guerrero.—The Campo Morado property is still in process of development, a large additional tonnage of copper-iron ore having been opened up. La Dicha mine of the Mitchell Mining Co., 55 miles east of Acapulco, on the Pacific coast, has been actively exploited. Much work has been done at this property, and a smelter with a 200-ton daily capacity is almost completed. At Mazapil operations are prosperous, the copper matte produced being shipped to Aguascalientes, while exploration work is active. North of Zacatecas, the Magistral mine is shipping 100 tons of copper ore weekly, and a mill has been erected on the Zaragoza mine, at Zacatecas, to concentrate 200 tons weekly of 4% copper ore.

Aguascalientes.—The Cobre mines, at Tepezala, have again resumed shipments of copper ore, and extensive exploration work is in progress. The Fortuna mine is making its regular production of 800 tons monthly of silicious copper. The Merced mine, shipping 600 tons per month, is also in a prosperous condition.

South America.

Chile.—The copper deposits at Copaquire are being worked by an English company. They are situated in the rainless high altitude of Chile. The copper occurs in the form of sulphate and the ore is of low grade. Valuable copper ore has been discovered at Huinquintipa. The lodes are of large size and the ore of good grade.

Peru.—Copper mining is successful at Casapalca, where there is a smelter in operation 88 miles from Lima, at an elevation of 13,606 ft. It is running on ore averaging 12% copper. The San Francisco mines at Morococha, near

Lake Morococha, are productive. In this district also the San Miguel mine is producing 800 tons monthly from ore averaging 22% copper and 10 oz. silver. The product of this mine, as well as that of the San Francisco, Gertrudis, Natividad, and numerous small mines is treated at the **Huacra-cocha** smelter. This plant consists of a water-jacket furnace of 30 tons capacity.[5]

At Yauli, 112 miles from Lima, at an elevation of 13,420 ft., the Santa Barbara smelting works has three water jackets, respectively of 30, 60 and 80 tons daily capacity. Copper occurs in the Cerro de Pasco and Huayllay districts, and there is a possibility of these remote districts becoming regular producers in a few years. English and American capital is now interested in some of the principal mines. The Cerro de Pasco mines were developed by an American company in which J. B. Haggin is largely interested. The construction of a 500-ton smelter was begun. This plant will go into operation in the fall of 1905.

The Copper Markets in 1904.

New York.—The course of the market during 1904 was monotonous until the late fall, when a sharp advance set in. It was again followed with marked attention, not only by those directly and indirectly connected with the industry, but also by the general public, owing to the latter's ever-increasing interest in copper shares.

While consumption in the United States during the first six months showed a falling off of about 30%, Europe had quite a revival of business, especially in the electrical industry, and large quantities were also required for war purposes. A new feature has been a heavy demand from the Far East, as the quantities bought for China assumed very large proportions, and contributed in great measure to the rise in values at the end of the year. Exports for the year reached the high figure of 248,053 long tons.

When, at last, American consumption improved, it caused a steady advance in price. At the present time the brass- as well as the sheet-mills are very busy indeed, while railroads and shipbuilders also are taking their usual quota. The most extensive demand for copper in the future, however, will be in the use of this metal for traction purposes, several of the most prominent railroads having decided to substitute electrical power for steam, not only for local, but also for long-distance traffic.

The year opened with Lake copper quoted at 12½c., electrolytic at 12⅛, and casting copper at 11⅞. Consumers both here and abroad, finding these values attractive, bought freely for early as well as future delivery, and prices advanced steadily to 12¾ for Lake, 12⅝ for electrolytic and 12¼ for casting. Toward the end of January manufacturers over here became very apathetic, and during February dullness reigned supreme, values re-

[5] Russel T. Mason, The Engineering and Mining Journal, June 8, 1905, p. 1,091.

ceding again to the opening quotations of the year, there being some pressure to sell on the part of leading producers.

The disturbed condition of the financial markets, caused by the outbreak of hostilities between Russia and Japan, also exercised a depressing influence. A strike occurred at the mines of the Baltic, Champion and Trimountain companies at the Lakes, which lasted for some time.

It was not until the second half of March that the aspect of the market changed. It became evident that while the European manufacturers had bought freely at the low prices ruling, home consumers had allowed their stocks to become depleted. At the end of the month Lake had advanced to 13c., electrolytic to 12⅞, and casting to 12½. During April, May, June and July the market ruled steady within narrow limits, heavy purchases for foreign account and consequent large exports remaining the chief feature.

In August, values might have improved if one of the prominent Lake companies had not pressed its product for sale and disposed of very large quantities, especially abroad, at low figures.

In September a better tendency was noticeable, and during the last three months of the year there was a steady advance, which finally carried prices to 15c. The causes for this are various. In the first place, there was an enormous demand from Europe, which at first was looked upon with suspicion, but which later on was found to be legitimate. Secondly, even before the election, business in the United States showed a decided improvement, and consumers who previously could not be induced to lay in a supply of copper at 12c., bought freely at the higher prices. Thirdly, there was the unexpected demand from the Far East, which assumed very large proportions, and which came at a time when the metal was badly needed at home.

Thus a price level has been reached which is a great boon to the producer, without at the same time being a hardship to the manufacturer, always provided that present values can be maintained. This ought not to be difficult if the interests of the trade are not subordinated to the exigencies of the stock market, as has been the case so often in the past. The intrinsic position of the market makes the outlook for the immediate future certainly very promising.

The closing quotations for the year were 14⅞@15c. for Lake copper; 14¾@14⅞ for electrolytic; 14½@14⅝ for casting copper.

AVERAGE MONTHLY PRICES OF LAKE COPPER PER POUND IN NEW YORK.

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
1900...	16.33	16.08	16.55	16.94	16.55	16.00	16.16	16.58	16.69	16.64	16.80	16.88	16.52
1901...	16.77	16.90	16.94	16 94	16.94	16.90	16.51	16.50	16.52	16.60	16.60	14.39	16.55
1902...	11.322	12.378	12.188	11.986	12.226	12.360	11.923	11.649	11.760	11.722	11.533	11.599	11.887
1903...	12.361	12.901	14.572	14.642	14.618	14.212	13.341	13.159	13.345	12.954	12.813	12.084	13.417
1904...	12.533	12.245	12.551	13.120	13.000	12.399	12.505	12.468	12.620	13.118	14.456	14.849	12.990

AVERAGE MONTHLY PRICES OF ELECTROLYTIC COPPER PER POUND IN NEW YORK.

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
1900...	15.58	15.78	16.29	16.76	16.34	15.75	15.97	16.35	16.44	16.37	16.40	16.31	16.19
1901...	16.25	16.38	16.42	16.43	16.41	16.38	16.31	16.25	16.25	16.25	16.22	13.82	16.11
1902...	11.053	12.173	11.882	11.618	11.851	12.110	11 771	11.404	11.480	11.449	11.288	11.430	11.626
1903...	12.159	12.778	14.416	14.454	14.435	13.942	13.094	12.962	13.205	12.801	12.617	11.952	13.235
1904...	12.410	12.063	12.299	12.923	12.758	12.269	12.380	12.343	12.495	12.993	14.284	14.661	12.823

London.—January opened with visible supply at 13,851 tons, while the nearest prices of Standard were £56 17s. 6d. cash and £56 10s. three months. Business, however, soon became brisk, and values rapidly advanced to £59 5s. and £58 12s. 6d., respectively; but under various influences they gradually drifted down to £55 15s. cash, rallying again before the month closed to £56 10s. spot and £56 5s. three months. Trade with consumers at the beginning of the month was brisk, and a large business was placed in refined sorts at advancing prices, the bulk of the orders being taken by the American producers. American and Continental demand was also good.

February witnessed the outbreak of the war between Russia and Japan, which has been an important factor in all markets ever since. Large and increasing shipments from America caused considerable bear selling, as it was not generally believed at the time that the copper could really be wanted in Europe for consumption; but, as later events proved, these fears were groundless, as Europe continued to take copper to an enormous extent, chiefly for electrical work, and indirectly to furnish munitions of war for Russia. Standard values opened at £56 5s. for spot and £56 for forward metal, and declined about 20s. from this level before a turn came, when prices were lifted about £1 per ton above the opening level. The Amalgamated company reduced its prices for refined, but this did not stimulate business, rather helping to scare consumers from buying. When the standard market, however, showed signs of improvement, a steady demand set in from manufacturers, both here and on the Continent, so that both the American and European producers were able to market considerable lines. India bought copper sheets and yellow metal freely at this time, which was a great help to the English market.

March began with 13,299 tons as the visible supply. For the first three weeks business in warrants was quieter than had been known for years, and transactions were few, prices showing but little change; but toward the end of the month warrants which had been locked up were put into circulation, and with some influential speculative buying values quickly improved until the close, when the nearest price was £58 for cash and £57 15s. for three months. Consumers did not follow standard, but bought rather liberally to cover orders, which were being placed with more freedom from all channels. Trade reports from the States were also strong, and the chief producers were able to sell largely and raise prices to the parity of 13c. for electrolytic. The market in America was in advance of ours, as was proved by large purchases of Chile bars, which were bought for shipment thence instead of for England as usual. This in turn caused a run on available furnace material on this side, for sulphate-making, which trade was just becoming busy in view of the summer and autumn trade.

April saw the stocks reduced to 12,496 tons. Fluctuations were unimportant, and were covered by about 10s. per ton, closing steady at £58 15s. spot and £58 10s. three months. Throughout the month a fair business was being done in America, which made producers independent of the European inactivity, and a further rise in the price of electrolytic and Lake was established. India again came in as a purchaser of yellow metal on an important scale, while sulphate was in brisk demand; for the manufacture of that article all brands of Chile bars were in good request.

May witnessed a further diminution in the visible supply, which had fallen to a new low-record level, being given as 12,026 tons; notwithstanding this apparent bull point, values of standard sorts commenced to dwindle away, as the news from America was not quite so satisfactory. Trade in England also showed signs of becoming quieter, and, although producers did not press sales, dealers were eager to liquidate their holdings of refined, and values suffered accordingly. Standard copper suffered more than other brands, and values gradually shrunk to £56 17s. 6d. for both spot and three months.

June saw a sharp cut made by some of the most prominent American producers, Lake being reduced to the parity of about £61 15s., and electrolytic to about £59 10s. This reduction proved attractive to many consumers, whose stocks had run low, and first hands did a fair business. The Amalgamated company then put the price again lower at £57 10s. A pause at this level was followed by an unexpected rush by consumers in England, the Continent and America, and buying became so fast that the leading producers, seeing the latent strength of the market, quickly raised their price to £58 10s. This in turn had the effect of checking the demand, and the rest of the month saw a steady trade, without any fresh advance. India bought largely copper and yellow metal, and sulphate makers took large lines of suitable material. Standard, after opening at £56 10s., fell away under realizations and bear selling until £55 10s. was reached, when a revival set in, and prices quickly improved to £57, closing at about this level.

July's visible supply was 11,137 tons, and this further reduction made an impression on consumers and speculators, so that prices in the warrant market soon improved to £57 10s., but selling soon became the order of the day, and prices declined to £56 17s. 6d., all positions. Trade was dull in England and France, but America showed marked signs of improvement, and Germany was busy, which enabled the Americans to raise their prices further and dispose of large quantities. The leading European companies sold good quantities at full prices to home dealers. The continued demand for material for sulphate making was a feature of the trade at this time.

When August came in, consumers were showing great reserve, owing to the liberal way in which American producers were offering, and all the buying was of a hand-to-mouth order. When, however, a lower-priced level for refined sorts was reached, the demand again set in with renewed strength. The Continental trade was growing at a tremendous rate, and its requirements were found to be much above what the most sanguine bulls were estimating. The revival in trade in the United States, which was evidenced by the broadening out of the iron and steel industry, was also another powerful factor in helping the copper trade, and when trade in America began to improve, it was found that no stocks had accumulated, and buyers covered themselves for some time ahead in their fear that sales for export might cause a shortage for delivery in their own country. At this time China appeared as a new buyer, and large purchases of ingots were made both in this country and America. The shipment of copper to that country has become one of the most remarkable features of the latter-day position.

September statistics gave the visible supply as 13,415 tons, and the nearest price was about £57 5s. for all prompts, but later in the month a good amount of speculative buying drove the price to £58 12s. 6d., but later on realizations caused a setback of about 15s. per ton. Trade in refined was quiet, consumers being in no further hurry to buy, seeing that the leading American producers were such willing sellers, but this level was the turning point, for consumers in all parts of the world again started to buy, and from this date onward a more confident tone was expressed in all branches of the copper trade with the exception of Great Britain, where trade throughout the whole year was decidedly bad, excepting sulphate, and the large business done with India at the lower range of prices.

October again saw a larger visible supply, which was given as 13,878 tons, the nearest value being £58 for all prompts. The month throughout was very active, a large speculative business being done, and prices rose day by day until £61 15s. was paid for cash and £62 for three months, and these were the ruling rates at the close of the month. Reports from America and the Continent continued to announce a large and growing trade, notwithstanding the higher price level which had been reached. Sulphate continued in demand, and prices were put up owing to orders being received, some even for shipment to America. These, in turn, were covered in Chile bars, which were largely sold at high premiums. Early in the month India bought fair quantities of yellow metal, and there was better buying on behalf of home consumers. The Rio Tinto company, after having been out of the market for some time, sold big lines at £62 10s. up to £65.

November opened with a visible supply of 13,490 tons, the nearest price being £62 12s. 6d. for cash and £62 17s. 6d. for three months; from this level values steadily improved to about £67 spot and £67 7s. 6d. forward. In spite of fresh gratuitous advice to sell copper, received by cable from New York, the chief American producers further advanced their prices, having found a very large demand from European consumers and for shipment to China. Chile was a fair seller throughout the month at gradually increasing prices; the continued demand for sulphate caused all this copper to be taken at a high premium. Throughout this month a very large and active trade was done, practically in every part of the world, with the exception of Great Britain. The standard market remained active throughout, and after several fluctuations closed at £67 2s. 6d. cash and £67 10s. three months.

Statistics on December 1 showed a visible supply of 16,044 tons. The demand for consumers was somewhat slack, owing to their having purchased so freely for their near requirements. The market kept, however, very firm, and, just as there was a prospect of a further upward move, a sudden break in values was caused by the heavy collapse in the price of Amalgamated and other American shares. The fresh decline in prices found numerous buyers, and the biggest decline from the highest values did not reach more than £2 5s. per ton.

During the remainder of the month there was a steady improvement, and the market for standard copper closed at the best—£68 6s. 3d. to £68 7s. 6d. for spot, £68 13s. 9d. to £68 15s. for three months.

AVERAGE MONTHLY PRICES OF STANDARD COPPER (G. M. B.'s) IN LONDON.
(In Pounds sterling per long ton of 2,240 lb.)

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1901...	71.78	71.17	69.54	69.61	69.60	68.83	67.60	66.34	65.97	64.11	64.51	52.34	66.79
1902...	48.43	55.16	53.39	52.79	54.03	53.93	52.89	51.96	52.68	52.18	51.03	50.95	52.46
1903...	53.52	57.34	63.85	61.72	61.73	57.30	56.64	58.44	56.82	55.60	56.30	56.36	57.97
1904...	57.500	56.500	57.321	58.247	57.321	56.398	57.256	59.952	57.645	60.012	65.085	66.375	58.884

PROGRESS IN THE METALLURGY OF COPPER.

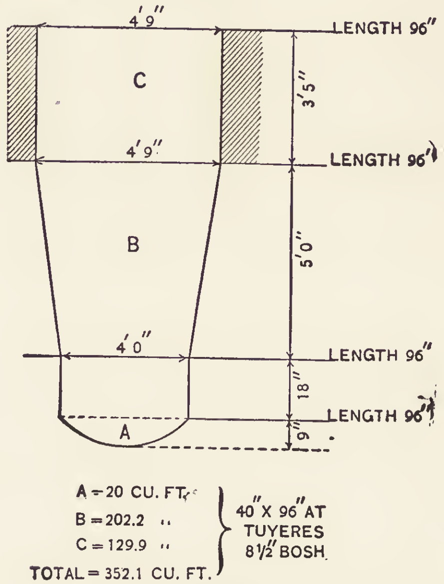
Pyrite Smelting.—This subject was discussed in THE ENGINEERING AND MINING JOURNAL during 1904 and 1905 by leading specialists. The discussion was fruitful in eliciting valuable facts relating to the subject that were not generally known. An able review by Prof. Edward D. Peters, summarizing the points brought forward will be found following the close of the discussion.[6] The field is too wide to be treated adequately in this volume, but attention is called to the fact that the whole discussion, with the summary and more recent matter, has just been issued in one volume, 'Pyrite Smelting.' An historical review of the subject has been given by Robert Sticht, of Mt. Lyell, Tasmania.[7]

Great Western Gold Mining Company.—The new smelter of this company at Ingot, Shasta county, Cal., has been described by Herbert Haas.[8] The furnace is water-jacketed and has the following dimensions: Horizontal sec-

[6] THE ENGINEERING AND MINING JOURNAL, 1904, LXXVII, pp. 88 881, 921, 959, 1,004, 1,043; LXXVIII, pp. 10, 58, 100, 140, 179, 218.
[7] Presidential Address, Australasian Institute of Mining Engineers, Annual Meeting, 1905.
[8] THE ENGINEERING AND MINING JOURNAL, June 8, 1905.

tion at throat, 57 by 96 in.; horizontal section at tuyeres, 40 by 96 in.; area at tuyeres, 26.67 sq. ft.; height, tuyeres to throat, 8 ft. 11 in.; brick shaft, height 3 ft. 5 in.; height tuyeres to top of crucible, 12 in.; water-jacket, height 6 ft. 6 in.; bosh slope, 8½ in. in 5 ft.; crucible depth, 9 in.; tuyeres, 12 in number, and each of 4 in. diam.; tuyere ratio, 5.06. (This is the tuyere area in square inches for each square foot of hearth area.)

The furnace has a matte tap-hole on each long side, and a slag tap-hole on each short end. A fixed fore-hearth is kept at each end of the furnace, one in operation, one in reserve. The fore-hearth shell is cooled by a fine spray of water (issuing from an inch pipe around the shell), which is collected in a trough at the bottom of the settler and is run off underground. The furnace lines are shown in the illustration.



Transverse Section of Furnace.

In the first concentration, with 2% coke on the charge, a matte with 30 to 35% copper is produced. The matte is broken and re-concentrated (with two-thirds of green ore in the charge, and the necessary quartz and limestone) to a 45 or 50% matte, using 3 to 4% coke. The temperature of the blast is 460 to 700° F.

Blast is furnished by an electrically driven No. 5 Connersville blower, and a No. 6 Green blower. The former delivers 24 cu. ft. of free air, while the latter delivers 45 cu. ft. per revolution. The total rated capacity is 12,150 cu. ft. air per min. and the actual capacity is about 75% of this. The designers considered a large air capacity necessary for these reasons:

(1) The air loses pressure and bulk by friction and leakage while passing through the hot-blast stove.

(2) A large percentage of iron pyrite has to be oxidized, as much as 7% of the burden consisting of this mineral. Only when an excess of air is furnished can a reasonable desulphurization be expected.

(3) To have control of the amount of blast and have a surplus in smelting.

Smelting at Mansfeld.—The reduction works at Mansfeld, Germany, comprise several independent plants. There are four smelters for treating raw ore, two roasting plants with sulphuric acid works attached, two matte smelting works, two furnace refineries, an electrolytic refinery, and a desilverizing plant.

The ore is transported from the mines to one of the four smelters situated at Eisleben, Helbra, Leimbach, and Hellstedt, where it is heap roasted and smelted in blast furnaces to crude matte. The raw ore is composed as follows: SiO_2, 29 to 39%; Al_2O_3, 11 to 16%; CaO, 11 to 15%; MgO, 2 to 5%; CO_2, 7 to 13%; Fe, 1 to 3%; Cu, 2.8 to 3%; Ag, 0.01 to 0.02%; S, 2 to 5%; and bitumen, 10 to 17%. There are also small quantities of zinc, nickel, and cobalt.

Three of the furnaces are furnished with cold blast, and the fourth (at Hellstedt) uses a hot blast. The blast is supplied by steam-driven air-compressors. A special furnace deals with the flue dust, and yields about 300 tons of silver-lead, 300 tons of crude matte and 6 tons of nickel matte per annum, from about 2,000 tons of dust. Recently the slag from the various furnaces has been utilized in making bricks and paving blocks.

Roasting at the Tyee Smelter.[9]—The main ore supply is derived from the Mount Sicker mines, Vancouver Island, B. C. It consists of chalcopyrite carrying gold, silver and zinc, as well as 5% copper, 11.9% iron, 13.5% silica, 16.6% sulphur, and 37.3% barium sulphate. A spur from the railroad runs to the top of the roast-yard receiving bins. There are 16 of these, having a total storage capacity of 1,600 tons. The ore falls from the railway cars to fixed screens placed in the bins. The screens are set at 40°, and separate to 3/8-in. size and less. The fine ore drops into another compartment built into the center of each bin. The ore is drawn off through bottom-discharge gates. The oversize goes to the roast piles, and the fine is made into bricks.

The roast-yard level is about 8 ft. below that of the tram-tracks under the bins. The tracks extend through the yard lengthwise on a series of six trestles built 60 ft. apart. These trestles are permanent structures; the fire from the burning ore does not reach them. At right angles there are six trenches, each 4 ft. deep and 35 or 40 ft. apart. The trenches and trestles divide the yards into beds. Between the permanent trestles there are movable bridges that travel on wheels. They are constructed so as to move freely over the ore-beds as required. The bridges carry tram-tracks which allow the side-dumping cars to run over them from the trestles.

[9] E. Jacobs, 'Roasting at the Tyee Smelter,' THE ENGINEERING AND MINING JOURNAL, November 10, 1904.

The ore piles are built 50 ft. long, 24 ft. wide, and 7 ft. high. Each contains about 300 tons. The ore is piled on a 12-in. layer of cordwood, each pile requiring eight cords of wood. The ore is discharged from both sides of the cars as they are moved along the bridges, and is uniformly distributed. The burning occupies about three weeks.

Bricks made from the fine ore are roasted with the oversize. The brick-making plant consists of two one-horse pug mills and a specially constructed drying floor so arranged as to equalize the heating over the whole floor space. The floor is bottom heated and fired from both ends with flues of red brick tiling connecting each fire-box with its stack. The capacity of this plant is 2,000 bricks, equal to 28 tons of ore per day.

The fine is dumped into the pit of one of the pug mills, where enough water is added to make a plastic mass for moulding. No binding material is needed. The moulding is done by hand. Bricks placed on the drying floor dry within 24 hours. They are then wheeled to the roast heaps and are covered with screened ore. The burnt bricks are hard and porous; the oxidation of the zinc, copper and iron is remarkably complete. Average samples give from 1.5 to 2.5% sulphur as sulphides as against 7% in the ordinary burnt ore. The bricks are in a very suitable condition for smelting in the blast furnace. This process does away with expensive roasting furnaces, and the roasted bricks it produces are said to be superior to the ordinary briquettes made from roasted fine.

Siemens and Halske Process.—This process of recovering copper from roasted sulphide ores consists in leaching the finely powdered ore at 90° C. with ferric sulphate solution, containing free sulphuric acid. The ferric sulphate is reduced to ferrous salt, and copper enters solution as sulphate. Subsequent electrolytic treatment in a diaphragm cell deposits copper at the cathode and oxidizes ferrous to ferric sulphate at the anode. M. De K. Thompson[10] has carried out a laboratory investigation of the several stages of this process. The dissolving action of ferric sulphate on cupric and cuprous oxides and sulphides was studied in detail, and then a natural copper ore was submitted to treatment. Copper pyrites before roasting is not appreciably attacked by ferric sulphate, but after roasting, in which it seems to be converted chiefly into oxide, it dissolves readily. The electrolytic treatment was carried out separately to study the anode and cathode reactions. At the cathode it was found that copper could be deposited in a firm adherent form from an acid solution of ferrous and copper sulphates until the concentration reaches a very low value, *e.g.*, with a current density of 0.47 amp. per 100 sq. cm., until the concentration of copper in solution was 0.5%, at which point the metal begins to be spongy. The oxidation at the anode, using carbon electrodes, is at first very efficient, but as the concentration of ferrous sulphate decreases, the process gradually falls off in efficiency.

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[10] M. De K. Thompson, 'Studies in Siemens and Halske Copper Process,' *Electrochemical Industry*, 1904, pp. 225-231.

Copper Assaying.—During the year, numerous improved methods of assaying copper were advocated. Most of them aimed at securing greater accuracy than is possible with common methods, or at the simplification of processes dealing with complex ores.

In determinations by the iodometric method, the precipitation of copper by aluminum occupies considerable time, and has several other disadvantages. Fairlie[11] has made determinations much more quickly and simply by using ammonium or potassium thiocyanate to precipitate the copper. The cuprous thiocyanate is dissolved in strong nitric acid, the solution boiled until red fumes are no longer evolved, then neutralized with ammonia, acidified with acetic acid, potassium iodide added and the copper determined in the usual manner.

Moser[12] has adopted the iodide method for determining copper in the presence of iron and arsenic, by adding excess of sodium pyrophosphate ($Na_4P_2O_7$) in which all three dissolve, forming complex ions. Of these ions, only that containing copper is decomposed by acetic acid (sulphuric acid breaks up all), and on adding potassium iodide therefore only cuprous iodide is precipitated, but it is important to allow time for this, about 15 minutes sufficing. Working conditions are made clear by a description of an actual analysis of copper pyrites containing 27.25% of copper and 31.84% of iron. About 2 gm. were digested, with shaking, for one hour in the cold with a little fuming nitric acid, and then more nitric acid was added, and the oxidation of the sulphur completed on the water-bath. The nitric acid was displaced by sulphuric acid, and excess of this was driven off almost completely on a sand-bath. The residue was taken up with water, and sodium acetate added, which gave a brown solution. The silica and lead sulphate were filtered off and washed with hot water, and the filtrate made up to 100 c.c.; 20 c.c. of this were precipitated with solid sodium pyrophosphate, and the precipitate dissolved in a little strong solution of the same reagent, when a blue solution was obtained. About 4 gm. of potassium iodide and 10 c.c. of 80% acetic acid were added, and the flask shaken for 10 minutes. The solution was then titrated with thiosulphate as usual. The results given are less than 0.3% too low.

An improved electrolytic method for copper determination was devised by G. L. Heath.[13] In the following description the reference is to 1 gm. of substance, but Heath advocates the weighing out of larger quantities, up to 5 gm. For metal containing arsenic and antimony, but less than 0.01% of nickel, cobalt and zinc together, dissolve in 10 c.c. of nitric acid, evaporate with 10 c.c. of concentrated sulphuric acid until the residue is white, take up with 70 c.c. of water, add 1 c.c. of nitric acid and just enough ammonia to redissolve, and electrolyze. For metal containing much selenium and tel-

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[11] A. M. Fairlie, 'Idometric Determination of Copper,' THE ENGINEERING AND MINING JOURNAL, November 17, 1904.
[12] L. Moser, *Zeitung Analytische Chemie*, 1904, pp. 597-616.
[13] *Journal* of the American Chemical Society, 1904, pp. 1,120-1,124.

lurium, but only traces of antimony, and less than 0.02% of arsenic, treat with nitric and sulphuric acids as above, dissolve in 60 c.c. of water, heat nearly to boiling, pass in pure sulphur dioxide for 10 minutes, settle over night, filter, and boil off the sulphurous acid. Ignite the filter, dissolve the ash in 1.5 c.c. of nitric acid, add to bulk of liquid, and electrolyze. For metal containing over 0.01% of antimony and other elements, heat with nitric and sulphuric acids, dissolve in 70 c.c. of water, add 1 c.c. of ferric nitrate solution (1 c.c. = 0.01 gm. of iron), boil, precipitate with ammonia, filter, and wash. Dissolve in dilute sulphuric acid and re-precipitate, adding filtrate to bulk. Redissolve and pass sulphureted hydrogen, extract the precipitate with a little hot dilute sodium sulphide, ignite, dissolve in 1.5 c.c. of concentrated nitric acid, and add to bulk. Acidify the collected liquors with sulphuric acid, concentrate to a suitable volume, and electrolyze. For metal containing much arsenic, but at most 0.01% of antimony, dissolve 5 gm. of the copper in nitric acid, dilute to 50 c.c. and add 3 c.c. of concentrated sulphuric acid. Add ammonia until a slight permanent precipitate forms, redissolve by 1 c.c. of sulphuric acid (sp. gr. 1.84), and stir in dry powdered ammonium nitrate to saturation, and electrolyze.

Scrap Copper.—Much of the copper going into consumption becomes, after years of service, available for new uses. In the United States, where over 400,000,000 lb. of fine copper are annually consumed, the collection and resmelting of scrap copper form important industries. The bulk of this consumption is credited to the electrical industry, and as the telegraph and telephone companies renew their wires periodically, this class of scrap copper is quite abundant. Usually old copper wire of good quality commands a premium over other forms of scrap metal, and sells today at about 13.5c. per lb. at New York, a price that is only 0.5c. to 1c. less than casting copper. Wire is made from the purest of copper, and, because of its freedom from foreign substances, is preferred for brass-making and similar purposes, when marketed as scrap. Other sources of supply of scrap copper are in the form of boiler and kettle bottoms, worth about 12c. per lb.; tubing, nails, type-shells, sheet clippings and the like, marketable at 12.75 to 13c. per pound. The demand for copper bottoms is limited, because their value is impaired by their shape and the fact that nearly all are tinned and soldered, causing difficulty in melting, and making an impure casting.

A peculiarity, rather surprising to the uninitiated, is the small margin between the price for old and new copper. Only in recent years, however, has this difference caused comment, but the fact that the demand from experienced foundrymen is increasing suggests a reason for the advance in the price of scrap copper.

Eutectic Copper.—Eutectic copper is that mutual mixture which freezes out last after the ingredient which is, or the ingredients which are, in excess shall have been removed by gradual cooling. In the case of casting copper, some cuprous oxide is sure to be formed; here the eutectic is a mixture of metallic copper and 3.4% of cuprous oxide, or 0.38% of oxygen. This eutectic can be seen under the microscope as a thin ground-mass surrounding grains of pure copper. It is transparent; blue in reflected light, and red in transmitted light. This eutectic may be a source of weakness, as in copper tubes which carry hot and reducing gases, when the resulting action may form fine cracks by forcing the metal apart, a condition popularly known as the "hydrogen disease" of Heyn.

Copper Sulphate.

The demand for copper sulphate during 1904 was keen, and stimulated production. Trade was brisk both in the United States and Europe. American production amounted to 63,234,557 lb., valued at $3,161,727.85; there was an increase of 20,110,103 lb. over the production in 1903. American exports amounted to 25,650,000 lb. The active market initiated an advance in price from $4.90 to $5.40 per 100 lb. for domestic deliveries, and from $3.77 to $4.81 for export.

Copper Sulphate as a Germicide.—It has been known for some years that copper sulphate is exceedingly active, both as a germicide and as an algaecide. Recent and numerous experiments confirm this. It appears that 1 part of copper sulphate in 8,000,000 parts of reservoir water will prevent and destroy all microscopic growths; and, after two or three days, the copper is removed by automatic precipitation. There is no danger from poisoning, as the dilution is so great that one would have to drink 40 gal. a day to obtain a medicinal dose. It is probable that the typhoid germ may be killed by 1 part of copper sulphate in 2,000,000 parts of water.

Manufacture.—A process of manufacturing copper sulphate from roasted copper ore has been patented by Gustave Gin, of Paris, France.[14] It consists in boiling a mixed solution containing sulphate of copper, ferrous sulphate and ferric sulphate with thoroughly roasted copper ore, or cement copper, so that the ferric oxide contained in the ferric sulphate will first be reduced, then reducing the ferrous sulphate remaining in the solution by raising the temperature to a point above 160° C., and then filtering the solution.

A. L. Walker,[15] New York, designed an apparatus for dissolving copper in sulphuric acid. Open frames, containing shot copper, are suspended over a vat into which sulphuric acid flows continuously, in such a manner that they can be successively immersed and withdrawn, at frequent intervals, by mechanical means. The vat is heated, and as the heavy crystallizable solution of the sulphate accumulates in the lower part, it is allowed to run off in proportion as acid is admitted to the top of the tank.

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[14] United States Patent, No. 763,748.
[15] United States Patent, No. 788,862, May 2, 1905.

COPPERAS.

The production of ferrous sulphate in the United States, not including those quantities of the salt that were made as transition products in the manufacture of Venetian red and other iron oxide pigments, amounted to 16,956 short tons, valued at $118,692, in 1904, as against 20,240 tons, valued at $121,440, in the preceding year.

The United States Steel Corporation, through its subsidiaries, the American Steel & Wire Company and the American Tin Plate Company, is the largest producer, followed by the Pennsylvania Salt Mfg. Company, Philadelphia. The E. I. du Pont Company, of Wilmington, Del., and the Forcite Powder Company, Kenville, N. Y., recover small quantities of copperas as a by-product in the manufacture of dynamite. The entire copperas output in 1904 of C. K. Williams & Company, Allentown, Pa., S. P. Wetherill Company, Philadelphia, and the Stauffer Chemical Company, San Francisco, was converted at once into red pigments, and its amount is not included in the above total. Of the remaining firms, listed in our last volume as producers in 1903, the International Nickel Company, Camden, N. J., and Wickwire Brothers, Cortland, N. Y., made no output in 1904.

Copperas in Agriculture.—Experiments seem to show that copperas may become of great value in agriculture, both as a fertilizer and as a remedy for plant diseases. E. Leclercq[1] announces that the effect of 250 parts of copperas on growing oats is as marked as that of 150 parts of sodium nitrate, while at the same time checking the growth of weeds. As nitrate costs about five times as much as copperas, a saving of two-thirds might be expected by the use of the latter. The fertilizing element is said to be the iron and not the sulphuric acid. Copperas solutions, of strengths varying according to circumstances, have been found to give valuable assistance in the war against the vine pests of Europe, the insect parasite *Phylloxera*, and the fungus growths *Peronospora* and *Phoma*. The salt is also an efficient remedy for chlorosis, to which all vegetation is liable, furnishing the iron that seems to be required for the proper functioning of the chlorophyl.

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[1] *Bulletin* Cercle Etudes Agronomiques, Brussels. 1903.

CORUNDUM AND EMERY.

Production of these abrasives in the United States shows a steady decline, in the face of an increasing demand. Consumption is supplied mainly by importations of crushed corundum from Ontario, and of emery from Greece and Turkey.

North Carolina and Georgia, which in former years supplied the whole domestic output of corundum, contributed little in 1904; Montana contributed 140 tons of corundum from mines at Salesville and Bozeman. Of emery, the Peekskill, N. Y., deposits supplied nearly three-quarters, Chester, Mass., and a new deposit in Kansas giving the rest.

Canada.—The Canada and the Ontario corundum companies are the principal producers, with mines in Hastings and Renfrew counties, Ontario. The output of 1904 was 919 tons, valued at $101,050; over two-thirds of it came to the United States. The Canada company has perfected its process and now sells its crushed corundum for 4½@5½c. per pound. The Ontario company is building a new concentrator of 75 tons per day capacity, using a dry process throughout.

UNITED STATES PRODUCTION AND IMPORTS OF CORUNDUM AND EMERY. (a)

Year.	Production. (a)		Imports.				
			Grains.		Ore and Rock.		Other Mfrs.
	Short tons	Value.	Pounds.	Value.	Long tons.	Value.	Value.
1900	4,305	$102,715	661,482	$26,520	11,392	$202,980	$10,006
1901	4,305	146,040	1,086,729	43,217	12,441	240,856	10,926
1902	4,251	104,605	1,665,737	49,107	7,157	151,959	13,776
1903	2,542	64,102	3,595,239	109,272	10,884	194,468	17,829
1904	1,932	57,235	2,281,193	109,772	7,054	138,931	11,721

(a) Statistics of the United States Geological Survey.

Greece.—The Government holds the emery deposits as a monopoly, leasing them to the peasantry and collecting a royalty of $1.52 per ton of mineral shipped, which is equivalent to 15% of the cost of production and transport to Syra, the point of export. The miners receive $8.34 per ton at Naxos, and carriage to Syra costs $1.89, total $10.23; at Syra the Government sells the product for $20.55 per ton. Exports of emery in 1904 were 107,324 metric tons, as compared with 99,148 tons in 1903. France receives the larger part, followed by the United States and England.

FELDSPAR.

The production of feldspar in the United States in 1904 amounted to 19,413 short tons of crude feldspar, valued at $66,714, and 25,775 short tons of ground feldspar, valued at $199,612; total, 45,188 short tons, valued at $266,326. This is an increase in quantity of 3,297 short tons, and in value of $9,593, as compared with the output in 1903.

PRODUCTION OF FELDSPAR IN UNITED STATES.
(In short tons.)

Year.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1900	1,787	$7,259	23,034	$173,712	24,821	$180,971
1901	9,960	21,699	24,781	198,753	34,741	220,422
1902	21,870	55,501	23,417	194,923	45,287	250,424
1903	13,432	51,036	28,459	205,697	41,891	256,733
1904	19,413	66 714	25,775	199,612	45,188	266,326

Composition and Occurrence.—Feldspar is a compound silicate of alumina with either potash, soda or lime. The three well-defined species are: (1) Orthoclase, the potash feldspar; (2) albite, the soda feldspar; and (3) anorthite, the lime feldspar. Intermediate species exist, between orthoclase and albite, and between albite and anorthite; a rare species of the potash feldspar contains barium. Orthoclase is the most extensively used in the arts, since it is found more abundantly in a relatively pure form, occurring, aside from its wide distribution in the rocks, as the main constituent in pegmatite, combined with smaller proportions of quartz and mica. Where other than the usual minerals are found they are generally so segregated as to be readily separated by hand-picking.

Uses.—Feldspar is chiefly employed in china and porcelain factories, where it serves as a flux to bind the other different constituents of the ware. Ironstone ware is made from a mixture of kaolin, ordinary cohesive clay, flint and feldspar. A typical mixture for making ironstone china is as follows: Kaolin, 35%; clay, 16%; quartz, or ground flint, 35%; and feldspar, 14%. The clay gives plasticity for molding, the kaolin furnishes a refractory body, the quartz, or flint, prevents excessive shrinkage in drying and burning, while the feldspar serves as a flux to unite all the ingredients into a partially vitrified material.

Feldspar is also one of the principal agents in the glazing of chinaware, porcelain and tile. It is used also in soap and in metal polish, and small quantities are employed in dentistry.

Prices.—Feldspar, to have commercial value, should be free from iron oxide, mica and quartz. There is often no objection to the presence of quartz in spar for pottery work, provided it is in uniform amounts. Prices vary with the grade and fluctuate with supply and demand. At the quarries in the Eastern States, crude spar f. o. b. varies from $3 to $4.25 per ton. In New York, the price of ground feldspar is from $9 to $10 per short ton.

Distribution of Feldspar.—The chief sources of feldspar in the United States are in Connecticut, Maine, Maryland, Pennsylvania and New York.

Connecticut has been one of the largest producers for many years. Quarries are operated near the towns of Middletown, Portland, Haddam, Chatham and Glastonbury.

In Maine, there are feldspar quarries near Auburn, Brunswick, Georgetown, North Turner and Topsham.

Pennsylvania is the largest producing State. In 1904 it gave 21,077 short tons, valued at $146,154. Chester Heights, Glen Mills, Chatham, Embreeville, Sylmar and Chadd's Ford are productive localities.

In New York, feldspar of good quality is obtained near Bedford. It occurs in pegmatite dikes traversing crystalline rocks, and is associated with mica, quartz and tourmaline. The composition of the orthoclase is SiO_2, 65.85%; Al_2O_3, 19.32%; Fe_2O_3, 0.24%; K_2O and N_2O, 14.1%; CaO, 0.56%; MgO, 0.08%. The output is shipped chiefly to the potteries at Trenton, N. J.

A prosperous feldspar industry has been established in Canada, east of Kingston, Ontario. The spar is in good demand for pottery, and is shipped to Trenton, N. J. The Canadian production of feldspar in 1904 amounted to 11,083 short tons, valued at $21,166, as compared with 13,928 tons, valued at $18,966, in the previous year.

FLINT.

The production of flint in the United States in 1904 amounted to 52,270 short tons, valued at $100,590, as compared with a total production of 55,233 tons, valued at $156,947, in 1903. This 1904 total comprised 41,490 tons of crude flint, valued at $28,890, and 10,780 short tons of ground flint, valued at $71,700. The lessened production was due to the operation of a smaller number of quarries. Maryland and Pennsylvania contributed the major part.

Much of the flint consumed annually in America is imported from England and France. The value of unground flint imported in 1904 was $94,793. Flint is found in chalk formations in central Texas and Florida, but in localities which are too remote from market.

PRODUCTION OF FLINT IN THE UNITED STATES.
(In short tons.)

Year.	Crude.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1900	18,611	$34,553	13,884	$51,798	32,495	$86,351
1901	16,777	30,602	17,643	118,605	34,420	149,297
1902	20,295	35,046	16,070	109,163	36,365	144,209
1903	40,046	38,736	15,187	118,211	55,233	156,947
1904	41.490	28,890	10,780	71 700	52,270	100,590

The best flint is imported, and is ground in revolving pans at Trenton, N. J. It is afterward calcined to whiteness, and mixed with china clay to make certain grades of porcelain. In America, vein quartz is largely substituted for flint in the manufacture of china articles of the commoner grades, but the English Cretaceous flint is preferable for the finer products of the potteries.

The larger part of the flint used in the United States is an amorphous and crystalline quartz found in Maryland, Pennsylvania, Alabama and Connecticut. In New York, quartz is quarried for pottery purposes at Bedford, in Westchester county.

Calcined Cretaceous flint is used in chemical works as a packing for Glover and Gay Lussac sulphuric acid towers, and for condensers for other acid gases.

Flint is found in many parts of Europe, and has been mined since a very remote period. In England and France there are several little villages in which flint knappers still carry on the ancient industries connected with working up flint into articles of commerce. In the village of Brandon, West Suffolk, flint knappers, living in little cottages built of flint nodules, still follow their almost obsolete vocation. Only a dozen men are now employed in quarrying and manufacturing flint implements in Brandon. Flint-lock guns, still used by the natives of many parts of Asia and Africa, create a small demand for gun flints; the average daily output in Brandon alone is about 13,000 or 14,000 pieces. Four sizes are manufactured—the smallest for pistols, two sizes for guns, and a large size for small mounted cannon. In many parts of England and France flint nodules laid in mortar are used for buildings and walls, constituting a very durable building material.

The production of flint in Great Britain in 1904 amounted to 65,256 long tons, as compared with 73,181 tons in 1903.

A recent development of great promise is the use of flint pebbles in tube mills, for grinding in metallurgical works, and in cement plants. Details of operation will be found under 'Progress in Ore Dressing,' by R. H. Richards, on a subsequent page of this volume. Supplies of pebbles come from the chalk beds on both sides of the English channel.

FLUORSPAR.

The production of this mineral during 1904 amounted to 36,452 tons, having a value at the mines of $234,755. As compared with the figures for the previous year, this shows a decrease in output of 6,071 tons, but an increase of $21,138 in value owing to the greater proportion of the output that was ground before marketing. The statistics for the last five years are given in the following table:

PRODUCTION OF FLUORSPAR IN THE UNITED STATES.
(In short tons.)

Year.	Tons.	Value.	Per Ton.
1900	21,656	$113,430	$5.24
1901	19,586	113,803	5.81
1902	48,018	271,832	5.19
1903a	42,523	213,617	4.28
1904a	36,452	234,755	6.44

(a) Statistics of the U. S. Geological Survey.

Kentucky, with 8 mines shipping, produced 19,096 tons; Illinois, with 5 mines, gave 17,205 tons, and the output from Tennessee and Arizona, one mine in each, amounted to 151 tons.

That this remarkable reduction in the annual output is not due to any relaxation in demand for the material is shown by the high average price, $6.44 per ton, maintained during 1904, as compared with $4.28, the average price during the previous year. The lessened shipping activity of several of the largest mines is explained by the fact that they spent a great part of the year, possibly eight months, in development and in the installation of mining and milling machinery. One Kentucky producer has installed a carefully designed hoisting plant at one of its mines, and equipped another with a Joplin mill of modern construction, having a capacity of 200 tons a day. Another Illinois producer was inactive for several months,

OUTPUT OF FLUORSPAR IN THE PRINCIPAL PRODUCING COUNTRIES OF THE WORLD.
(In metric tons.)

Year.	France.	Germany.	Spain.	United Kingdom.	United States.
1900	3,430	30,310	4	1,472	19,646
1901	3,970	28,741	Nil	4,232	17 768
1902	2,650	......	93	6,388	47,190
1903	......	......	4,000	12,102	38,577
1904	......	......	......	18,450	33,069

owing to labor troubles, and by the time these were adjusted, low water prevented shipments by the usual river routes. The increase in the number of Kentucky producers and the care with which the leading ones have been enlarging their scale of operations promise an increased output, under the influence of the high prevailing prices and the growing demand.

The price of fluorspar in the American market is graduated according to the purity of the material, silica being the most objectionable contaminant. If desired for the manufacture of hydrofluoric acid, not more than 1% SiO_2 is permissible; for steel making, 4% SiO_2 is the limit; but for blast- or cupola-furnace use, a higher proportion of silica is allowable. The prices of Kentucky fluorspar gravel, f. o. b. mines, range about as follows: Unwashed, containing 73% calcium fluoride, $3.50 per ton; 80%, $4; 90%, $5; 95%, $6.50; 98%, $7.70; ground, 99%, $12; ground, pure, for acid making, $15. The highest price paid for lump material was $11.50 for the Arizona output; the lowest, $3.60, was paid for a small part of the Kentucky product.

Uses.—Fluorspar is used in the manufacture of hydrofluoric acid, and of glazes and enamels. Its most important application, however, is as a flux in iron and steel metallurgy. It possesses to a high degree the power of liquefying the more refractory gangue minerals, such as calcium and barium sulphates, but has little tendency to dissolve basic oxides. Its chief value in this connection is its ability to carry sulphur and phosphorus into the slag. It is rapidly coming into favor with foundry operators, as a means of thinning their slags, thereby affording cleaner separations and giving more homogeneous and stronger castings. It is of particular value in permitting the use of an increased proportion of scrap iron. At the open hearth plant of the Allegheny Steel Company, a charge of 50 tons of cheap scrap, when melted with 2,500 lb. of fluorspar, is said to give as fine a steel as the best pig. An article on 'The Uses and Technology of Fluorspar' was contributed by F. Julius Fohs to THE MINERAL INDUSTRY, Vol. XII.

GARNET.

The dark red, or alamandine variety of garnet, having a hardness greater than that of quartz, has long been used in certain industries as an abrasive, and it will remain in demand in spite of the increasing output of carborundum and other artificial grinding materials. The production during 1904 amounted to 2,952 tons, valued at $89,636, as compared with 4,413 tons, valued at $146,955, in the preceding year. The production of garnet during the last five years is given in the following table:

PRODUCTION OF GARNET IN THE UNITED STATES.

Year.	Short Tons.	Value.
1900	3,285	92,801
1901	4,444	158,100
1902	3,722	122,826
1903	4,413	146,955
1904	2,952	89,636

The New York locality, near North Creek, in the Adirondacks, continues to afford the largest output, but the opening of some new deposits near Marshall, Madison county, N. C., promises a heavy production from that district. The workings are conveniently located on the main line of the Southern Railway, between Salisbury, N. C., and Chattanooga, Tenn. The property is owned by the North Carolina Garnet Company, of Brooklyn, N. Y., who commenced operations in January, 1904. Though not working continuously, they recorded a substantial output for the year. The garnet is included in a band of chloritic schist 20 ft. wide and traceable for nearly a mile. The crystals are of unusual size, averaging 2 in. diameter, and often exceeding 6 in. While slightly chloritized near the outcrop, the garnet from the deeper workings is perfectly fresh, and is easily separated from its enclosing material, yielding a clean, sharp product.

Gem garnets of the essonite or yellow variety have been obtained at Ramona, San Diego county, Cal., and of the pyrope or green variety in Elliott county, Ky., in association with peridotite dikes, and at Syracuse, N. Y., in the same association.

GEMS AND PRECIOUS STONES.

Amber.

The chief source of amber is along the Baltic coast of Germany, where the mines operated by the Government yield about 500 metric tons annually. Amber is also obtained from the bed of the sea by divers and by a steam dredging plant at Schwarzort. The amber is classed as osseous or bony amber; mottled osseous; oily or misty; and clear amber. The rare green and reddish-brown tints are believed to be due to some peculiar coloration of the original sap in the conifers from the resin of which amber is derived. The rare dark blue tint is thought to be caused by deposits of pyrite disseminated in minute cavities and cracks.

The raw amber for trade purposes is grouped under three heads, viz.: pieces suitable for the manufacture of pipes (*platten and fliesen*); those that can be used for beads and other ornaments, and those (*firnis*) which, from their small size, can be used only to make varnish. Within these chief groups there are about 150 trade subdivisions distinguished by color and size. The finest beads and ornaments are sold in England and Turkey, while there is a large market for amber in France and Russia, and in Roman Catholic and Mohammedan countries.

The famous Burmese amber diggings are situated in the Hukong valley, in the Nangotaimaw hills, near Lalung. The amber occurs in clays believed to be of Miocene age. The amber is fashioned into beads and other trinkets, chiefly in Mandalay. The amber of Burma differs both chemically and physically from all other known varieties. The Prussian amber contains from 2½ to 6% of succinic acid, but the Burmese variety contains none; on dry distillation, formic acid and pyrogallol are obtained. Its ultimate chemical composition is as follows: Carbon, 80.05; hydrogen, 11.50; oxygen, 8.43; sulphur, 0.02%. Its specific gravity varies between 1.030 and 1.095. It is distinguished from many other amber-like resins by its superior hardness, greater toughness, and a peculiar fluorescence which it possesses. The Burmese amber-mining industry at present is in a depressed condition, owing to the competition of the cheap German amber.

An interesting occurrence of amber has been discovered in the Province of Santiago, Santo Domingo. The amber is disseminated through a friable, much broken sandstone and conglomerate containing large amounts of lignite. The amber is usually in ovate masses, from ¼ to 2 in. diameter, and is covered with a brown surface crust. It possesses somewhat of the opalescent character of the Rumanian and Sicilian amber, and varies in color from yellow to a rich brown. The occurrence is, however, of doubtful economic importance.

Diamonds.

Production in all the South African diamond fields made rapid progress in 1904, the progression in monthly yield being extremely marked.

Orange River Colony.—The report of the De Beers Consolidated Mines, Ltd., of Kimberley, for the year ending June 30, 1904, states that its newest mine, the Dutoitspan, is undergoing active development. A recently erected dynamite factory has permitted economy in the obtaining of explosives, and a railroad is being constructed to bring coal from the coal mines at Vierfontein, in which the De Beers corporation owns a large share. The sale of diamonds recovered at the company's four mines—De Beers & Kimberley, Premier, Bultfontein and Dutoitspan—brought £4,918,568. Mining cost £987,335, and milling £599,466; the balance available for dividends, after allowing liberally for all fixed charges, was £2,066,197. The company's capital stock is £4,500,000, and its bonded liabilities £4,241,245.

The average yield and value per load (16 cubic feet) of the 'blue ground' and the stocks remaining unmilled at the close of the year were as follows:

DE BEERS CONSOLIDATED DIAMOND MINES.

	Yield per Load. Carats.	Value Per Carat.	Value Per Load.	Stocks on Floors. Loads.
De Beers and Kimberley	0.54	48s. 11.8d.	26s. 7.1d.	2,213,499
Premier	0.28	34s. 10.5d.	9s. 10.6d.	1,356,260
Bultfontein	0.29	29s. 7.8d.	8s. 6.5d.	397,503
Dutoitspan	...	....	....	15,555

Transvaal.—The output for the fiscal year ending June 30, 1904, was 497,917 carats, valued at £685,720. The progressive condition of the industry may be seen by the following statement of the output by months:

1903.	Carats.	1904.	Carats.
July	16,670	January	34,516
August	16,751	February	43,579
September	20,332	March	51,907
October	28,895	April	77,737
November	29,701	May	78,735
December	30,120	June	68,976

The following limited liability companies contributed: Premier (Transvaal) Diamond Mining Co.; Shuller Diamond Mines; Kaalfontein Diamond Mines; Eastern Diamonds; Montrose Diamond Mining Co. Six other companies, engaged in washing diamonds from alluvial deposits, added something to the total. The Premier not only leads in point of output, but its progress is more marked than at the other mines.

The report of the Premier (Transvaal) Diamond Mining Co., Ltd., of Johannesburg, for the second year of its existence, ending October 31, 1904, states that development is still maintained, and that, while no dividends have yet been distributed, all the equipment has been paid for out of earnings, and that the balance of the year's profit is ample for, and will be directed toward, the completion of the elaborate system of operation now being instituted.

A washing plant, thoroughly equipped in every detail, is being erected, which will afford a total capacity of 20,000 loads per 24 hours. The plant is so situated as to provide ample room for the disposal of tailing, and to permit the use of steam shovels in the mine. This plan is expected to economize labor, and to minimize loss from theft. Additional area has been secured, and a system of water reservoirs will provide a copious supply of water. Railroad connection with the main line at Rayton Station is complete.

The most promising feature of the outlook is the large size and fine quality of the stones. A certain lot of stones, weighing 385 carats, when cut, yielded brilliants weighing 191 carats, and three other stones, weighing 689 carats, were valued at £14,066, or over £20 per carat. Loads, of 16 cu. ft. each, raised from the mine, numbered 1,289,234, at a cost of 2s. 7.6d. per load. They yielded 749,654 carats, or 0.80 carat per load. This yield was less than in the first year, owing to the inclusion of a thick overburden of lean material in the working face, but was superior to the record of the De Beers & Kimberley during the same period—0.54 carat.

Returns from sales of diamonds were £866,030, the net income from which was £667,738, making a balance of £770,601 in the two years.

At Christiana, in the Transvaal, diamonds are found in the bed of the Vaal river, and the alluvial diamond workings support a number of individuals, but the total yield is not large and has no immediate prospect of increasing. Reports of diamond discoveries in the northern parts of the Transvaal are frequent, but investigation never verifies them. The probability of the occurrence of a large diamond field in that part of the country, however, is considered rather good.

In the Orange River Colony, 127,771 carats of diamonds, valued at $1,777,680, were obtained in 1903. The returns for 1904 are not available, but the production was very large. The value of the diamonds sold varied from $7 to $15 per carat, according to quality.

The export of diamonds from British Guiana in 1904 amounted to 11,046 carats, valued at $85,947, which compares with 164,315 stones, weighing 10,742 carats, valued at $103,123, in 1903—an increase of 304 carats in quantity, but a decrease of $17,176 in value. The greatest activity prevails on the Mazaruni river. Prospecting on the Potaro river is attracting attention.

New diamond deposits, which promise to be profitable, are being developed in the Martapura district, in southern Borneo. The western fields continue to yield about 700 carats of diamonds annually.

Diamonds are found on the Diamantina, Bagagem, Matto Grosso, Goyaz and Grao Mogul fields in Brazil. The value of the precious stones (mostly diamonds) exported in 1904 was $316,798, as compared with $545,033 in the previous year.

Diamonds weighing 14,296 carats, valued at $55,776, were obtained from the New South Wales mines in 1904. This is an increase of 2,057 carats and $7,838 in value over the production in 1903. Australian miners are able to obtain only $6 per carat for their stones, for which reason only the richest mines can be worked profitably. Better prices would greatly stimulate production, as diamonds occur over a very large area in the State.

An interesting feature of the Australian industry in 1904 was the discovery of a diamond in the Inverell district, New South Wales, in a dolerite matrix. It was an irregularly shaped (twinned) white crystal of about one-third carat in weight. The dolerite differs altogether from the volcanic breccia in which the Kimberley, South Africa, diamonds are found, and, instead of a pipe, it occurs in the form of an intrusive dike. The formation is apparently extensive and is being developed.

Emeralds.

The mines in the State of Boyaca, Colombia, between May 1, 1904, and January 31, 1905, produced 768,938 carats of emeralds; 10% was of first-class grade, the remainder of inferior grades. The mines were worked for centuries by Indians, then for 300 years by Spaniards, and more recently by lessees from the Colombian Government for short terms. Some of the emeralds found in narrow veins are of most beautiful green tints; others are of light green, white, yellow and red coloration. The emeralds are found in a formation lying from 100 to 200 ft. below the surface, and a great amount of barren material has to be removed to reach the gems. The mines are now being worked by an English company, and it is estimated that they yielded a net profit of $700,000 last year.

Kunzite.

A pale pink and lilac-colored spodumene discovered in California has received the name of kunzite. It is found in a pegmatite dike on Pala mountain, San Diego county. Ordinarily the dike is a coarse muscovite granite containing black tourmaline. Lepidolite occasionally replaces the muscovite, and when it does, red, blue and green tourmaline take the place of the common black variety. The new variety of spodumene is associated with the gem tourmaline. Kunzite cuts and polishes well. It has been placed on the market for a little more than a year, and has gained popularity. It is valued at about $5 per carat when nicely colored. Kunzite crystals have been found that have weighed from 7.7 to 31 oz., and varied in dimensions from 13 by 6 by 2.52 cm. to 23 by 4 by 2 cm. These are the largest and finest crystals of this mineral that have been obtained.

Spodumene is a silicate of alumina and lithia, rather complex in constitution and peculiarly liable to alteration. The common variety is found in small quantities in New England, South Dakota and California, in the United States; also in Peru and Brazil, in South America; in Sweden, Ireland, Scotland and the Tyrol, in Europe. The discovery of the transparent lilac spodumene in California adds a new and elegant stone of purely American production to those used in jewelry. It has also scientific interest from some remarkable properties which it possesses in connection with the action of the Roentgen rays, and those of radium and radio-active substances.

Opal.

Australia continues to contribute the largest part of precious opal to the European market. The chief mining center is at White Cliffs, New South Wales. This field yielded $268,800 worth of opal in 1904, as compared with $480,000 in 1903. During the past year, important discoveries of opal of splendid quality were made at Wallangulla, 50 miles north of Walgett, New South Wales. Some of the gems obtained here sold for $50 per ounce. The Queensland fields yielded opal valued at $16,800 in 1904. This small output is attributed to a dull market and the exceptionally low prices offered.

Ruby.

Burma is still the chief source of the ruby. The principal mines are in the Mogok district, and are controlled by the Burma Ruby Mines Co. This company in 1889 was granted the right to mine the rubies and levy royalties from persons working in competition. The concession was renewed in 1896 for a period of 14 years, at a rent of $102,060 per year, plus a share of the profits. The financial results, however, being unsatisfactory, the rent was reduced in 1898 to $64,800, the interest of the Government in the company's profit being at the same time raised to 30%. Since then production has steadily increased, and the industry is now on a sound and profitable basis. Some of the rubies found in Burma are of exceptional size. One stone found in 1899 weighed 77 carats and was valued at $130,000.

Rubies are the most valuable gem stones of Ceylon, a country which has enjoyed a reputation for the production of beautiful gems for many centuries. The Ceylon rubies never possess the splendid red of the Burma ruby, although they are frequently more brilliant than the Indian variety. A ruby of about 1 carat size, flawless, and of the best color, sells in Ceylon at from $100 to $266; as much as $5,000 has been offered for a fine ruby weighing 4 carats. A few rubies have been found at different times in the gem-mining districts in the vicinity of Anakie, Queensland.

Artificial Rubies.—These have been made by Dr. A. Vermeuil, a German chemist, by melting a mixture of clay and oxide of chromium at an even temperature of several thousand degrees. The two substances are carefully placed above each other in layers, so as to prevent cracking in the crystallized mass. He succeeded in producing an artificial ruby weighing 5 lb., which he valued at $600. From this it may be judged that the quality of the product was not first class. In order to produce the exceedingly high temperature indispensable for success in the operation a blast of oxyhydrogen gas was employed to act directly on the top of the ingredients in the furnace. The hardness of the ruby was obtained by quick cooling through sudden interruption of the oxyhydrogen blast. The artificial ruby is said to be pure and brilliant, possessing all the physical properties of natural rubies. It can be cut, and takes a high polish.

Sapphire.

The Anakie sapphire field, Queensland, produced 14,100 oz. of sapphires in 1904, valued at $50,760. The industry gives employment to 200 miners. The Anakie deposits are the most extensive in the world; but the great obstacle to their development is the difficulty in disposing of the product at satisfactory prices. Attempts to establish selling depots in European and American cities have not proved successful, and producers are dependent upon the visits of foreign buyers.

A beautiful sapphire, 57 carats in weight, and valued at $10,000, was recently found in the Ratnapura district in Ceylon.

Turquoise.

Turquoise of good quality is being successfully mined in several districts in California, New Mexico, and Nevada. The turquoise when pure and of good quality is cut into gems. The white and blue combination known as turquoise matrix is cut and polished as an ornamental stone. The pale varieties of turquoise are cut into beads. The demand for this gem is not now so keen as it has been within a few years.

GOLD AND SILVER.

BY T. A. RICKARD.

The gold output of the world increased during 1904 to $347,267,064, as compared to $329,628,356 in 1903. This increase was due, for the most part, to better conditions in the Transvaal, and to the continued successful mineral development of the United States. In Australasia new sources of production failed to balance the exhaustion of certain of the old ones. The overshadowing event in the record of gold mining in 1904 was the introduction of Chinese labor into South Africa and the consequent immediate stimulation of mining on the Rand.

Australasia exhibits a slight decrease, attributable almost entirely to Western Australia. Nevertheless, the Federation, together with New Zealand, is again the largest gold-producing region in the world, a distinction which it will hold for the last time for many years if progress in the Transvaal fulfils present expectations. Gold mining in Australia during 1904 was characterized by absence of important events. The decrease in Western Australia is not important because it is distributed over a large number of districts. The bulk of the output continues to come from 16 large mines, most of them situated at Kalgoorlie. Despite several scandals due to mixing gambling with business, there has been a gradual approach to cleaner methods, and this has been accompanied by the application of unusual technical skill. Results from diamond-drilling on the 1,900-ft. level of the Great Boulder mine afford strong encouragement for deeper exploitation, and strengthen confidence in the life of the group of big mines to which the State owes its eminence as a gold region.

In Victoria, the greater depth attained at Bendigo is more interesting than important, the deepest workings in that old district having proved disappointing. The Victoria quartz mine has explored at 4,024 ft. without result. But the shallower mines have done well, so that the output is the best for 30 years. The elaborate operations, now fully started, on the 'deep leads' in the Ballarat and adjacent districts, give promise of a development in Victorian gold mining which will contribute notably to an increase of production. If the water can be handled at a reasonable expense, the exploration of these ancient alluvial channels will be highly stimulated during 1905. English capital is heavily invested and the outcome is being watched with keen interest. In Queensland the most notable event is the proof at Mt. Morgan of an enormous body of gold ore, containing copper.

In New South Wales the exploitation of copper deposits is yielding an increasing amount of gold. Dredging of river bottoms is a factor in the gold production of Victoria and New South Wales, but operations are on a small scale. In northern Tasmania the unwatering of the Tasmania mine will affect the output favorably. The new districts in the desert country of South Australia are only of local importance, although there remains a large area of unexplored country which may prove productive when the transcontinental railroad is completed. In New Zealand dredging of the southern rivers has progressed, until now more than one hundred machines are in operation, the total yield from this source being valued at over $2,000,000 per annum. This industry is maintained by local enterprise and appears to have reached its maximum importance. In the north island, the Hauraki peninsula is still feeling the collapse of the boom of 1895 and 1896, when a large number of mines were placed on the London market, with unfortunate results. The Waihi continues to be one of the great mines of the world, having produced $2,900,165 in the year ending last June. Other mines in the Ohinemuri district are undergoing development, but, on the whole, a decreasing production is likely.

The Transvaal ended the year in good spirits; the introduction of Chinese coolies under indenture has proved an economic success, and it appears likely now that there will be a sufficiency of labor, not only to supply existing mines, but also to permit of starting many new enterprises held in abeyance since the war. Production on the Witwatersrand is nearly on a level with the maximum attained in 1899, the yield for December amounting to 349,889 fine oz., as compared to 378,801 fine oz. in August, 1899, just before hostilities began. This rate is certain to increase steadily, as the influx of Chinese allows more stamps to be started. Better success in recruiting for Kaffirs also encourages the hope that the supply of natives will be augmented, as has been the case of late. On a plentiful labor supply the vast investment of capital depends for regular returns, and this appears assured. Metallurgical progress has been a feature of 1904, and successful prospecting with drills on the eastern Rand has extended the known productive area. Apart from these definite improvements, there has been the steady decrease of costs due to greater efficiency in organization and to competition among skilled men eager to produce the best results. While the lessening of expense must have a limit, that limit has not been reached as yet, so that it will continue to be an encouraging factor until such time as the economic minimum is attained. The average yield decreases as expenses are lessened; they are now about $9.25 per ton, and are likely to go down to $7.50. It is believed that, despite disappointments to be encountered in mining below 4,000 ft. of vertical depth, the output will go on increasing until the Transvaal contributes annually $150,000,000 or even $200,000,000 to the world's gold supply.

Rhodesia has grown in importance. Apart from a record yield of 233,199 oz. fine gold, valued at $4,820,223, there have been several discoveries of moment. These include the 'banket' found in the Lomagunda district and gold-bearing gravel in the Victoria district. The value of these occurrences has yet to be determined, but there is reason to believe that they will prove the basis for a notable increase of activity in the territory of the British South African Co. This company has modified the mining ordinance in such a way as to encourage prospecting. There is a vast area in this part of Africa which is steadily being explored, and it is likely that, with the enlarged operations of existing mines, Rhodesia will within a few years be contributing gold at the rate of 500,000 oz. per annum. Despite its deadly climate and the failure of many unwarranted undertakings, West Africa continues to maintain a steady output, and is likely to do better as the few large enterprises come to fruition. West African mines are yielding at the rate of 115,000 oz. per annum; this output includes two dredging companies.

Russian gold comes almost entirely from the Siberian mines, the placers of the Ural having dwindled to unimportance. Of the total output only about 10% comes from quartz mines, the remainder being extracted from gravel deposits distributed over an enormous range of territory, but chiefly in the Nertchinsk district of the Trans-Baikal and on the Amur. Dredges are being introduced and several are at work in the South Yenesei region, the Altai and the Ural. While the production of gold has not been materially increased by the application of dredging, the fact is important as indicative of a more progressive spirit among operators in an important mining region.

In Canada the output comes mainly from the placers in the far north; these maintain a steady production, the exhaustion of bonanza ground being partially compensated by the systematic exploitation of the larger and poorer gravels. The whole of the Canadian Yukon is credited with $10,337,-000, the decrease of $1,913,000 being due to the lessened output from the Klondike. The season was unusually favorable, the rainfall was copious and the snow melted slowly. The construction of several reservoirs and ditches will aid production during the coming season. In the south, British Columbia, with an output of $5,704,908, exhibits a slight increase, due chiefly to the Similkameen district. In western Ontario there is a scattering of gold mines, but their total output continues to be small. The same is true of the old mining districts of Nova Scotia.

In Mexico, progress in gold mining forms part of a general activity which is lifting the Republic to a splendid position. The chief gold district is El Oro, 90 miles from Mexico City, where there is a group of remarkable mines, now in excellent condition, and likely to continue productive for several years. In northern Mexico there have been important discoveries at Lluvio de Oro, Miñaca and Santa Barbara. Mexico is likely to increase its gold output steadily.

In Egypt there has been a revival of activity in the Sudan, the Um Rus mine giving encouraging results. The participation of John Taylor & Sons and of Mr. George B. Robinson in Egyptian mining has stimulated interest. No great increase of production is recorded as yet, most of the operations being of an exploratory nature. Indian gold mining centers in the Kolar goldfield, where a group of seven companies maintains a large output; it is not likely that this will undergo further expansion, as several of the mines have now passed their period of maximum productiveness. During 1904 the production of this field was 561,319 oz. fine, an increase of 21,265 oz. In Korea, the Oriental Consolidated mines, in the Wunsan district, produced $850,000; but the war interfered with smaller operations, so that the output of the country is estimated at $1,000,000. Much of the gold appearing in Korean exports is of Chinese origin. Japanese gold mining, hitherto negligible, has become prominent by reason of important discoveries made in the Iwate district. In Sumatra, the Redyang Lebong, Lebong Soelit and neighboring mines are in the ascendant, but the goldfields of the Celebes, Borneo and New Guiana have not fulfilled expectations.

The Production of Gold and Silver in the United States.

BY T. A. RICKARD.

The production of gold in the United States in 1904 showed a large increase over the previous year. The silver output remained practically unchanged.

Colorado has made up most of the diminution in gold output chronicled a year ago, and nearly reached the maximum attained in 1900, when the yield was $28,829,400. In this State, Cripple Creek continues to make the preponderating contribution, the output being estimated at $14,456,536, as compared to $13,000,000 the year previous. These figures indicate forcibly that the labor troubles, which gave this district so much unfortunate notoriety, did not hinder mining operations as much as was feared. The tonnage produced was greater than in 1903, and the dividends were larger. Several surface discoveries of a promising character have supplemented the opening up of new orebodies in the older mines, and greater activity in exploitation has followed the lowering of treatment charges. This stimulus, due to more favorable rates, together with higher prices for the lead and copper occurring in ores that are smelted, undoubtedly encouraged mining all over the State. Outside of Cripple Creek, the other districts exhibited no marked difference, save in San Miguel and Ouray counties, where, despite the yield from several big mines, there was a falling off, due in part to the continued strife between mine-owners and mine-workers; but this is now practically at an end, so that in 1905 the Camp Bird, Tomboy, Smuggler-Union and Liberty Bell are sure to increase their aggregate output.

California is worthy of her traditions, the production exhibiting a steady increase during recent years. During 1904 there was plenty of water for the stamp-mills, so that the reopening of old mines on the Mother Lode, due to better economic conditions, was facilitated. The most interesting feature was the growth of the dredging industry, which is now responsible for as large an output as the hydraulic and drift mines combined. From Oroville the application of dredges is being extended to other more mountainous districts, with a success which has proved stimulating to the investment of capital.

In Alaska, important discoveries were made on the Tanana river, where 3,000 men have been at work during the season. The Fairbanks district generally has witnessed a period of increased activity. Capital is being invested in several comprehensive ditch systems, the completion of which will permit of large hydraulic operations. At Nome, also, long ditches are being built. The beach deposits at Nome are being depleted; but, despite this fact, the inland placers are contributing sufficient gold to keep the output at nearly $5,000,000, the estimate being $4,878,500 for 1904, as against $4,437,400 in 1903. Of the total gold output of Alaska, about one-third comes from the Treadwell group of lode mines on Douglas island, where a depth of 1,000 ft. has now been attained. There is more intelligent exploration on foot in Alaska today than in any other mining region on this continent, and the scope of it is being immensely increased by greater accessibility and facility of transport, due to the building of railways and wagon roads from the coast to the interior. Progress is slow but substantial.

South Dakota is feeling the benefit of advanced methods of cyanidation, and shows a general progress, in which the famous Homestake is taking the lead. Of the total output of this State, about two-thirds is contributed by the Homestake company, whose equipment has been increased by 100 stamps, together with additions to its cyanide plants.

In Nevada, the completion of the railroad to Tonopah has not only helped that district, but it has stimulated operations at an adjoining camp named Goldfield, the rapid growth of which constitutes the most interesting episode of the year. Situated in an almost waterless desert, Goldfield has shown, as was the case at Tonopah, that rich gold ore can give profits sufficient to overcome natural obstacles, however great. The production of this new district is dependent entirely upon narrow seams of phenomenally rich ore, the persistence of which will be tested during the ensuing year. Expectation of further discoveries is afforded by the results of prospecting in the adjoining region, and also in Lincoln county, where Searchlight and other camps are springing up, by reason of the construction of the new railroad between Salt Lake City and Los Angeles.

Montana also exhibits a healthy increase. Fergus county is the chief gold district; a group of progressive mines, exploiting lodes, some of which are in limestone, maintains a steadily increasing output, which undergoes treatment by cyanide. At Helena, the old Whitlach-Union mine has been resuscitated, and in the country tributary to Helena there are other productive mines of some promise. Dredging in Alder gulch continues. Besides the extraction of gold by direct methods, a large part of Montana's output is incidental to the refining of the immense quantity of copper produced by the mines at Butte. Fully $1,350,000 is derived from this source.

This applies also to Utah, where the recent expansion of copper mining in the Bingham district has helped gold production, through separation of the precious metals occurring in copper sulphides. This is a specially important feature of the low-grade copper deposits of the 'porphyry belt.' The complex ores produced in the Centenial-Eureka, and in other mines of the Tintic district, yield gold in association with silver. This is true also of the big mines at Park City. On the other hand, the essentially gold mining districts, such as Mercur, have not done particularly well. In the Gold Mountain district, the Annie Laurie and Siever mines have enlarged their cyanide mills. General progress undoubtedly has been stimulated by the growth of the smelting industry in the Salt Lake valley, the reduction of the big output of copper sulphide ore affording a good market for silicious material containing the precious metal.

Arizona is apparently without change. The principal activity is in the San Francisco district, where the Gold Roads mine is the chief producer. Among the older mines, the Congress has found good ore at 1,500 ft., and is increasing its equipment. Around Prescott, especially in the Bradshaw mountains, a large number of small mines are contributing, their success being aided by a local market for their ores at the Val Verde smelter. In the desert country bordering the Colorado river there is a revival of activity.

In Idaho, Oregon and Washington, gold mining holds its own, without noteworthy incident. The southern States all show a healthy increase, save Virginia; but their aggregate production is small when compared to the efforts made to awaken interest in a region which first produced gold in the United States.

The silver output of the United States is practically unchanged. An increasing proportion of it is incidental to the mining of other metals. Colorado appears to have lost the lead, although her production is very close to that of Montana; in any event, the dominating position of Colorado as a silver producer is a thing of the past, for not only does Montana rank equal, but Utah is pressing close. In Colorado, Leadville still contributes one-half the total; that district enabled Colorado to win the supremacy from Nevada, as soon as the Comstock declined, in 1880; and to the exhaustion of the big silver-lead ore deposits of Leadville is due the gradual decrease of silver production in Colorado from its maximum, 26,350,000 oz., in 1892. Aspen is practically exhausted, and Creede furnishes a dwindling output, so that a large proportion of the silver is accessory to the extraction of gold and lead in Clear Creek, San Juan, San Miguel, Ouray and other counties.

GOLD PRODUCTION OF THE WORLD.

Countries.	1903. Fine Oz.	1903. Kilograms.	1903. Value.	1904. Fine Oz.	1904. Kilograms.	1904. Value.
AMERICA, NORTH:						
United States (h)	3,560,000	110,727.5	$73,591,700	3,904,986	121,445.1	$80,723,200
Canada	911,639	28,352.	18,843,590	793,420	24,675.4	16,400,000
Newfoundland	6,844	2,112.3	141,477	11	0.3	209
Mexico	(a) 556,887	17,321.0	11,511,530	609,781	18,966.7	12,605,300
Central America	90,711	2,821.4	1,875,001	54,214	1,686.3	1,120,700
AMERICA, SOUTH						
Argentina	1,451	45.1	30,000	446	13.9	9,200
Bolivia	944	30.	19,520	147	4.5	3,000
Brazil	110,014	3,517.8	2,274,000	98,354	3,058.8	2,032,984
Chile	32,172	1,000.6	665,000	30,812	958.4	636,900
Colombia	131,785	4,098.9	2,724,000	95,513	2,970.8	1,974,400
Ecuador	13,304	413.8	275,000	6,430	200.0	132,900
Guiana (British)	77,939	2,424.1	1,611,000	70,661	2,198.0	1,460,580
Guiana (Dutch)	21,212	659.8	438,564	25,169	782.9	520,212
Guiana (French)	101,645	3,161.5	2,101,000	86,532	2,691.5	1,788,800
Peru	34,667	1,078.3	716,567	19,335	601.4	399,654
Uruguay	2,796	83.9	57,800	1,227	40.0	25,368
Venezuela	14,514	451.4	300,000	14,512	451.4	300,000
EUROPE:						
Austria-Hungary	108,789	3,383.8	2,251,086	108,378	(e) 3,371.0	2,240,166
Germany	82,692	2,572.	1,707,650	88,029	2,738.	1,817,288
Italy	2,025	63.	31,663	2,128	66.2	44,000
Norway	358	11.1	7,404	350	10.9	7,234
Portugal	42	1.3	864	40	1.2	827
Russia	1,208,530	37,590.5	24,980,320	1,212,055	37,700.0	25,075,358
Spain	260	8.1	5,382	257	8.	5,316
Sweden	1,640	51.0	33,900	1,958	60.9	42,235
Turkey	997	31.0	20,607	1,400	43.5	29,000
United Kingdom	4,951	154.0	102,339	4,952	154.0	102,400
AFRICA:						
Transvaal	2,963,681	92,164.3	61,259,281	3,779,381	117,554.	78,122,701
Rhodesia	201,960	6,280.	4,174,513	233,199	7,238.3	4,820,223
West Coast	59,981	1,865.6	1,239,807	72,569	2,257.2	1,500,000
Madagascar	55,150	1,715.4	1,139,963	65,076	2,024.1	1,345,121
ASIA:						
Borneo (British)	35,075	1,090.9	725,000	(e) 35,000	1,090.	723,450
China	314,417	9,779.4	(e) 6,500,000	217,688	6,771.0	4,500,000
East Indies (Dutch)	24,238	753.9	501,000	32,046	1,003.0	662,500
India (British)	542,007	16,860.2	11,140,069	561,319	17,457.0	11,602,464
Japan (g)	100,951	3,140.	2,086,657	217,707	6,771.6	4,500,000
Korea	169,328	5,266.6	3,500,000	(e) 48,379	1,505.0	1,000,000
Malay Peninsula	15,724	489.1	325,000	18,990	590.7	392,522
AUSTRALASIA (d)	4,316,349	134,256.5	89,220,102	4,213,868	131,069.0	87,100,852
Unspecified (f)	72,570	2,257.2	1,500,000	72,570	2,257.2	1,500,000
Totals	15,950,239	497,977.3	$329,628,356	16,798,889	522,487.2	$347,267,064

(a) Figures based on exports and coinage. (b) As reported by the *Statistique de l'Industrie Minerale*. (c) Includes output from domestic ores only. (d) Six States and New Zealand. (e) Estimated. (f) Includes Servia, Persia, West Indies, Formosa, British New Guinea and Philippine Islands. (h) Statistics reported by Mr. George E. Roberts, Director of the United States Mint. (g) Exclusive of Formosa.

NOTE.—The value of gold is $20.67 per troy ounce, which is equivalent to $664.55 per kilogram.

Leadville prospered during 1904, not so much in output of silver, which decreased, but in the proposed extension of known ore channels, the full benefit of which will become apparent during the present year.

In Montana, the Granite Mountain and Bimetallic mines continue to be the most important producers of silver, and the old Alice mine, at Butte, has been in operation, but these once famous properties are responsible for only a fraction of the output, the bulk of which is accountable to the copper industry of Butte. The proportion of silver separated in the refining of this copper is decreasing as the mines become deeper, so that the production of silver does not increase as the copper industry grows.

In Utah, nearly two-thirds of the silver is obtained from the lead ores of Park City, together with Eureka, Mammoth and other mining centers in the Tintic district. One-third of the silver is derived from the refining of copper smelted from sulphide ores, mined chiefly at Bingham. This indirect source is growing faster than the mining of silver-lead ores, and promises to assume a preponderating importance within a few years.

The mines of the Cœur d'Alene account for fully six-sevenths of the total output of Idaho; this district is in a flourishing condition, recent activity having been stimulated by the deeper development of large orebodies in the Bunker Hill & Sullivan mine, at a time when that property was supposed to be on the verge of exhaustion. A new mine, the Snowstorm, has come to the front, and, on the whole, the outlook in the Cœur d'Alene is excellent. On the Comstock, in Nevada, there has been some mining activity, but this has been subordinate to the share market. Tonopah is responsible for the bulk of the output, which ought to be well maintained, with the aid of Goldfield. In Arizona, the reopening of the Tombstone mines is proceeding satisfactorily; but the Commonwealth mine, at Pearce, is nearly exhausted. Approximately one-half of the silver production comes from copper ores obtained chiefly in the Bisbee district and in the Bradshaw mountains. The silver of California and the other States not mentioned in this review is incidental to gold mining, except that of the Presidio district, in Texas.

Gold and Silver Mining in the United States in 1904.

Alaska.—The activities of the year in the several mining districts of Alaska are reviewed by Alfred H. Brooks on a subsequent page of this volume. The Treadwell mines on Douglas Island, opposite Juneau on the south coast, are the only extensive exponents of lode mining in Alaska, and are notable for their financially successful manner of handling large deposits of low-grade ore.

During 1904, development work in the Alaska-Treadwell amounted to 9,372 ft., the largest year's work yet recorded. In the mine 939,137 tons of ore were broken during the year, of which 774,575 tons were sent to the mill. The estimates of ore reserves, including ore that must remain as pillars, was, at the close of the year: Above 220-ft. level, 459,826 tons; above

SILVER PRODUCTION OF THE WORLD.

Countries.	1903.			1904.		
	Troy Oz.	Kilograms.	Commercial Value.	Troy Oz.	Kilograms.	Commercial Value.
AMERICA, NORTH:						
United States	54,300,000	1,688,905.5	$29,322,000	57,786,100	1,797,147.7	$33,515,938
Canada	3,198,581	99,475.9	1,709,642	3,718,668	115,650.6	2,127,859
Mexico (a)	67,832,760	2,109,818.0	36,256,610	60,808,978	1,391,764.	35,269,200
Central America	2,100,000	65,316.2	1,122,450	655,357	20,381.	380,100
AMERICA, SOUTH						
Argentina	50,000	1,555.2	28,616	66,153	2,058.0	38,400
Bolivia	6,614,957	205,725.2	3,543,632	6,083,333	189,252.	3,528,300
Chile	(e) 1,650,000	51,320.3	882,925	868,067	27,005.	503,500
Colombia	(e) 2,000,000	62,208.1	1,069,000	946,066	29,432.	548,700
Ecuador	(e) 40,000	1 244.2	21,380	....	....	....
Peru	5,491,349	170,804.	2,935,126	4,667,074	145,165.6	2,670,500
Uruguay	1,000	31.1	572	1,093	34.0	600
EUROPE						
Austria	1,279,972	39,812.5	684 145	1,254,888	39,032.3	732,219
Hungary	619,877	19,280.8	386,106	643,000	(e) 20,000.	367,931
France	751,890	(e) 23,387.0	401,855	609 638	18,966.	353,600
Germany (c)	5,830,000	181,020.8	3,110,790	12,532,938	389,827.	7,172,817
Greece	1,090,367	(e) 33,915.0	582,801	895,172	27 848.	519,200
Italy	784,074	24,388.	420,286	757,777	23,574.	439,500
Norway	240,898	7,269.0	132,030	257,200	(e) 8,000.	147,170
Russia	260,776	8,111.0	139,347	172,912	5,379.	100,300
Spain	4,090,000	127,212.2	2,186,105	4,876 076	151,695.	2,828,100
Sweden	32,298	1,004.6	18,481	20,923	650.8	12,113
Turkey	486,297	(e) 14,566.0	250,305	564 685	17,567.	327,500
United Kingdom	174,896	5,440.	100,075	174,517	5,439.	101,200
ASIA:						
Dutch East Indies	124,678	(e) 3,878.0	66,640	175,479	5,459.	101,800
Japan	1,770,152	(e) 54,745.0	946,146	3,208,620	99,820.	1,861,000
AUSTRALASIA	11,909,040	370,110.1	6,365,382	14,558,892	452,926.	8,444,200
AFRICA	450,000	14,000.0	257,600	486,408	15,129.3	282,100
OTHER COUNTRIES (d)	48,226	1,500.0	25,676	50,000	1,213.1	28,610
	173,222,088	5,386,043.7	$92,965,723	176,840,014	....	$102,402,457

(a) Statistics compiled from exports and coinage. (c) Silver produced from domestic ores only. (d) The output is mostly from China and Persia. (e) Estimated. (f) Estimate furnished by Mr. George E. Roberts, Director of the United States Mint. (g) From the *Statistique de l'Industrie Minerale.*

NOTE.—Unless specified to the contrary, the statistics have been taken from official sources or have been collected directly from the producers by THE MINERAL INDUSTRY. The average commercial value of silver for 1903 was 53.45c. per ounce, equivalent to $17.18 per kilogram; for 1904 it was 57.221c. per ounce, or $18.40 per kilogram.

330-ft. level, 886,676; above 440-ft. level, 314,267; above 600-ft. level, 991,773; above 750-ft. level, 791,585; broken ore in pits and stopes, 573,162; total, 4,017,289 tons. Of the ore sent to the mill 43.7% came from pits and underhand stopes above the 110-ft. level, and 26.2% from stopes on the 440-ft. level.

During the year an average of 37.5 machine drills were at work daily in the mine, 18.5 being employed on stoping, 9 on development, 7 in pits and 3 in cutting out. The total number of feet of holes drilled in the mine was 917,136, and the number of tons of ore broken was 939,137, an average of 1.02 ton for each foot of drilled hole. The average drilling of the machines was 33.55 ft. per 10 hours.

The company has two mills. In the old mill of 240 stamps, run part of the time by water power and part of the time by steam, water power was used 168 days, the total running time being 342 days. This mill crushed 370,648 tons of ore, an average of 4.52 tons per stamp per day. A shortage of battery water and a forced shut-down of the steam power plant reduced the running time in March and April. The 300-stamp mill, which uses water power only, ran 244 days, crushing 404,502 tons of ore, an average of 5.5 tons per stamp per day. The total amount stamped by both mills was 775,150 tons. The recovery from one ton of ore was $1.1519 in the mill and $1.2083 in the sulphuret treatment, total $2.3602, at a cost of 97.24c. for mining, 15.83c. for milling and 14.61c. for sulphuret treatment; total,

PRODUCTION OF GOLD IN THE UNITED STATES. (a)

	1901.		1902.		1903.		1904.	
	Fine Ounces.	Value.	Fine Ounces.	Value.	Fine Ounces.	Value	Fine Ounces	Value.
Alabama	150	$3,100	119	$2,500	213	$4,400	1,417	$29,300
Alaska	333,096	6,885,700	403,730	8,345,800	416,738	8,614,700	450,091	9,304,200
Arizona	197,515	4,083,000	198,933	4,112,300	210,799	4,357,600	161,761	3,343,900
California	817,121	16,891,400	812,319	16,792,100	779,057	16,104,500	924,427	19,109,600
Colorado	1,339,673	27,693,500	1,377,175	28,468,700	1,070,376	22,540,100	1,180,147	24,395,800
Georgia	6,023	124,500	4,730	97,800	3,000	62,000	4,688	96,900
Idaho	90,427	1,869,300	71,352	1,475,000	75,969	1,570,400	72,742	1,503,700
Maryland	....	....	121	2,500	24	500	116	2,400
Michigan	1,490	30,800	....	....	....	....	....	....
Montana	229,495	4,744,100	211,571	4,373,600	213,425	4,411,900	246,606	5,097,800
Nevada	143,374	2,963,800	140,059	2,895,300	163,892	3,388,000	208,390	4,307,800
New Mexico	33,302	688,400	25,693	531,100	11,833	244,600	18,475	381,900
N. Carolina	2,685	55,500	4,390	90,700	3,411	70,500	5,994	123,900
Oregon	87,950	1,818,800	87,881	1,816,700	62,411	1,290,200	63,366	1,309,900
S. Carolina	2,259	46,700	5,896	121,900	4,872	100,700	5,892	121,800
S. Dakota	313,446	6,479,500	336,952	6,265,400	300,243	6,826,700	339,815	7,024,600
Tennessee	....	....	....	....	38	800	208	4,300
Texas	....	....	....	....	....	....	110	2,300
Utah	178,513	3,690,200	173,886	3,594,500	178,863	3,697,400	203,902	4,215,000
Virginia	256	5,300	148	3,100	654	13,500	184	3,800
Washington	28,082	580,500	13,166	272,200	13,589	279,900	15,862	327,900
Wyoming	614	12,700	1,879	38,800	175	3,600	793	16,400
Other States	29	600	....	....	468	9,700	....	....
Total	3,805,500	$78,666,700	3,870,000	$80,000,000	3,560,000	$73,591,700	3,904,986	$80,723,200

(a) Statistics furnished by Mr. George E. Roberts, Director of the United States Mint.

$1.2768. Net earnings for the year were $1.0714 per ton of ore mined. Dividends aggregating $525,000 were distributed, and $160,524 was written off for depreciation and loss.

Arizona.—A general review of progress during 1904, by W. P. Blake, will be found on a subsequent page. The gold yield in Arizona in 1904 was less than in the previous year, owing largely to an exceedingly dry period that caused a dearth of water.

The Gold Road mine at Acme, Mohave county, is developing well. At the 600-ft. level the vein is 40 ft. wide. The ore is of high milling grade and not so refractory as formerly.

In the Gold Nugget mine, in the eastern part of Cochise county, a new 10-ft. ledge is being developed; assays up to $60 per ton have been obtained. Arrangements are being made to double the capacity of the mill.

California.—A review for 1904, by Charles G. Yale, will be found on a subsequent page. The auriferous black sand deposits on the San Andres foothills, Monterey county, are to be worked by magnetic concentrators. A company, having experimented with them, is satisfied that the new process will be a commercial success. Numerous attempts have previously been made to deal with these black sands, but without success. The working of the new magnetic machines will be watched with interest, as there are numerous other black-sand deposits in the State, which could be turned to commercial account if the gold and iron could be cheaply separated.

Few, except those directly interested in the companies or the lands, have a proper idea of the rapidly growing importance of the gold dredge-mining industry of California. Even the men engaged in quartz and other branches of mining in the State have as yet scarcely realized how rapid are the strides being made by the new branch of gold mining. It has eclipsed already both the hydraulic and drift-mining interests, and, indeed, its yield is now greater than both of those industries combined. It was at first supposed that the area of lands available for dredging around Oroville was restricted to the flat portions near the river, but it is found now that some of the high ground may be mined by that process. A good deal of land south of the town has been bonded for dredging, and it is expected that the bald hills extending almost down to Palermo may become the scene of dredging operations.

Thirteen gold dredges are planned for the lower Yuba river bottom in Butte county, within and above the area in which the Government is expending $600,000 on débris restraining works. In this field a syndicate, in which Eastern capital is largely interested, has already installed two of the largest dredges on the Pacific Coast. Long and careful prospecting of some miles of the stream-bed preceded the two dredges mentioned, extensive areas have been acquired, and an expansion of the industry there is to be anticipated. Gold-dredging projects are also under way on this stream, higher up the slope.

The filling up of rivers and streams by the débris from gold-dredging and hydraulicking operations is a frequent cause of trouble between miners and agriculturists. Disputes of this nature have been serious in California, and have done much injury to the development of many of the low-grade placers. In the interests of the miners, the Commissioner of Public Works appointed three prominent civil and mining engineers to consider the shoaling and flooding of the Sacramento river. As a result of their investigations they reported that hydraulic mining is the main cause of the shoaling of the river and the many troubles resulting therefrom. As a remedy, not only is the Sacramento river, throughout its course from Stony Creek to Collinsville, to be leveed, but also the Feather, Yuba, Bear and American

PRODUCTION OF SILVER IN THE UNITED STATES. (a).

	1901.		1902.		19 3.		1904	
	Fine Ounces.	Commercial Value.	Fine Ounces.	Commercial Value.	Fine Ounces.	Commercial Value.	Fine Ounces.	Commercial Value.
Alabama	100	$60	......	$53	....	....	200	116
Alaska	47,900	28,740	92,000	48,760	143,600	$77,544	210,800	122,264
Arizona	2,812,400	1,687,440	3,043,100	1,612,843	3,387,100	1,829,034	2,744,100	1,571,578
California	925,600	555,360	900,800	477,424	931,500	503,010	1,532,500	888,850
Colorado	18,437,800	11,062,680	15,676,000	8,308,280	12,990,200	7,014,708	14,331,600	8,312,328
Georgia	400	240	400	212	400	216	1,500	870
Idaho	5,542,900	3,325,740	5,854,800	3,103,044	6,507,400	3,513,996	7,810,200	4,529,916
Michigan	81,000	48,600	110,800	58,724	50,000	27,000	127,800	74,124
Montana	13,131,700	7,879,020	13,243,800	7,019,214	12,642,300	6,826,842	14,608,100	8,472,698
Nevada	1,812,500	1,087,500	3,746,200	1,985,486	5,050,500	2,727,270	2,695,100	1,563,158
N. Mexico	563,400	338,040	457,200	242,316	180,700	97,578	214,600	124,468
N. Carolina	20,300	12,180	20,900	11,077	11,000	5,940	14,800	8,584
Oregon	160,100	96,060	93,300	49,449	118,000	63,720	133,200	77,256
S. Carolina	200	120	300	159	300	162	500	290
S. Dakota	78,000	46,800	340,200	180,306	221,200	119,448	187,000	108,460
Tennessee	....	....	12,300	6,519	13,000	7,020	59,200	34,336
Texas	472,400	283,440	446,200	236,486	454,400	245,376	469,600	272,368
Utah	10,760,800	6,456,480	10,831,700	5,740,801	11,196,800	6,046,272	12,484,300	7,240,894
Virginia	700	420	5,900	3,127	9,500	5,130	6,700	3,886
Washington	344,400	206,640	619,000	328,070	294,500	159,030	149,900	86,942
Wyoming	21,400	12,840	5,000	2 650	200	108	4,400	2,552
Other States	....	....	....	....	97,400	52,596	....	....
	55,214,000	$33,128,400	55,500,000	$29,415,000	54,300,000	$29,332,000	57,786,100	$33,515,938

(a) Statistics furnished by Mr. George E. Roberts, Director of the United States Mint.

rivers and other tributaries are to be so treated. Even the small creeks are to be lined with levees, and the hill drainage is to be collected and carried off in canals. Through the great basins there are to extend waterways for drainage, which during the period of channel improvements will operate as by-passes to receive and carry away the spill from the river. An essential feature of the project is cutting off bends and straightening the river between the mouth of the Feather and the city of Colusa, it being proposed to reduce the present length of this part of the stream, which is almost 70 miles, to 47 miles. In order to increase the scour of the river in its lower reaches, it is proposed to close the sloughs through which a part of the discharge now enters the San Joaquin. The estimate of cost is $23,776,022.

Colorado.—Gold mining in Colorado continues to progress, notwithstanding the labor troubles and serious political disorder. In 1904 the gold yield was valued at $24,223,008, as compared with $22,540,100 in the previous year. Silver fell from 12,990,200 fine oz. in 1903 to 12,960,777 oz. in 1904.

Gold mining still centers at Cripple Creek, where operations are now proceeding smoothly, with excellent reports of new discoveries in a large number of mines. Leasing is responsible for much healthy activity; in fact, the lessees have demonstrated that they can work mines with better results, both in economy and discovery of ore, than large companies. The number of leased properties far exceeds the mines worked by the owners. Despite serious interruptions early in the year, the gold output of the district, aided by a large production during later months, was $14,456,536, an increase of $2,616,264, as compared with 1903. At the end of the year, production was at the rate of 55,000 to 60,000 tons per month.

Among the noteworthy features at Cripple Creek are the discoveries in the mines of Beacon Hill, due largely to the lowering of the general water-level of the district by drainage adit. An unusual number of surface discoveries have been made, affording the basis for new exploration. In some of the older mines, such as the Portland, Elkton, Gold King, Gold Coin and Blue Bird, new orebodies have been uncovered at the deeper levels. Apart from successful mining, there has been greater activity in local cyanide practice. The Homestake mine is treating 200 tons of $2.50 ore from a large quarry, 1,500 ft. long and 700 ft. wide. This mill is to be increased to 1,000-ton capacity. Over a large area of Ironclad hill there exists an enormous quantity of low-grade oxidized material, which can be mined and cyanided at a small cost. Other mills are likely to be erected for this purpose.

GOLD AND SILVER PRODUCTION OF COLORADO IN 1904.

County.	Gold.		Silver	
	Ounces.	Value.	Ounces	Value
Boulder	19,912	$411,581	57,424	$32,858
Clear Creek	30,799	636,615	873,949	500,074
Gilpin	67,918	1,403,865	318,406	182,192
Lake	57,419	1,186,851	5,085,151	2,909,723
Mineral	10,782	222,864	1,664,633	952,503
Ouray	104,367	2,157,266	294,028	168,243
Pitkin	113	2,336	2,129,618	1,218,567
San Juan	67,569	1,396,651	1,042,044	596,258
San Miguel	74,072	1,531,068	667,710	382,064
Summit	10,069	208,126	180,554	103,313
Teller	699,397	14,456,536	47,817	27,361
Others	29,475	610,249	599,443	342,701
Total	1,171,892	$24,223,008	12,960,777	$7,416,157

The new deep-drainage tunnel, which the mine owners of Cripple Creek have decided to build, will cost approximately $800,000 and will, it is believed, practically drain the whole productive area. Its total length will be 27,140 ft. It will start at a point in the bed of Cripple Creek three miles below El Paso shaft. From the portal it will be driven northeast to El Paso shaft, a distance of 14,000 ft.; thence a little north of east to the Vindicator property, a distance of 12,640 ft. It will cut El Paso workings at an approximate depth of 1,325 ft., the Elkton at approximately 1,680 ft., the Portland at over 2,000 ft., and the Vindicator at over 2,125 ft. in depth. The cost will be borne by the leading properties in the district drained. The former drainage tunnel for this district is 770 ft. above the level of the new one.

A new lease of life has been given to Leadville by the Reindeer and Coronado discoveries. The first is on a lease held by the Campion brothers; it indicates the southwest extension of the Rock and Dome shoot. Another important development was made by lessees in the 'downtown' territory, where the Coronado shaft penetrated a fine body of ore under the parting quartzite and below the Elk fault, apparently the western extension of the Henrietta-Maid shoot. The wide bearing of this discovery has been confirmed by drill-holes. The ore is a typical silicious Leadville carbonate, but it carries copper. Among other promising events, the old Iron Silver mine has come to the front with discoveries of sulphide ore in the Moyer. The Yak Tunnel has become a large producer, sending out 3,500 tons per month; large bodies of sulphide ore have been cut, and A. R. Meyer is erecting a 200-ton concentrator at the entrance of the adit. During the year the production of Leadville was at the rate of 50,000 tons per month, of which 30,000 tons went to the American Smelting & Refining Co., 15,000 tons of zinc ore and concentrate went to Canyon City, Pueblo, Kansas and abroad, while the Salida smelter secured the remaining 4,000 to 5,000 tons.

The San Juan region maintained its output except at Telluride, where work was hindered by labor disturbances. But Telluride continues to be a progressive center; the Gold King has installed four flint-mills for fine grinding and has made a successful trial with the De Laval steam turbine; at the Liberty Bell slime treatment has been carefully investigated and improved methods have resulted. The Smuggler-Union is said to be yielding a profit since the adoption of the leasing system. At Ouray, the Camp Bird maintained a gold output of $130,000 to $150,000 per month, and met with success in exploratory work. At Silverton, the Silver Lake suffered by the burning of the middle tramway station, which interrupted production for several months.

In the old districts of Gilpin and Clear Creek there was healthy activity, stimulated by favorable smelter rates. Northern Gilpin and Boulder counties benefited by new railroad facilities. In Boulder, the Old Town Mining & Milling Co. declared two dividends during the year. The most conspicuous improvement, however, was in connection with the working of the old Gregory-Bobtail property, at which a new discovery was made by crosscut from the Cook shaft to the main Mammoth-Fisk-Gregory-Bobtail vein system.

Placer mining showed an increase. The Keystone company at Telluride secured handsome returns; the Snowstorm and other placers in the Fairplay and Alma districts had a good season; at Breckenridge, the American dredge worked satisfactorily and a new dredge of the double-lift type was erected on French gulch; on Clear creek two electric dredges of the single-lift type were installed and commenced operations; and the Twin Lakes placers had a satisfactory season.

Idaho.—Silver is the most important product of the Idaho mines, and gold takes a position after lead. The silver production in 1904 was valued at $10,558,184, and that of gold amounted to $1,845,828. The mountain areas of Idaho, covering over 84,000 square miles, are more or less gold-bearing throughout, but particularly so in the Owyhee range and the granite areas stretching from the northern border of the Snake River plains to the Canadian boundary.

Owyhee county continues the chief gold-producing center, due largely to the successful operation of its two famous mines, the Trade Dollar and Delamar. Both of these properties yielded better ore and larger profits during 1904 than for several years previously. The most important event in this field was the resumption of work on the Sinker tunnel at War Eagle mountain, near Silver City. This enterprise suspended operations for financial reasons several years ago, after successfully tapping the War Eagle vein at a depth of 2,100 ft., or over 800 ft. below the lowest point of previous development. These mines when first worked yielded $20,000,000 of gold. Where it was cut by the tunnel, 1¼ miles from the portal, the vein was found to contain bunches of very rich gold ore, but exploration ceased before connection was made with the old workings.

An important discovery of telluride was made in the Iron Spring mine, on a tributary of the Rapid river, five miles north of Black lake. A belt of schist runs through the mine, carrying pyrite which sometimes gives high assay values, due, apparently, to the presence of gold tellurides. A specimen of tellurium ore from this district contained small quantities of hessite and petzite, and assayed 75 oz. gold and 1,061 oz. silver per ton.

The Thunder Mountain district made rapid progress during 1904, in the completion of the new wagon road and the increased bullion output of the Dewey mine, valued at $78,000. The average value of the ore is between $16 and $18. The Sunnyside mine at Thunder mountain is developed well and is expected to be a regular producer in 1905.

A pump dredge has been in successful operation on the Snake river, 30 miles southwest of Minidoka, since 1894, and as a large area of this river's bed is auriferous, it is probable that gold dredging will be carried on in the near future to a much larger extent.

Montana. (By B. E. St. Charles.)—The mines of Fergus county have done well. The Barnes-King, at Kendall, mined and treated 6,500 tons of ore per month, did a lot of development work, and installed a 75-h. p. motor with which to operate the mill. An adit was started to traverse the entire length of the property (a mile), and two shafts are being sunk to ventilate. A depth of over 700 ft., on the dip of the lode, has been attained. At the Kendall mine, owned by the company of that name, 9,000 tons of ore per month were mined and treated. The orebody has been prospected to a depth of more than 1,000 ft., with a diamond drill. The Whisky Gulch mine, near Gild Edge, yielded 3,000 tons of ore per month, and the Gold Reef, 4,000. In the Little Rocky district of Choteau county, the Barnes-King company extracted 3,000 tons per month from the Alder Gulch mine. An adit has been started to tap the orebody below the old workings, 250 ft. deep. Two other companies were organized to operate in this district; they are now building mills, each of which will have a capacity of 3,000 tons per month.

The Whitlach Union mine, in Lewis and Clarke county, after being closed down 27 years, was reopened in 1904. A two-compartment shaft has been sunk 400 ft. At the Big Indian, four miles south of Helena, 300 tons of ore per day were treated in the 60-stamp mill, run by electricity.

The plant of the American Smelting & Mining Co. at East Helena received 2,000 tons of ore per month from Butte. Other supplies came from Madison, Jefferson, Broadwater, Lewis and Clarke, and Cascade counties, Montana; and from the Cœur d'Alene district of Idaho. The company spent $10,000 in improvements, and opened up its own limestone quarry near the smelter. Shipments from the Southern Cross mines, 17 miles west of Anaconda, during the last six months of 1904 aggregated 60 tons per day, the average value of which was $25 per ton. The company recently erected a 60-ton concentrator. In Madison county, the Leviathan company mined and treated 5,000 tons of $10 ore during the last eight months. The Montana-Revenue company started its new 60-ton mill in October.

Among the silver mines, the Granite Mountain-Bimetallic kept one-half its 100 stamps supplied, crushing about 100 tons per day. The Alice, under tribute, produced an average of 30 tons per day, and the Goldsmith yielded 50 tons per day. At the Liverpool, in Jefferson county, an average production of 10 tons of high-grade ore per day was maintained from development work.

New Mexico.—Gold production in New Mexico has shown a steady decrease for several years past, notwithstanding that gold is found over a large area in the State. The principal producer in 1904 was El Oro dredge, on the Moreno placers, in Colfax county, which produced over one-third of the entire gold output of the territory. Next in gold production come Grant and Sierra counties, while the placers in southern Santa Fé, Taos, Lincoln, Sierra and Socorro counties all contributed. The richest gold mines in the territory are in the Mogollon, the Red river and the Elizabethtown districts, but their remoteness from railroads and the difficulty of treating the ores reserve their importance as gold producers for the future.

Oregon.—Interest centers in the Cornucopia camp, 60 miles east of Baker City, where active work was conducted on old and new properties. In the Mayflower group, owned by the Stampe de Mining Co., of Tacoma, discoveries of high-grade ore were made.

The dredging grounds of southern Oregon are attracting the attention of many California operators. Foots, Galls and Crane creeks, and other tributaries of the Rogue river are being closely examined. A factor favorable to the development of this industry is the establishment of electric power plants at many available points, as Gold Bay, Grant's Pass, etc. The Condor company has already extended its lines to many dredging districts, and promises to penetrate to the uppermost reaches of the Rogue valley.

South Dakota.—Gold mining in South Dakota is confined to the Black Hills, a small mountainous area 40 miles broad by 80 miles long. The mining industry is in a healthy condition, and the immense bodies of ore the various companies have developed indicate a prosperous future. The estimated outputs of the principal producers in 1904 were as follows: Clover Leaf, $166,200; Columbus Consolidated, $36,000; Dakota, $90,955; Golden Reward, $414,190; Hidden Fortune, $136,000; Homestake, $4,950,-558; Horseshoe, $412,837; Imperial, $239,800; Lundberg, Dorr & Wilson, $142,000; A. Maitland, $315,078; National Smelter, $45,056; Spearfish, $236,000; Wasp No. 2, $111,000.

The following plants were built during the year, the figures representing their estimated capacity per day: Branch Mint, 900; Globe, 100; Eleventh Hour, 150; Victoria, 200; Queen of the Hills, 100; Puritan, 100; Ruby, 40; Lucky Strike, 250; Golden West, 150. During the year the following mills were put in commission: Hidden Fortune, 120; Homestake (increase), 400; Lundberg, Dorr & Wilson, 100; Gilt Edge-Maid, 150; Black Eagle, 60; Horseshoe, 400. Aside from the producing companies, not less than a quarter of a million dollars was spent in the development and equipment of prospects. Among the prominent companies that installed machinery for development purposes were: Elliptic, Dizzy, Goldstake, Lucky Strike, Puritan, Big Four, Hidden Treasure, Dakota, Horseshoe, Black Eagle, Grand, Deadwood Standard, Queen of the Hills, Gopher, Mainstay and Ivanhoe.

Results generally were gratifying from the standpoint of both the investor and the metallurgist. Horseshoe and Hidden Fortune, two companies that a year ago were in serious financial difficulty, are now operating their mills steadily and successfully.

The Homestake company paid its first dividend on October 1, 1878. Since then not a month has elapsed without a distribution of profits. With its 1,000 stamps it treats 4,000 tons of ore daily. The annual report for the year ending June 1, 1904, shows bullion receipts of $4,800,558, exceeding those of the previous year by $273,616. There were milled during the year 1,299,057 tons (19,982 more than in the year before), and the average per ton was $3.695, or 15.6c. per ton better than during the preceding year.

During the year 12 monthly dividends of $54,600 each were paid, or 25c. a share for the 218,400 shares of stock outstanding. The 1,100-ft. level reached a year ago in the Ellison shaft has been opened sufficiently to show that the ore vein being worked above that level continues to it, and also holds its width at that depth. The shaft has been sunk to 1,250 ft., where the next level will be opened.

Utah.—Prosperity in 1904 was evidenced by a marked increase in the gold and silver output, and mainly attributable to the Bingham district. Conditions at Bingham were described under 'Copper,' and Park City will be mentioned under 'Lead.' At Mercur, improvements in metallurgical practice have effected reductions in expenses, although dividends have not been resumed.

The Consolidated Mercur Gold Mines Co., during the year ending June 30, 1904, mined and milled 226,701 tons of ore averaging $3.89 in value, the decrease of 119,658 tons from the amount treated in the preceding year being due to the diversion of one-third of the mill's tankage capacity to slime treatment. The Moore process was given a trial, lasting through a large part of the year, and was finally abandoned, owing to mechanical difficulties. Assays of the tailing varied from $0.83 in July, 1903, to $1.43 in April, 1904, averaging $1.03 for the year. Recovery averaged $2.86, and miscellaneous receipts raised the total to $2.92 per ton. Mining cost $1.40 and milling $1.60; total charges, $3, showing a deficit of 8c. per ton. Recent developments have extended the boundaries of the known orebody, and have indicated some improvement in grade.

The gold districts in the southern part of the State are already feeling the stimulus of through railroad connection with the Pacific coast, afforded by the recently completed San Pedro, Los Angeles & Salt Lake Railroad; the San Francisco, Beaver Lake, and Gold Mountain districts are those most directly benefited.

Washington.—Gold and silver production is steadily increasing, but not at a rate commensurate with the State's great mineral resources. The industry suffers from want of capital, and is almost entirely dependent upon the efforts of residents. The Sherman camp, ten miles northwest of Republic, on the dividing boundary of Ferry and Okanogan counties and west of the great granite bed which traverses the western side of the Republic district, is again attracting attention after a lapse of two or three years' comparative inactivity.

The Philippines.—Gold is found in almost every large island in the Philippine archipelago. The placers of the Camarines have for many years made good yields of gold. The placers of Bulacan, Pigholugan, Arroroy and Pigtao also have been large producers.[1]

Quartz veins occur in Benguet, Lepanto, and Surigao provinces. The

[1] *Annual Report* of Mining Bureau of the Philippines, 1904. Abstracted in THE ENGINEERING AND MINING JOURNAL, June 1, 1905.

best-defined veins appear to be confined to the older crystalline rocks; those of the Camarines and Masbate notably so. In the provinces of Lepanto and Benguet there are several deposits of low-grade refractory ores.

It is proposed to work some of the placers in the Camarines, Masbate, and Mindanao by hydraulicking, and by dredges. The Masbate Gold Mining Co. has a large bucket dredge built by the Risdon Iron Works, of San Francisco. The dredge has a capacity of 3,000 cu. yd. daily.

The transportation problems are being rapidly solved by Government construction of roads and bridges, while unsettled conditions due to brigandage and insurrection are no longer such as to delay mining development.

Gold Mining in Foreign Countries.

Africa.

Egypt.—In the past five years a large amount of English capital has been invested in developing gold in Egypt. The results in many instances have been satisfactory, and it is probable that this part of Africa will again, after a quiescence of many centuries, become an important gold producer.

The result of the past four years' work is: Two mines have been opened up to a considerable extent—Um Rus and Um Nabardi. Three rich prospects have been found—Nile Valley, North Nile Valley and Atallah; the Nile Valley may turn into a rich mine at any time. One prospect, not rich, but with possibilities, exists in Eridia; another, more speculative, in Fatira. The best prospecting areas in which no real mining work has been done are the Nubias, the Gold & Gem, and the Gabait.

British Central Africa.—There are promising gold deposits in the Shiré highlands. The known veins are of large size, but carry only low values. A lode of argentiferous galena in Angoniland assays 81% lead and 26 oz. of silver per ton.

German East Africa.—Concessions for dredging in the navigable rivers flowing into Lake Victoria and the Indian Ocean respectively have been granted to E. von Mandelsloh and P. Wilken, both of Durban, for the purpose of extracting gold and diamonds from the sand. Besides these the local authorities granted 105 licenses to prospect for minerals (as against 92 in 1903), of which 65 were for the district of Muanza, where gold-bearing quartz veins have been discovered.

Prospectors sent out by the Central African Lakes Co. discovered gold on Lake Victoria Nyanza. A company with a capital of half a million marks ($125,000) has been formed, under the title of the Central African Mining Co., to exploit the fields.

Gold Coast.—The principal gold mines are situated in the Wassau, Sefwhi, and Ashanti districts. The producing mines are the Ashanti Gold Field, Ashanti Sansu, Bibiani, Broomassi and Wassau. In 1904 two dredges—the Birrim Valley and Offin River—yielded good returns.

Madagascar.—Gold discoveries on this island are becoming numerous and have led to the formation of prospecting syndicates, English capital being particularly available for this purpose. Some of the alluvial deposits have already begun to pay. A single claim on which work began in 1904 has already yielded 250 kg. of gold, and the monthly yield now averages 35 kg., with 2,000 men employed. Quartz veins in the vicinity have been found, assays of which were sufficiently encouraging to lead to a thorough development.

Rhodesia.—The gold output of 1904 was the largest yet recorded, viz., 267,737 crude oz., which was an increase of 35,865 crude oz. over 1903; the output has exhibited a steady growth, as the following table indicates:

Year.	Oz. Crude.	Year.	Oz. Crude.
1898	18,085	1902	194,268
1899	65,303	1903	231,872
1900	91,816	1904	267,737
1901	172,060		

The fineness of the output is not published; in November, 1904, it was 0.844, and in December it was 0.850. The silver output was 67,759 oz. in 1904 and 15,952 oz. in the last four months of 1903, when silver was first separately reported. The source of the gold may be indicated by the following analysis of the December, 1904, output:

	Number of: Mines.	Number of: Stamps.	Ore Crushed. Tons.	Product from: Mill. Oz.	Product from: Tailing. Oz.	Product from: Other. Oz.
Matabeleland	32	470	50,327	16,994	3,038	37
Mashonaland	18	188	19,847	5,949	1,407	674
Totals	50	658	70,174	22,943	4,445	711
Value				£86,735	£13,283	£2,836

A noteworthy feature of the industry is the increasing number of small producers. The British South Africa Co., whose concession covers the gold area, was accustomed to lease its properties, for exploitation, to individuals on terms which allowed them to crush up to 750 tons per month on payment of a royalty of 2½% upon the gross output of gold whenever the profits exceeded £100 per month. Experience proved that the ordinary 5-stamp battery, when supplemented by a Huntington mill, was capable of crushing from 1,000 to 1,200 tons per month. Accordingly the South Africa company made new proposals, based on the assumption that the maximum tonnage crushed by an individual worker would not exceed 1,200 tons per month. With this tonnage it was considered that an output of 750 oz. would give an excellent profit, with a royalty of 2½%. From this point a further 1% had to be paid on every additional 100 oz. of gold obtained up to 7½% on 1,500 oz. A proposition capable of producing gold in greater quantities than 1,500 oz. was not considered one that should be taken into account in arrangements designed solely to assist small workers. These new arrangements came into force on August 18, and their effect was soon marked. A larger working population was encouraged, several small batteries were erected or re-started, and further reduction plants are being erected each month. The list for December shows the full number of producing properties to be 50—a great increase when compared with the figures of a little over a year ago, and a distinctly satisfactory sign. The stamps, which in January numbered 398, had by the end of August risen to 530, and to 658 at the end of the year.

A noteworthy feature of the year was the discovery of a gold-bearing conglomerate in the district of Lo Magundi, in Mashonaland.[2] The chief discovery was made in the Eldorado mine, where the banket consists of a matrix almost exclusively composed of hornblende, feldspar and quartz, with occasional olivine. The structure is microgranitic, and the appearance is not unlike fine quartz diorite, or the granulites of Western Australia. The matrix belongs probably to the holo-crystalline group of igneous rocks, and it would rank as a granulite or an aphanite. In places an excess of quartz, probably due to segregation, makes it an almost ideal quartz diorite, although these zones would appear to be somewhat scarce and localized. The foot-wall of the conglomerate, in depth, is very much of the same appearance and composition, although it is generally highly laminated with concentration in parallel bands of the quartz and the hornblende, and occasional micaceous streaks and slickensides. The junction of the foot-wall schists and the conglomerate often shows lenticular quartz segregations carrying gold, but apparently no other mineralization. The matrix is generally close-grained and compact, but portions exist where the crystals are of larger size, and where infiltrations have had an opportunity of percolating. Occasional joints are also in evidence along certain lines of weakness and have become highly mineralized by infiltrations. Many samples of the conglomerate where the matrix is extremely fine-grained and compact, and where apparently no chance existed for subsequent infiltrations and mineralization, have shown the presence of gold in small quantity and also of pyrite in minute specks. This fact, coupled with the occurrence of gold-bearing quartz segregations, would show that gold was one of the original constituents of the matrix. The rich parts of the matrix apparently are due to the segregated portions of gold and also to mineralized portions from subsequent infiltrations from deep-seated sources. The foot-wall portion of the conglomerate shows more scattered and more varied enclosures consisting of syenite, felsite, chert, and quartz. Certain parts of the foot-wall also show a matrix of hornblende and quartz, fine-grained, with well-developed crystals of white plagioclastic feldspar, and occasional grains of light-blue quartz. The formation consists of two or three distinct bands of conglomerate separated by bands of schists of varying thickness.

Arsenical pyrite and small quantities of tellurides occur closely asso-

[2] Harry D. Griffiths, 'Banket in Rhodesia,' The Engineering and Mining Journal, June 29, 1905.

ciated with the rich shoots in the Eldorado mine; on the Matwatzi river, one analysis gave 2.36% of gold and 2% of tellurium; two others gave tellurium in smaller quantities. The tellurides apparently occur in a peculiar form as a coating upon the arsenical pyrite, and have the appearance and glance of sylvanite.

South Africa.—An exhaustive review of progress in the Transvaal, by W. Fischer Wilkinson, will be found in the latter part of this volume.

Asia.

Borneo.—The chief gold-mining districts in Borneo are Sambas, in the west of the island, on the Kehajang and Kapuas rivers in the center, and on the southeast coast. Chinese are the principal miners. In British Borneo, the Borneo company, Ltd., is working a profitable gold mine, equipped with a large mill and cyanide works. The annual yield is between 30,000 and 40,000 oz. of gold.

China.—Gold and silver deposits have been worked in many parts of China since a remote period. These metals are found in quantity in the provinces of Hunan, Kuangsi, Fohkien, Shantung, and Yunnan. The vein and placer deposits of Chili and Fohkien are of great value, and, when developed by modern methods, will become large producers. Gold is found also in the rich silver-lead-copper ore mined in the Tien-Pau-Shan mines.[3]

India.—The output of the gold-producing States is indicated by the following table:

	1899.	1900.	1901.	1902.	1903.	1904.
Mysore	£1,678,463	£1,879,085	£1,923,081	£1,969,442	£2,283,999	£2,384,483
Nizam's Dominions	33,335	9,375	....	....	14,505	(*a*)
Burma	4,386	3,327	7,606	5,894	3,988	(*a*)
Madras	1,261	17	....	....	....	(*a*)
Totals (*b*)	£1,717,445	£1,891,804	£1,930,687	£1,975,336	£2,302,492	£2,384,483

(*a*) Statistics not available. (*b*) Totals do not include small amounts recovered in river washing, for which no accurate returns are available.

The Kolar field, the sole contributor to the output from Mysore, accounts for over 99% of the Indian yield. Its output in 1904 was equivalent to 561,319 fine oz., worth $11,602,464. All the mines in the district work on the same vein, averaging 4 ft. wide and auriferous for only four miles on the strike, and the yield approximates closely 1 oz. per ton of ore crushed. Of the several mines, five paid dividends in 1904, viz.: Champion Reef, Mysore, Ooregum, Nundydroog and Balaghat, which mines gave 98% of the field's output; three others contributed bullion, viz.: Coromandel, Mysore West and Mysore Wynaad; six more were in operation, but made no production—Road Block, Oriental Gold, Kempinkote, Kadur-Mysore, Gold Fields of Mysore and Nine Reefs; the Mysore Nagar ceased operations. At

[3] John C. Shengle, 'The Tien-Pau-Shan Mines,' THE ENGINEERING AND MINING JOURNAL, June 1, 1905.

the Bellara Block, active development is under way, and at East Betarayaswami and Bodimardi further exploration is contemplated.

Within the last four years the cost of extraction has been reduced by 6.786s. per ton of crushed ore, the principal retrenchments having occurred under the heads of fuel and labor. Coal now costs at the mines 21s. per ton; while most of the electrical power used has cost £29 per horsepower per annum, though this figure has now been reduced to £18. The reduction in costs, despite the lower grade of ore treated, has enabled larger dividends to be paid; it is, however, chiefly due to enlarged scale of working, the ore hoisted having increased by 80%, from 552,146 tons to 998,818 tons, with consequent reduction in standing charges. Little further improvement in this direction, however, can be hoped for in the immediate future, as the supply of ore to the mills cannot be much increased for some time; more economical working and better extractions are the ways in which further reduction in costs must be sought. In this direction a good deal may be hoped for, as the present high figure of 28.205s., when compared with the 21s. 3.19d., recently given as the Rand average, or still more with the 14s. 1.33d. per long ton of the Great Fingall, 14s. 10.33d. of the Cosmopolitan, 15s. 10.66d. of the East Murchison, and 17s. 6.83d. of the Sons of Gwalia, to take similarly free-milling ores in Western Australia, would suggest. The average weight of the stamps in the six chief mines of the field is 1,057 lb., giving a duty of 3.03 tons per day, against the Transvaal figure of 4.8 tons for a somewhat heavier head. With the exception of preliminary breaking in the rock crushers, the stamps do the whole of the crushing, the ore being amalgamated in the mortar boxes and the pulp passed through 34.7 mesh. This is the finest crushing it receives. The pulp is then stacked in heaps for some months to weather before cyaniding.

The report of the Champion Reef Gold Mining Co., the leading producer, for the year ending Sept. 30, 1904, shows that 181,948 tons of ore were hoisted and crushed, and that the year's development placed 419,895 tons in reserve. Of the 215,687 oz. of bullion (equivalent to 210,096 oz. fine) recovered, 84.3% came from the batteries, 15% from cyanide treatment of sand and slime, and the remainder from scraping the plates. The mill contains 220 heavy stamps, and electrical equipment is being installed as rapidly as power can be obtained. Mining cost $5.34 per ton; milling, $1.50; cyaniding, $0.71; and $1.07 per ton was paid as royalty. During the year the company paid dividends aggregating nearly 168% on its £260,000 capital, after providing for income tax and depreciation.

Korea.—Korea is rich in minerals, and gold and silver deposits are found over a wide area. At present several American and English companies are successfully developing large mining concessions. The principal quartz veins now being worked for gold are at Usan and Tangokae. The Province of Ping-Yang is reputed to be especially rich in gold-bearing veins. In 1904 the Oriental Consolidated mines, in the Wunsan district, produced

$850,000 gold. The war interfered with smaller operations, and for this reason the total yield for the year is estimated at about $1,000,000.

Japan.—Gold placers are worked in the district of Esashi on Hokkaido. The principal quartz mines are in the Provinces of Echigo and Satsuma. In 1904 gold deposits were found at Iwate. The whole goldfield has been declared Government property and will be developed under the supervision of the State. Engineers who have visited the field report that it is the richest in Japan. Gold also occurs in Formosa, in the neighborhood of Kelung, in placers and veins. The yield is about 40,000 oz. per annum.

The gold-mining industry of Japan has recently received active encouragement from the Government, with excellent results. Working of the lode mines has been pushed, and the number of men engaged in placer mining has largely increased. The result is that the production last year showed, according to the Japan *Gazette,* an increase of more than 50% over any previous year. For the twelve months ending February, 1905, the output was 9,000,000 yen in value. To this is to be added 3,000,000 yen from Formosa, making a total of 12.000,000 yen—about $6,000,000—from Japanese territory.

Determinations of the fineness of native gold from various localities in Japan and other Asiatic countries have been made by J. Yokobori (*Memoirs* of the College of Science and Engineering, Kyoto Imperial University), with the following results:

		Gold.	Silver.
PLACER GOLD.			
Aikawa, Sado,	Japan	585.1	....
Futsmi.	"	597.5	....
Nubo,	"	620.0	....
Nishimikawa, Sado,	"	666.6	....
Peichan, Hokkaido,	"	792.3	192.9
Teshio,	"	838.0	158.3
Usotannai,	"	807.7	142.3
Yuhbari,	"	895.0	97.2
Sorachi,	"	843.0	....
Toimaki,	"	868.9	82.5
Shogawa, Hida,	"	838.3	157.1
Yoshinogawa, Iyo,	"	903.9	....
Kiufun, Formosa		733.9	237.9
Irkutsk, Russia		905.2	94.8
Tomsk,	"	911.1	88.9
Barnaul,	"	846.0	154.0
Korea		802.8	....
Manchuria		838.5	127.4
LODE GOLD.			
Sado,	Japan	565.8	....
Idsu,	"	512.5	....
Kago,	"	607.5	....
Yamagano,	"	635.7	....
Hoh,	"	816.9	....
Ohkudzu,	"	926.6	....
Ohtani,	"	725.0	269.5
Ushio,	"	720.8	227.8
Serigano,	"	393.8	....

The gold from the Siberian placers is remarkable for its fineness, reaching a point seldom found in alluvial gold anywhere.

Malay Peninsula.—Gold mining is limited to certain mines in Pahang and Negri Sembilan. In Pahang the result is unsatisfactory. The total export of gold in 1904 was 20,157 oz., valued at approximately £80,600. The quantity obtained during the year from actual crushings was in Pahang 12,625 oz. from 54,691 tons, and in Negri Sembilan 2,189 oz. from 3,438 tons. In addition, 146 oz. were won from alluvial workings, and 2,115 oz. from 11,350 tons of tailings by the cyanide process.

Siam.—Mining in Siam is confined to gold, tin, sapphires and rubies. The mining industry is under the control of the Royal Department of Mines and Geology, which was created in 1890. The Siamese mining act of 1901 is now in force for most parts of the country, and prospecting licenses and mining leases may be obtained without difficulty.

Gold is widely distributed in Siam, and is washed out of the alluvium by the natives in several districts. The chief of these are Pu Kirin, Bangtaphan, Kow Suplu, and Tomoh. In the latter district Chinese workers carry on lode mining as well as alluvial. The native gold-mining industry is, however, unimportant, the total number of persons regularly employed probably not exceeding one thousand.

Gold mining according to modern methods has not been successful in Siam. Many concessions have been granted by the Government, and much capital has been expended; but in no single instance have mining operations met with any success. This may be accounted for, partly by the difficult nature of the country for carrying on mining by Europeans, and partly by bad management.

Sumatra.—The principal gold workings are at Redjang Lebong, in the southwest part of the island, and at Soemalata and Palaleh. According to Hundeshagen,[4] gold deposits occur under the coal formation between the Lawoe and Siajoc rivers in the extreme southeast of the Province of Tapanoeli. The gold-bearing fissure veins occur in diorite. Most of the ore is in quartz veins heavily charged with pyrite; but the richest that has been opened has a gangue chiefly composed of a greenish garnet rock. Assays of the coal, which is of inferior quality and carries much ash, show small quantities of gold and vanadium. These deposits have been worked for many years in a crude manner by the natives; they are shortly to be developed by European capital.

Australasia.

In General.—The gold production of the Commonwealth of Australia and New Zealand was 4,213,892 fine oz., as compared with 4,315,759 fine oz. in the previous year, thus showing a decrease of 101,867 oz., or in value, of $1,967,805. The details are shown in the table at the top of page 186.

The total decrease was 2.3%. Only the States of New South Wales, Tasmania and South Australia showed gains.

Western Australia was chiefly responsible for the recorded decrease, the

[4] L. Hundeshagen, 'Coal and Gold in Sumatra,' THE ENGINEERING AND MINING JOURNAL, March 23, 1905.

State.	1903.		1904.	
	Fine Ounces.	Value.	Fine Ounces.	Value.
Western Australia	2,064,801	$42,679,437	1,983,231	$40,993,385
Victoria	767,351	15,861,145	765,596	15,824,869
Queensland	668,546	13,631,088	639,151	13,031,683
New South Wales	254,260	5,184,139	269,817	5,501,323
Tasmania	59,891	1,237,947	66,400	1,372,488
South Australia	21,195	438,101	23,250	480,578
New Zealand	479,715	9,781,589	466,440	9,641,315
	4,315,759	$88,813,446	4,213,892	$86,845,641

shortage amounting to 81,571 fine oz. This State's contribution formed 47% of the total production.

The State of Victoria showed only a slight decrease from the year 1903, but outside of the Bendigo field the returns compared unfavorably with those of the previous year. Bendigo showed an increase of 28,180 fine oz., while Ballarat showed a decrease of 4,275 oz. In Queensland, the decrease was even more pronounced, Mount Morgan alone having shown any increase. Charters Towers still remains in the lead, its production being nearly twice that of Mount Morgan, its closest competitor.

The returns from New Zealand are based upon exports only, which showed an unusual falling off for December. The figures, therefore, can not be taken as a criterion of the gold-mining industry, which has in reality made very great progress during the year.

New South Wales, though contributing a smaller yield than the neighboring States, recorded a decided increase over the previous year. The declining tendency exhibited during the first ten months was more than counterbalanced by a marked improvement during the last two months.

Shipments of gold from the Commonwealth during 1904 showed a decrease of £661,609, as compared with the previous year, the figures being as subjoined:

Port of Shipment.	1903.	1904.
Melbourne	£4,631,081	£3,360,916
Sydney	4,438,212	4,797,990
Adelaide	103,750	25,000
Fremantle	7,421,843	7,749,371
Total	£16,594,886	£15,933,277

Destination.	1903.	1904.
India	£8,829,721	£9,314,927
Hong Kong	288,018	310,178
Bremen	100,000	700,000
San Francisco	1,500,000	1,161,042
Elsewhere	5,877,147	4,447,130
Total	£16,594,886	£15,933,277

New Guinea.—Gold is mined by Australians on the Louisiade, Sudest, and Misima islands, and on the Yodda, Mura, Milne Bay and Musa fields in British New Guinea. Most of the gold is obtained from placers. Accurate returns are not procurable; but the annual production ranges around 14,500 oz. of gold.

New South Wales.—Although New South Wales leads the eastern States of the Commonwealth in the amount and variety of its mineral output, it holds only fourth place as a gold producer. Gold mining is only a minor industry, notwithstanding that the State's gold-bearing area is extensive.

Cobar maintains its position as the principal goldfield of the State; the production in 1904 amounted to 69,140 oz., valued at £262,213. This is slightly below the 1903 yield, owing to the restricted operations of the Cobar Gold Mines Co. toward the end of the year. The Mount Boppy mine contributed an extensive output, and now ranks as a leading producer. Wyalong is the next in importance, the yield for the year amounting to 28,388 oz., valued at £109,993. The Hillgrove field furnished an output of 22,700 oz., valued at £78,400. Satisfactory yields were obtained at Araluen, Forbes, Wellington, Orange, Sofala, Adelong, Stuart Town and Pambula.

The gold dredges obtained 32,345 oz., valued at £123,656; an increase in value of £19,353 when compared with 1903. This branch of the gold industry is in a flourishing condition, and plans are being drawn for a number of new dredges to work additional areas. At the end of 1904 there were 42 dredges, worth £235,576, operating in the State. The average yield per cubic yard of material treated by 'bucket' dredges was 2.52 gr. gold per ton; the average yield of the 'pump' dredges was 3.49 gr. gold per cubic yard.

New Zealand.—The total output from the Hauraki field in 1904 was approximately £883,675, a decrease of nearly £76,000 from the 1903 production. The great Waihi mine, with a total of £673,101, increased its output by nearly £23,000, and was responsible for over 75% of the bullion won, but nearly all the other producing mines have gone back, the largest falling off being due to the Crown mine at Karangahake, whose 1904 returns were £46,263 below those of the previous year. The Talisman mine, adjoining the Crown, with a total return of £84,826, almost maintained its 1903 yield, and Komata Reefs, with £34,430 for the year, nearly held its own.

At the Thames the output for the year was £13,779, or less than half the 1903 yield. Till within a few weeks of the close of the year the prospects of this once famous gold-mining center were not good, but the discovery of a rich patch in the old Waiotahi mine has caused a change of feeling. This patch has already yielded more than £7,000 worth of gold, mostly from a few hundredweight of picked ore.

During September and October the Molyneux river was fairly low, and in consequence the river dredges obtained some excellent returns, especially those working in the neighborhood of Cromwell. Though the yield of gold from dredging during 1904 is slightly in excess of that for 1903, it has not reached the figures obtained in 1902 by many thousands of ounces. The average weekly yield of the Otago dredges was about 1,750 oz., and that from dredges working on the west coast of the South island 550 oz., or a total per week of about 2,300 oz. The apparent average per dredge per week is somewhat over 30 oz., but as many dredges are constantly laid up for repairs, etc., the real average is probably not more than 23 or 24 oz., equal to about £90 per dredge. Working expenses, including repairs, average

£60, so that about one-third of the gold obtained represents gross profit and is available for dividends.

The total amount of gold won by dredging in the South island during the last year was probably over 130,000 oz., of a value of at least £500,000.

The bullion reported from all sources in 1904 was equal to 467,260 oz. fine gold, or $9,659,260 in value.

Exports of silver were 935,741 oz. in 1904, as against 911,914 oz. in the previous year, a gain of 23,827 oz.

Queensland.—The value of the Queensland gold yield was £2,714,934, a decrease as compared with the preceding year of £124,876. The mining companies paid £831,966 in dividends. Charters Towers easily maintains its position as the largest producer; in output and dividends it takes second place among the goldfields of the Commonwealth, but in the value of its ore and in profits earned per ton it is first. During the past eight years the gold mines at Charters Towers have produced £13 16s. worth of gold and paid £4 16s. in dividends for every £1 invested by shareholders. The return on mining investments during that period was 480%, a record that is not excelled by any other goldfield where a similar amount of capital is invested.

The market value of the mining securities, the assessments levied and the dividends paid during the past three years were as follows:

	Market Value.	Assessments.	Dividends.
1902	£1,129,917	£109,404	£411,664
1903	1,216,535	129,680	400,434
1904	1,129,507	83,067	399,128

A new company, the Queen Deep Mines, Ltd., has been formed to work the deep ground of No. 7 Queen Golden Gate and Sunburst mines, which 12 years ago paid £140,000 in dividends. It is intended to spend £20,000 in developing the deep ground on the eastern end of the Queen reef; and it is believed that, by concentrating and cyaniding, the reefs previously unpayable in shallow ground may be found to be payable, as neither method was employed when the mines were previously worked.

The mines at Gympie during 1904 hoisted 209,645 tons of ore for a yield of 153,517 oz. gold, of an approximate value of £537,000. Dividends declared for the same period totaled £239,905, and capital called up £70,957, thus showing a balance of dividends over calls of no less than £169,047. Though the past year was not equal to 1903, when 186,642 tons of ore were crushed for a return of 176,370 oz. gold, and dividends amounted to £318,859, never before has so much ore been treated by the batteries, and only in 1903 was the yield of the precious metal exceeded. Dividends, though good, were disappointing, but this was only to be expected on account of the lower grade of ore raised. Calls have been less than usual, due in part to the closing down of some of the call-paying ventures for a portion of the year, but mainly to some of the mines previously on the call list having become self-supporting.

The Croydon mines yielded satisfactorily; Golden Gate continues to be the chief center of activity. The Golden Gate Consols orebody appears to become richer and larger with depth, and its richness will probably stimulate the owners of other mines in the district to test the deeper ground.

At the Mount Morgan mine, operations have been greatly facilitated by the introduction of steam shovels for excavating the large quantities of overburden that have to be removed in carrying out an open-cut system of mining. The first steam-shovel plant consists of one 65-ton Bucyrus shovel, two 10-ton locomotives, and 20 side-dumping cars. The daily capacity of the shovel was 1,500 tons.

A large amount of prospecting by means of diamond drills resulted in the discovery at the 750-ft. level of a new copper orebody showing approximately 534,200 tons, of an average assay value of 3.5% copper and 0.4 oz. gold; 103,900 tons averaging 3% copper and 0.125 oz. gold, and a large body of undetermined extent averaging about 2.5% copper and 0.075 oz. gold. The ore occurs as a continuation of the main orebody, and differs from the pyrite higher up only in containing less gold and much more copper. The zone of payable ore is very irregular in shape, and is contained in an immense mass of apparently very similar material to that of the bodies of payable pyrite ore now being mined.

The treatment of the auriferous copper ore has been the subject of close attention, with results which may be summarized as follows: A large proportion of the ore is best treated by direct smelting in blast furnaces, but there is not sufficient pyrite in it to insure a minimum consumption of coke and flux, consequently it will not be smelted as cheaply as where pyrite smelting is practiced. Although ore containing an excess of pyrite has been met with in parts of the mine—and is mined for its sulphur for sulphuric acid making—it has not yet been found in sufficient quantities to make it an important factor, though the proportion of pyrite has increased with depth. The erection of a smelting and bessemerizing plant for treating the more suitable ores has been started.

The remainder of the ore is much too silicious to be smelted economically, and wet methods of extraction will be resorted to, unless ore containing an excess of pyrite is found in the meantime. Results of this method of treatment in the present works have been eminently satisfactory on ores containing small quantities of copper, and experiments with higher grades have shown that, with extra plant, equally good extraction can be expected with no very great increase in working cost.

The ore treated in the reduction works during the year ending May 31, 1904, was 118,906 tons sulphide, 118,555 tons oxidized and 30,794 tons tailing. The product was 122,252 oz. bullion, containing 109,903 oz. fine gold, distributed as follows:

	Tons.	Gold, oz.	Value Per Ton.
Sulphide	118,906	59,146	$10.14
Oxidized	118,555	46,971	8.05
Tailing	30,794	3,786	2.50
Total	268,255	109,903	$8.34

Copper matte was also produced and shipped to the amount of 157 tons, containing 75 tons copper and 1,794 oz. gold.

The cost of treating sulphide ore at the chlorination works was $3.20 per ton, or 44c. less than in 1903. The cost of treating oxidized ore at the West works was $2.44 per ton, a saving of 37c. as compared with the preceding year. The copper canals on Mundic creek were added to, and 188 tons of copper precipitate recovered, carrying about 77% copper. In connection with these canals, a return water service has been installed, whereby all waste and spent liquors are returned to the works and re-used for various purposes, principally for sluicing out vats, thus obviating the necessity of drawing on the fresh water supply in the dams.

A sluicing scheme is now well in hand, which has reduced the cost of emptying vats from 16c. to 12c. per ton. On the West works, owing to the increased percentage of pyrite in what has hitherto been free oxidized ore, a more careful and thorough roast has been found necessary. To effect this the erection of a set of gas producers at the plant is proceeding, and, when completed, will materially increase the efficiency of the furnaces, and should at the same time decrease the cost of treatment.

South Australia.—Good progress is being made in opening up the Tarcoola, Arltunga, and McDonnell Ranges fields in central Australia. The Government has erected public quartz mills and cyanide works at each of these island centers in order to assist in their development.

Tasmania.—The principal gold-mining centers in Tasmania are the West Coast, Mathinna, and Beaconsfield. The Mount Lyell mine is the largest producer in the West Coast field. The Tasmania mine leads at Beaconsfield. This mine has produced 598,168 oz. of gold from 530,451 tons of quartz. Its main shaft is 915 ft. deep; the 900-ft. level is 400 ft. long, and the lode is here between 10 and 11 ft. wide, averaging a little more than an ounce of gold per ton. The gold is extracted by amalgamation and chlorination. There are 726 miners employed in the mine. Underground operations have been hampered by water; but new pumps designed to work at 2,000 ft. lift with a combined delivery of 8,000,000 gal. per day are being erected and will shortly enable sinking operations to be resumed. Gold-mining prospects at Beaconsfield and the adjoining Lefroy field are in a distinctly encouraging condition.

Victoria.—The Victorian gold yield for 1904 was 765,596 oz. fine, against 767,351 oz. fine for 1903. The gross output as reported by the Mines Department was 821,017 oz., as against 822,424 oz. for 1903. The Mines Department shows that the average earning per miner in the State during the last two or three years has gone up steadily. Thus, in 1903 the sum reached £130 10s. per head, which is the highest figure since 1854, the days of the gold rushes to the magnificent alluvial deposits at Forest Creek and other districts. The cause for this is the concentration of men in the big mines of the State and the gradual extinction of alluvial mining, apart from deep lead mining.

The record of the Bendigo field is the best since the boom period of 1876. The following shows the production for the last two years, in ounces:

	Yield.	Dividends.	Assessments.
1903	233,589	£322,415	£141,977
1904	248,000	367,896	168,095

There are 24 dividend-paying mines, and for the fourth year in succession the South New Moon mine heads the list. The principal producers in 1904 were:

	Quartz Crushed. Tons.	Yield. Oz.	Dividends.
South New Moon	28,182	37,189	£120,000
New Moon	30,140	18,099	48,000
Ulster	8,821	11,511	32,800
Great Northern	15,889	15,133	32,250
Clarence	18,254	9,210	18,750
Sea	7,013	6,807	16,800
Hustlers Reef No. 1	15,293	8,331	16,192

The total quantity of gold won since the opening of this field is estimated at 16,929,000 oz. fine. The increase in the calls made during 1904 is taken as an indication of strong confidence on the part of investors. The work of deep sinking has been prosecuted with great perseverance, but so far no results of any value have been obtained. At the New Chum Railway mine a depth of 4,056 ft. from surface has been reached by means of a winze from the 3,856-ft. cross-cut, while at the Victoria quartz mine a depth of 4,024 ft. has been obtained by a winze sunk from the 3,700-ft. level. It is intended to continue the prospecting work to a still greater depth. The noteworthy feature of the year's operations was the location of the New Argus Reef at a depth of between 1,680 and 1,780 ft. This should enable a number of mines to resume work and maintain a profitable output during the present year.

At present a number of large English and Australian companies are preparing to develop some of the rich, deep alluvial gold leads, and within a short period alluvial gold should again figure prominently in the annual gold returns. The Victorian central group of deep leads passes from south to north from Ballarat to the Murray River flats. From Ballarat to Bunninyong, a distance of about eight miles, following the sinuosities of the Manuel, an average of about $5,000,000 per mile has been won. At the south end there are three main heads. The eastern branch comprises the

Eganstown and Smeaton workings. The Central branch includes the Creswick, Berry, Kingstown and Allendale; while in the western branch are the Ballarat, Midas, Ascot and, as a tributary, the Clunes. Near the junction of these three heads is the Campbelltown, and on the main lead the Moorlort and Loddon. On a lower easterly branch are the Castlemaine mines, and on the lower westerly branch the Carisbrook workings, including the Chalks and Majorca.

The Loddon valley deep leads are covered with basalt. At the upper end, two main branches have been proved, that on the west being known as the Majorca-Chalks lead, which for a distance of about six miles from its source has yielded $12,500,000, while that on the east, known as the Berry or Moorlort lead, has yielded $27,500,000, over a distance of six miles.

Europe.

Austria-Hungary.—Most of the gold comes from the mines in Hungary; especially from the mineral region of Zalatna, and from the neighborhood of Nagybánya, in the county of Szatmár. Gold mining was resumed in September, 1904, in the historic mines at Roudnéy, in Bohemia. The ore is being treated by amalgamation, concentration, and cyaniding. The ore is rich in silver as well as gold, and pyrite. Beneshaw is another Bohemian mining field, producing small quantities of gold and silver.

Russia.—The chief production is derived from the placer mines in Siberia, and the Ural mountains. A number of rich placers are being worked in Eastern Bokhara. The Bokhara fields yield about 5,000 oz. per annum, and the returns from the Urals and Siberia are about 300,000 and 800,000 oz. respectively yearly. The estimated value of the total production of gold in the empire during 1904 was $22,500,000, a decrease of $2,480,000 when compared with the returns for the previous year.

Russia's foreign movement of gold and silver is shown in the following table, in rubles, one of which is worth 51.5c. in United States currency:

FOREIGN GOLD AND SILVER MOVEMENT OF RUSSIA. (In rubles.)

	Gold.		Silver.	
	1903.	1904.	1903.	1904.
Imports	20,919,000	6,924,000	6,996,000	19,152,000
Exports	2,821,000	4,010,000	1,756,000	32,227,000
Excess	18,098,000 Imports.	2,914,000 Imports.	5,240,000 Imports.	13,075,000 Exports.

Turkey.—A little placer gold is obtained in Thessaly, and in some of the valleys of Macedonia. The river Pactolus, so famous as a producer in ancient times, no longer yields any gold. Statistics are not kept in the Turkish

Empire, and the mineral production is difficult to estimate. The annual production of gold is probably between 1,000 and 1,500 ounces.

North America.

Canada.—Gold production in Canada, which reached a maximum in 1900, continues to decline. The value of the output in 1904 was $16,400,000, as compared with $18,843,590 in 1903. Practically every Province, excepting British Columbia, shows a falling off as compared with the returns for 1903. The decrease in Nova Scotia, which ordinarily has an output of about half a million dollars, is nearly half its production.

In Ontario, although a considerable amount of prospecting and development work was done, most of the mines that were formerly important producers were not operated during the year. The Sultana mine, on the Lake of the Woods, was the chief contributor.

In British Columbia, the value of the mineral production in 1904 was the second highest on record. The gold yield from placers was 55,765 oz., and from lode mining it amounted to 222,042 oz., the total value of which was $5,704,908. The placer gold output shows an increase of $44,880, which is mainly attributable to one district, the Atlin, the other districts only about holding their own; while in those districts where the placer gold is obtained from the river bars, exposed only at lowest water, there is this year a marked falling off in production, since the spring opened up early and the gradual melting of the snow in the mountains allowed no extreme low water, so that the bars could not be worked in this manner. The districts showing an increased output, named in the order of precedence, were East Kootenay, the Boundary, the Coast, and the Slocan. The greatest decrease was in the Rossland camp, accounted for by changes in the management of some of the producing companies, and by experiments being conducted as to the best methods of treatment of the low-grade ores of the camp.

The ore mined in the Province, amounting to 1,461,609 tons, showed an increase over the preceding year of 175,433 tons, or nearly 14%. This increase was made chiefly by the Boundary, East Kootenay and Slocan districts, which also offset decreases in certain other districts. The tonnage mined in 1903 was in itself greater than that of the preceding year (1902) by about 29%, so that the 1904 tonnage output has increased in these two years about 46%. The number of mines shipping in 1904 was 142, as against 125 in 1903, an increase of 17, of which 15 were in the silver-lead district. These, however, shipped less than 100 tons each during the year. Of these 142 mines shipping, only 76 shipped 100 tons or over during 1904, as against 74 in 1903, indicating that there has been no material addition to the larger shippers, but that such increase has been confined to the smaller high-grade properties, and was largely due to the introduction of the 'tribute system.' The total number of men employed during the year in these shipping mines was the same as in 1903: 3,306, as compared with 3,303 employees.

In addition to the shipping mines, there were 26 mines reported as employing 159 men, under development, but shipping no ore.

The bounty granted by the Dominion Government stimulated silver-lead mining. The St. Eugene mine, in East Kootenay, after three years' idleness, resumed operations and produced 540,000 oz. of silver. Silver 0.999 fine is now turned out at the refinery of the Canadian Smelting Works at Trail, B. C.

The Cariboo hydraulic mine yielded $85,936 worth of gold. Exceptionally unfavorable weather conditions prevailed, and the water supply lasted only 89 out of a possible season of 212 days. The upper gravels and volcanic mud upon which the year's work was conducted averaged 6.42c. per cubic yard, although some bottom gravel upon which a short experimental run was made gave a return of $1.52 per yard.

The gold production of the Klondike is treated in a special article later in this volume.

Costa Rica.—The most important gold-mining districts in Costa Rica are Miramar and Abangares. The former is 15 miles from Puntarenas, and the latter 18 miles from Puerto Yglesias, on the Gulf of Nicoya. English and American capitalists are operating the Union, Bella Vista, Guacimal, and Abangares mines. The annual yield is between 10,000 and 12,000 oz.

Guatemala.—Placer mines are being worked in the foothills of the mountain range separating Guatemala and Honduras. The placers of Las Quebradas, 15 miles from the Morales railroad station, have been operated for the past 25 years. These placers are about two square miles in extent. They yield, by hydraulicking, an average of 20c. per cubic yard from the surface gravel. The development of mining in the country is hampered by the dense vegetation and heavy soil, which render ordinary methods of prospecting ineffectual.

Honduras.—Gold and silver deposits are worked in a small way in many parts of Honduras. In the department of Alancho, both lode and placer mining is carried on. The largest and richest placers are on a tributary of the Rucio river. An important lode-mining center is in the Lepaterique mountains, 30 miles from the Gulf of Fonseca. The largest individual producer is the New York & Honduras Rosario Mining Co., whose property is at San Juancito, in the department of Tegucigalpa. This company's plant is not far from the Pacific coast, and is approached from the port of Amapala. A railroad is being built from Amapala to the mine. During 1904 development comprised 5,264 ft. of drift and cross-cut, and 1,443 ft. of raise, resulting in the opening of 23,930 tons of ore. Employees numbered 861; the cost of mining averaged $13.33 per ton. The mill has a daily capacity of 85 tons, and is arranged for stamping, amalgamating and concentrating. In 1904, 21,005 tons, assaying 59.54 oz. silver and 0.28 oz. gold, were treated, with recoveries of 84.35 and 86.70% respectively, at a cost of $6.14 per ton. The company's gross earnings were $724,170, and the profit $217,290. In the previous year 15,620 tons were mined and treated for a return of 3,653 oz. gold and 683,806 oz. silver. The 1904 yield exceeded this by 1,445 oz. gold and 370,000 oz. silver.

Nicaragua.—The Cordillera mountains, particularly on the eastern slope, are rich in minerals. Gold is being worked in the districts of Tunki, Pispis, Siuna, Coco, Cincuinta, Rio Grande, and La Gapera. At present about 100 mines are operated, and the gold yield is between 20,000 and 30,000 oz. per annum. The industry is hampered by scarcity of labor, water, and crude means of communication.

Panama.—There was much activity displayed in mining in the Republic of Panama during the latter part of 1904, and no doubt some of the gold lodes which have been discovered from time to time will soon be worked, as the changed political conditions guarantee security in the Republic, for which reason capital will be invested more freely than hitherto.

The principal mine is the Cana, situated in the Darien district, the property of the Darien Gold Mining Co., Ltd. The results in 1903 were satisfactory; 40,384 oz. of bullion, valued at £159,708, were shipped to Europe.

Other mines, of less importance, are being worked in the Veraguas and Cocle districts, but there is no information of a positive character regarding their value.

There is an export tax on precious metals of 2% on the value as shown in the certificate of smelting and assay; on ore, the tax is $2 per ton.

Salvador.—Several gold mines are being developed in Salvador. Most of them are small and are owned by native capitalists. The most important mines in this district are Butters' Salvador, and the American-owned Salamanca mines.

Butters' Salvador mine is noted for the successful application that has been made of the Butters process, in the treatment of its ore. The extraction from sand and slime reaches nearly 95%, this high efficiency being due to the metallurgical excellence of the process employed.

At the end of April, 1904, the ore positively developed amounted to 42,560 tons, with an average content of 2.75 oz. The ore mined during the year weighed 14,371 tons. Net profits for the year ending April 31, 1904, were £61,685, and £46,786 was brought forward from the previous year.

Santo Domingo.—Gold has been worked in the island of Santo Domingo for a very long period. According to Spanish writers, the production of placer gold from 1502 to 1530 was between $200,000 and $1,000,000 per annum, and it is said that at one period, shortly after the time of Columbus, as much as $30,000,000 worth of gold and silver was exported from the island in a single year.[5] The gold in the upper Haina river is coarse and of

[5] F. Lynwood Garrison, 'Gold in Santo Domingo,' THE ENGINEERING AND MINING JOURNAL, June 15, 1905.

a deep yellow color, showing a high degree of purity. An assay of 12 oz. of the Haina river gold, made at the United States Mint in 1870, showed a fineness of 0.946.

In the northern part of the island—that is, on the northern flank of the Cibao—alluvial gold is found in a number of places, especially in streams flowing from these mountains into the Yaqui river. In the early days Santiago appears to have been the headquarters of those engaged in gold washing.

Quartz veins are known in a number of localities in Santo Domingo; the general impression is that they are small and lean, but it is impossible to say how far this conclusion is justified.

South America.

Brazil.—Gold mining in Brazil is confined to alluvial workings and to the development of low-grade quartz mines by the St. John del Rey company at Morro Velho, and by the Ouro Preto Gold Mining Co. at Passagem. In the river beds of the district a few natives, *faiscedores,* eke out a scanty existence by washing in *bateas* the river sands.[6] The Ouro Preto Gold Mining Co. is working a flat vein having a dip of 20°. Its width varies from 5 ft. to over 30 ft. The ore is quartz with arsenopyrite and some iron pyrite. The hanging wall is itabirite, the foot-wall a schistose quartzite. It is worked to a depth of 1,500 ft. on the incline through slopes sunk on the vein. Timber is entirely dispensed with in the stopes because of the adaptability of the slab-shaped quartzite blocks for use in building of dry arched galleries and drifts. Where the vein is of such a width that no quartzite is broken down it is brought from other parts of the mine.

The 80-stamp mill at this mine also presents some peculiarities. The ore is first hand-sorted by native women and boys, who reject about 10% of it. It then goes through Blake crushers and is stamped in mortars of English make but of American pattern, through 30-mesh screens. The pulp flows over short blanket strakes, not over 5 ft. long, which are washed frequently in vats of water. The overflowing pulp from the blankets is concentrated on 32 Frue vanners, the concentrates going to the cyanide plant, while the tailings go to long canvas strakes, on which a small additional amount of concentrate is made. The blanket washings are still further concentrated on canvas strakes. The enriched concentrate resulting is washed in *bateas* by native women and the gold separated is almost perfectly clean when taken out.

The remarkable feature of the process is that over 80% of the total mill-saving is made in these *bateas.* No mercury at all is used anywhere in the process. The total extraction is about 83%. The value of the ore is about $7 per ton. The concentrates from vanners and canvas strakes which are

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[6] Martin Schwerin, 'Gold Mines of Minas, Brazil,' THE ENGINEERING AND MINING JOURNAL, October 6, 1904.

cyanided, together with that part of the blanket washings rejected in their subsequent concentration on canvas strakes, are fed into small iron vats in charges of 5 or 6 tons and agitated with cyanide solution for from 24 to 40 hours. The solution is drawn off by vacuum filtering and the solids run to waste. After the extraction of the gold from the solution, by precipitation on zinc shavings, the solution is run to waste. This is necessitated by its foul condition.

Throughout the plant water-power only is used for mill and shop purposes, compressing air for mine drills, hoisting ore, and even for vacuum for filtering. Mining is done under the contract system, the contractors employing their own men. Wages average from 3 to 3.5 *milreis* per day, which at the present exchange of gold is equivalent to from 72c. to 84c. Boys, of whom quite a number are employed about the mills, especially in connection with the canvas strakes and in sorting, get about half of men's wages. Skilled white labor is paid about $80 per month.

Colombia.—Gold mining is the most important industry in Colombia. Gold is obtained by dredging the rivers, hydraulicking, and by working auriferous veins. A large amount of foreign capital is employed in the industry. Antioquia, Cauca, and Choco are the most important mining districts. The Zancudo, Otromina, Frontino, and El Cerro mines are the largest quartz producers. The annual production is about 130,000 oz. gold and 2,000,000 oz. silver.

Guiana—British.—Placer gold is obtained in the Barima, Barama, Demerara, Cuyuni, Essequibo, Mazaruni, Potaro, and Puruni districts. The total output from these districts in 1902-03 was 104,525 oz., and in 1903-04, 90,336 oz. Hydraulicking is successfully carried out in Essequibo, and gold dredges are operated on the Arakaka and Gilt creeks. More than 12,000 natives are engaged in mining in British Guiana, and in the next few years an extension of gold dredging will give employment to many more.

Gold exported in 1903 was 79,322 oz., valued at $1,381,544; in 1904, from Jan. 1 to Nov. 29, the gold export amounted to 75,521 oz., or $1,338,848 in value.

Dutch.—During 1904, discoveries of valuable dredging ground in Dutch Guiana caused excitement among holders of gold concessions, and attracted a number of American and English mining men to the country. The placer deposits in Surinam are being carefully prospected.

The Pittsburg Dredging Co. has prospected a tract on the Saramacca river, finding ground which is considered to be promising. It expects to have a dredge in operation early in 1905. A peculiar feature in the instalment of dredges is said to be the non-existence of patent laws in the Dutch colonies. For this reason a dredge, involving numerous patented devices, may be built in the United States, and shipped in separate parts, to be assembled on arrival, thus evading all royalties, and lessening the cost one-half.

The gold output of Dutch Guiana during 1904 is reported from official sources as follows:

District.	Grams.	Value.
Surinam	294,235	$195,519
Saramacca	142,832	94,912
Marowijne	121,834	80,959
Lawa	223,961	148,822
Totals	782,862	$520,212

This is equivalent to 25,169 troy ounces, Dutch official returns being stated as fine gold.

French.—Gold occurs over a large area in French Guiana. It was first discovered by a Brazilian miner in 1853, and has been worked in a desultory manner since. At present, mining is greatly hampered by lax government regulations and inadequate transport facilities. Traveling is chiefly by small sailing boats on the rivers, which is both slow and expensive. The payment of 10 fr. per kilogram on all gold won, and an export duty of 8%, extorted by the Government, is not calculated to stimulate mining.

The Maroni river is the largest in the colony, and has yielded the most gold. At present, a good deal of placer mining is being successfully prosecuted along its banks.[7]

The Mana river ranks second in the production of gold. Among the large placers that formerly existed and have later suspended operations is that of Enfin, which was exploited for about 30 years, giving an average yield of 100 kilograms per month, with not more than 200 men. There is no doubt as to the occurrence of rich quartz veins in the neighborhood. Numerous rich samples, containing visible gold, have been broken from the outcrops of veins scattered over the country.

The Sinamary river, in which the French made their first settlement in 1620, unlike the others, does not appear to be auriferous, except within an area 20 miles square. Within this area is situated the celebrated St. Elie placer, which has been worked continuously for more than 30 years, and has given 100 to 150 kilograms per month with an average gang of 250 men. Both quartz mining and dredging were attempted along this river on a small scale, but unsuccessfully. The deposit on the Appronague river, where gold was first discovered, must have been very rich, for as much as five kilograms per day were taken out by a sluice operated by 20 men. This was continued for a long time, but owing to two serious landslips, which killed 60 and 100 men, the mine was shut down by the Government. The Materony company, on Iponcin creek, was the largest concern on the river, with a gang of 700—all East Indians—and a managing force. The men received 10c. and the women 6c. per day. The placer gave an average yield

[7] David E. Headley, 'Gold Mining in French Guiana," The Engineering and Mining Journal, January 19, 1905.

of 80 kilograms of gold per month for a long time, and it is still being worked by small companies, which pay 10% on all gold won.

Peru.—Gold mining is chiefly confined to the Cerro de Pasco region. Several large properties are being developed by American and British capital, the more important mines being the Chuquitambo, Inca, Santo Domingo and Quinua. Some gold and a large amount of silver is also obtained from the large copper and lead mines of Cerro de Pasco.[8]

The Yauli, Chuquitambo, Morococha and Salpo mining fields are attracting English capital. The Salpo district is 12 miles from the city of Otuzco, the capital of the Province of La Libertad, and about 50 miles from the seaport of Trujillo, with which it is connected by wagon road. The district has an elevation of 11,000 ft., and contains numerous deposits of gold and argentiferous galena.

Uruguay.—During the six months ended December 31, 1904, 9,058 tons of ore were mined in Uruguay, which yielded 29.768 kg. of gold, valued at $12,684. The mines are situated at Cuñaperú and are operated by a French company, which pays the Government 0.5%.

Venezuela.—Gold mines are worked in a small way at Caratal. The metal occurs in many other districts; but the country's mineral resources are neglected by capitalists on account of unsettled political conditions. Silver amounting to about $1,000 per annum is produced, and the gold yield has been: 1900, $321,200; 1901, $321,200; 1902, $433,800; 1903, $600,000; 1904 returns are not available.

Progress in Gold Milling in 1904.

BY ROBERT H. RICHARDS.

The Morison High Speed Stamp.[1]—This stamp combines the principles of a pneumatic and of a gravity stamp. At the Meyer and Charlton Mine in South Africa, a battery of this type with five stamps weighing 1,600 lb. each was erected and run by the builders from April to October, 1904, when it was turned over to the mine staff. A crushing rate of 10 tons per stamp head per day is claimed, exceeding that of any gravity stamp as yet in use. These stamps are lifted not by cams, but by cranks set at equal angles on a crank shaft along the top of the battery frame. To each crank a connecting-rod joins a cylinder, which moves vertically as the crank revolves. In the cylinder is a piston, whose rod passes down through the lower cylinder head and constitutes the stamp stem. A jacket surrounds the cylinder and ports enter above and below the piston, but at some distance from the cylinder heads. Below the lower port the cylinder and the jacket contain water, while above the water is an air space in both cylinder and jacket. Soap is added to the water for lubrication and to prevent corrosion. To

[8] Russel T. Mason, 'Peru,' The Engineering and Mining Journal June 8, 1905.
[1] *New Zealand Mines Record*, Vol. VII, 1904, p. 480. For full description see *Ibid*, Vol. I, 1897, p. 36.

provide for loss by leakage, a continuous flow is kept up in the cylinders through tubes, the height of which regulates the height of water in the cylinders. As the cylinder rises the piston closes the lower port, and piston and stamp are thus supported by a liquid. In falling, the stamps drop as fast as the cranks and gravity permit, and a speed of 125 to 130 drops per minute may be attained as easily as 90 to 100 with ordinary stamps. There is but little vibration and the usual noise, except that of the shoes on the dies, is absent. The makers claim that there is no shock, the liquid being gradually squeezed out until the whole weight is supported.

Concrete Battery Foundations for Stamp-mills.[2]—The part of a mill that will contribute most to its efficiency, if solidly and durably built, is the foundation. The maximum life of wooden foundations is about twelve years, but frequently they last only five or six. The latest method is to build concrete foundations, capped with heavy iron anvil-blocks on which the mortars are fastened. The new mills at Douglas island, Alaska, are so built, and many mills in South Africa are introducing these foundations. At the Village Deep mill, the anvil-block is 2 ft. 9 in. high and weighs 14 tons. It carries two mortars and is bedded in timbers 14 in. deep, which in turn rest on a solid 66-ton block of concrete with grooves for the anchor bolts. From its increased rigidity, this design is expected to increase the duty of the stamps some 15 per cent.

Masonry Foundations for Stamp-mills.[3]—A new 40-stamp mill built by the Union Iron Works at the Central mine, Grass Valley, California, has several new features in its construction. The ore-bins are built entirely of masonry and the battery frame of structural steel, wood being practically eliminated from the whole plant. The mortars have extra-wide bases and are set on masonry mortar-blocks. The batteries are arranged in two units of 20 stamps each, each unit being driven by two 10-stamp cam shafts with pulleys at opposite ends. Each 20-stamp unit has 5 double posts of heavy channel steel, bolted to cast-iron anchor plates, and the whole is securely tied to the masonry mortar-blocks by heavy eye-bolts and T-rail anchors. The whole frame is braced at the back like a back-knee wood frame, by heavy steel I-beams, two to each battery-post, embedded for one-third of their length in the front masonry wall of the ore-bin. A countershaft at the top of the front ore-bin wall drives the batteries by friction-clutch pulleys. Concrete is used nowhere except in the floors. The mortar and the ore-bin foundations are on the solid ledge. Some settling and cracking has occurred, but was easily repaired. The mortars are set on 8 ft. of solid masonry, and are held in place by 2-in. anchor bolts, built in solid. (If these bolts are built in so that they cannot be easily replaced, it may be questionable practice.) The masonry ore-bins have sloping bottoms; their front consists of iron plates held in place by

[2] *The South African Mines, Commerce and Industries,* Vol. II, 1904, p. 316.
[3] *Mining and Scientific Press,* Vol. LXXXIX, 1904, p. 120.

I-beams built into the end and partition walls. The rock-breakers, one to each 20 stamps, are placed on masonry piers above the ore-bins. This construction gives slight chance for vibration and makes the batteries rigid.

To the writer, masonry does not seem to possess any advantages over concrete except that the masonry may set a little more quickly. Masonry and good concrete are of practically equal strength, while concrete possesses the great advantage of cheapness and rapidity of erection.

Milling Practice at Kalgoorlie, Australia.[4]—The plant at the Ivanhoe mine has adopted all the successful methods in vogue in that district, namely, wet crushing in the battery with inside and outside amalgamation, concentrating followed by roasting and cyaniding of the concentrate, leaching of the sand, bromo-cyanide and filter-press treatment of slime, and the dry crushing, roasting, and cyaniding of telluride ore, of which a small amount found in the mine is treated separately. The ore is broken to 2 in. and delivered through Challenge feeders to the mortars. The mill contains 100 stamps, weighing 1,100 lb. each, dropping 96 times per minute with an 8-in. drop. This gives a duty of 5.2 tons per stamp in 24 hours, through a 20-mesh wire- (or its equivalent punched) screen, the pulp consisting of 65% sand and 35% slime. The pulp is separated by spitzkasten, the fine and the coarse being concentrated separately. About 31 tons of concentrate are obtained daily. With ore containing 0.75 oz. gold per ton, the residues carry 0.1 oz., showing an extraction of 87%. On a capacity of 16,000 tons per month, the total cost of treatment from ore-tipple to residues is $2.28 per ton.

Amalgamation on the Rand.[5]—Inside amalgamation (with plates) is now seldom seen, although it is still customary to feed mercury into the mortars, with the idea of catching some gold in the mortar sand, and also of allowing the excess of mercury that passes through the screen to assist in keeping the plates in good condition. If, however, the plates are properly dressed every four hours, not only is this continual inside addition of mercury unnecessary, but it meets several strong objections. First, there is an excessive loss of mercury. When floured by the beating of the stamps, it passes through the screen in this fine condition, goes to the cyanide works and is lost. With outside amalgamation the loss of mercury is 0.3 oz. per ounce of gold recovered. (Loss of mercury is often stated as so much per ton of ore crushed, but such a statement is misleading, because the loss of mercury is proportional to the amount used, and this again depends on the amount of gold recovered. With a low-grade ore, but little gold is recovered and little mercury is used, therefore the loss is small; the reverse is true of high-grade ore.) A second objection to feeding mercury to the mortars is that small beads of amalgam collect on the blanketings and frames of the screens, to fall upon the plates when screens are changed.

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[4] The Engineering and Mining Journal, Vol. LXXVIII, 1904, p. 632.
[5] *Ibid,* Vol. LXXVII, 1904, p. 841.

If not then collected before the water is turned on again, this amalgam will be carried away. A final objection is that accurate screen samples cannot be obtained, because amalgam is likely to come through into the sample.

If no mercury is fed inside the mortar, a sample of the pulp as it comes through the screen will represent the ore brought to the mill. Some gold is retained in the mortar sand, but after three months' running it is found that this latter is only slightly richer than the pulp that goes through the screen. The difference between the screen sample and the sample of the pulp as it leaves the mill shows the extraction on the plates. To take the screen sample, a sheet-iron lip 1 in. wide is bolted at the bottom of the screen, to carry the pulp clear. An enamel sample-tin, 1 in. wide, 1 in. deep and 12 in. long, with a handle at one end, is moved along the full width of the screen once every hour. The total of these hourly samples gives a good daily sample.

The Hunter Ore Feeder.[6]—This is a new feeder introduced at the Crown Reef mine, on the Rand. A test in comparison with the Challenge feeder was made from May 10 to June 8, 1904. The screen was equivalent to one of 26-mesh wire. Shoes and dies were half worn down at the beginning of the test. The total running time was 631 hours, 41 minutes. The total ore crushed was 870.7 tons, equivalent to a duty of 6.61 tons per stamp per 24 hours. The average duty of the Challenge feeders in the rest of the mill during the same time was 5.9 tons per stamp, an advantage of 12% in favor of the Hunter.

Elevation of Stamp-mill Tailing.[7]—In South Africa it is generally necessary to elevate the mill tailing for delivery to the cyanide plant, and there are four general methods: Tailing-wheels; tailing-pumps; bucket-belt elevators; air-lift pumps. Air-lift pumps are much discussed, but their efficiency is low, and probably sharp sand would cause great wear to the pipe column. The vanes of centrifugal pumps are rapidly cut by sand, and also the ports and valves of plunger pumps, but either of these types may be successfully used to elevate slime. The tailing-wheel, although the most expensive in first cost, is the device in general use on the Rand, where a number of wheels of 60 ft. diameter, capable of raising the tailing from a 200-stamp mill, are running. They are reliable and durable, and their cost of maintenance is low. A test of a 25-ft. wheel with a lift of 19 ft. gave an efficiency of 49%; for a larger wheel the efficiency would probably be much higher. Rigid spokes have been found more satisfactory than tension spokes. Manila rope drives outlast wire rope and belts; a manila rope at the Ferreira Deep mill lasted 4½ years, or 3½ years of actual working. The peripheral speed in practice varies with the diameter of the wheel, from 350 ft. per minute for a 20-ft. wheel to 700 ft. for an 80-ft. wheel.

At Bodie, California, at the Standard Consolidated Company's[8] mill,

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[6] *The South African Mines, Commerce and Industries*, Vol. II, 1904, p. 427.
[7] THE ENGINEERING AND MINING JOURNAL, Vol. LXXVII, 1904, p. 481.
[8] *Ibid*, Vol. LXXVII, 1904, p. 597.

where the problem was to raise 45 ft. 60 tons of quartz sand and 90,000 gal. of water per day, an air-lift pump was operated with fair success, but when part of the mill fell idle, the heavy sand settled back and blocked the pipe. The efficiency was very poor. A bucket elevator was found unsatisfactory, aside from the wear on the links, on account of sand adhering to the buckets in cold weather. A centrifugal pump was used for a year at a cost, for consumption of metal, of 4c. or 5c. per ton of sand pumped. The efficiency was very low, the power required being 15.5 h. p., while the theoretical requirement was only 0.85 h. p. Frenier pumps have given good service, taking less than one-third of the power consumed by the centrifugal pump. There is no excessive wear except, possibly, at the stuffing-box in the axis. The pumps are sensitive to sudden changes of feed, and the pump-box may overflow while the pump is adjusting itself to changed conditions.

Hydraulicking and Placer Working.

Placer Mining in Alaska.[9]—Placers afford the main gold output of Alaska, the Seward peninsula being the center of interest. To provide reliable water supply, 100 miles of ditch are in successful operation on the peninsula, proving that water can be obtained more cheaply by ditches than by pumping, with the present high price of fuel, as at Nome, where coal costs $20 to $25 per ton. (Plans are being considered to build a pier at Nome out into deep water to reduce the cost of landing freight, which is now $5 per ton.) Gasolene retails at 25c. per gal. The introduction of petroleum, with which tanks can be filled directly from tank steamers, may revolutionize the fuel question. Forty miles north of Nome is abundant water supply for electric generating. Wages are $5 per day. Freight rates to Nome in the spring of 1904 were $15 per ton. (A combination of ocean vessels later doubled this.) Three months' sluicing can be counted on. Pay streaks have yielded $30 to $100 per cu. yd., and profitable mining has been done on gravels yielding not over $3 or $4. Cost of mining is being reduced, and it is expected that values of 50c. to $1 per cu. yd. will be mined. Dredges and steam shovels have not been successful except in rich ground. Underground drifting has yielded good returns by the use of steam thawers and steam hoists.

Placer Mining in British Columbia.[10]—On the Fraser river and its tributaries are some large drift and hydraulic mines. Among the most important is that of the Cariboo Hydraulic Mining Company, on the Quesnelle river. It has 33 miles of ditches, and storage reservoirs for 1,016,000,000 cu. ft. of water. The total expenditure of the company in 8 years from its beginning has been $1,817,730. The total receipts of the company during this time have been $1,077,855, so that the net cost of the property is about $750,000. Its reserve gravel deposits are estimated at 500,000,000 cu. yds. of an average gold tenor of 20c. per cubic yard.

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[9] *Mining Reporter*, Vol. L, 1904, p. 189.
[10] *Mines and Minerals*, Vol. XXIV, 1904, p. 297.

Placer Mining in Colorado.[11]—The Gold Pan Mining Company at Breckenridge, Colorado, draws its water through a ditch 4 ft. deep by 12 ft. wide at the top and 8 ft. at the bottom. It is 2½ miles long and has a capacity of 7,000 miner's inches. This is succeeded by a 5-ft. pipe-line, 8,000 ft. long, made of 3/16 to 7/16-in. boiler plate. This discharges into a group of Evans hydraulic elevators which lift from 70 ft. below the surface and discharge 20 ft. above it. With a head of 350 ft., corresponding to a static pressure of 150 lb. per sq. in., these elevators have a capacity of 2,000 cu. yd. per 24 hours.

Débris Dams in California.[12]—The Federal Government has united with the California State Government in a joint appropriation of $800,000, to build a series of dams or barriers on the Yuba river. The object is to allow hydraulic mining on the Yuba and yet prevent the débris from flowing into the Feather river and thence into the Sacramento, to the detriment of navigation. The plan also calls for a large settling-basin 12 miles above Marysville, which is to have a capacity of 14,000,000 cu. yd. of sediment and may be enlarged to hold 50,000,000. Nothing of the sort has ever been attempted before, and much doubt is felt as to the success of the project.

Gold Dredging.

Gold Dredging Industry.[13]—The basic reason for the great success attained by gold dredging in the last eight years is the practical certainty with which the costs and the returns of an investment may be determined before operations are begun. A deposit suitable for dredging must lie practically flat and have its values spread over a wide area. Narrow, torrential streams with rocky bottoms, and deposits whose values lie upon hard bed-rock cannot be dredged to advantage. Dredging is usually carried on, not in the rivers, but on adjoining benches, a pit being dug, and the dredge floated therein. Prospecting ground for dredging is done by drilling 6-in. holes, averaging 1 hole to 10 acres. From the samples thus obtained, the value of the ground is calculated. F. W. Griffin's experience shows that a dredge will recover about 70 per cent of the arithmetical average value, as shown by drill-holes placed about one to 10 acres. In estimates as to cost of a dredging project, due consideration must be given to the factors of power and transportation.

Prospecting and Valuing Dredging Ground.[14]—The land is divided into blocks of from 5 to 10 acres, and a hole is drilled in the center of each block. At Oroville, Cal., the Keystone drill is preferred. The land is surveyed and the drill-holes numbered and marked by flags. The hole is completed on striking bed-rock or passing through the pay stratum. After getting through the surface dirt, a careful record of the drill-hole is kept, foot by

[11] *Mining and Scientific Press*, Vol. LXXXIX, 1904, p. 124.
[12] The Engineering and Mining Journal, Vol. LXXVIII, 1904, p. 588.
[13] *Mining and Scientific Press*, Vol. LXXXVIII, 1904, p. 260.
[14] *The Canadian Mining Review*, Vol. XXII, 1903, p. 211.

foot. The drillings extracted from each section by the sand-pump are 'rocked' separately, great care being taken to save the extremely fine gold. The character of the ground and the clean-up results of each section are recorded, which records furnish data for a cross-sectional map which will show any rich or barren streaks, false bed-rock, water level, etc. At the completion of the hole, all the gold from it is collected by quicksilver, the amalgam dissolved in nitric acid, and the gold annealed and weighed. From the weight of this gold and the cubic contents of the hole, the value of the ground at this particular spot is calculated in cents per cubic yard.

The outside diameter of the pipe is taken for the calculation of the cubic contents of the drill-hole; thus, for the 6-in. pipe ordinarily used, 6½ in. is taken as the diameter of the hole, giving a volume of 0.23 cu. ft. for every foot in depth. This puts much too high a value on the ground, probably because the pump draws in gravel from beyond the circumference of the pipe. A common figure used for a 6-in. drill-hole is 0.27 cu. ft. per foot in depth. This is called 'Radford's factor,' and gives fair results.

After drilling is finished, the value of each hole in cents per cubic yard is multiplied by the depth of the hole in feet, and the sum of these products divided by the sum of the depths of all the holes. This gives the average value in cents per cubic yard of all the ground blocked out.

It is the custom now to keep a drill working all the time, well in advance of the dredge, and to guide the dredge by the results of the drilling.

Arrangement of the Digging and Gold-saving Apparatus of a Modern Dredge.[15]—The modern dredge has an endless chain of buckets carried on rollers which rest on a steel ladder. The top of this ladder is hinged on a gantry-frame some 20 ft. above the deck, while the bottom is suspended by cables by which it can be raised or lowered. The buckets pass over tumblers at the top and bottom of the ladder, the driving power being applied through gears on the top tumbler. The chain of buckets descends on the under side, the buckets fill themselves and are raised along the upper side to the top tumbler, where they discharge through a hopper or chute into a revolving or a shaking screen. The gold and fine gravel is washed through the screen by water under pressure to riffled tables, which in turn discharge into sluices; the latter deposit the fine tailing well behind the dredge. The coarse tailing, which passes over the screens, is taken up by a conveyor, which carries it about 50 ft. back of the dredge and stacks it 20 to 30 ft. high.

The riffled tables[16] are covered first with a layer of calico, then with a layer of cocoanut matting, and on top of these, sheets of expanded metal. Every few days these coverings are taken up and washed into a large gold box, from which the gold is later panned out and retorted.

Requirements of a Dredge.[17]—There are four distinct requirements of a

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[15] *Mining and Scientific Press,* Vol. LXXXVIII, 1904, p. 260.
[16] The Engineering and Mining Journal, Vol. LXXVII, 1904, 82.
[17] *Mining and Scientific Press,* Vol. LXXXVIII, 1904, p. 260.

dredge: To dig large definite quantities of gravel per month; to screen and wash as much as the buckets can dig; to save the gold; to dispose of the tailing. The development of the dredge has come through actual working experience. The size and strength of the machinery has been steadily increased; for instance, the weight of buckets from 500 to 1,200 lb., and the total weight of all machinery from 150,000 lb. to nearly 500,000 lb. in the larger machines, while the capacity has been increased from 20,000 to 75,000 cu. yd. per month. The machinery is designed to withstand a maximum strain far in excess of the normal pull of the motor. Thus the rated horsepower of a 45,000-yd. dredge is about 155, and of a 75,000-yd. machine about 230, while the average horsepower used is 100 and 150, respectively. The screening area must be ample to prevent loss of gold from overloading, and plenty of water under pressure is needed for washing. The character of the gravel determines whether a revolving or a shaking screen is used, or a combination of the two. The saving of gold is made easy by screening out the coarse stuff and distributing the finer gold-bearing material over tables where the water can be regulated. Beneath the screens, about 85 per cent of the gold is obtained and the percentage of loss is particularly small. The gold-saving riffled area is about 1,200 sq. ft. In disposing of the tailing the conveyor or elevator must be long enough to stack the coarse material at a sufficient height and distance behind the dredge to prevent it from running back, and the fine tailing sluice must be at such an elevation as to insure storage room. With a great amount of sand, it is necessary to use a sand-pump to discharge the fine material well over the top of the coarse-tailing piles.

Running a Dredge.[18]—To be successful, a dredge must run as nearly twenty-four hours per day as possible, for while production is stopped practically all expenses continue. A dredge is about on the same footing as a mill. Duplicates of all essential pieces and all wearing parts must be kept ready. In this particular, more care is needed than in a mill, where one battery alone can be hung up, while in a dredge the whole plant must stop for trivial repairs. Well managed dredges make a monthly average of about 80 per cent of the possible running time.

Size, Capacity and Speed.[19]—In New Zealand, the best rate of discharge is considered to be 16 to 20 buckets per minute. In California, where the buckets are close-connected, the rate ranges from 18 to 28, and in the bucket and link type, 12 to 14 buckets per minute. The size of the buckets varies from 3 to 8 cu. ft. As to the most economical size and capacity, opinions differ. A 45,000-yd. dredge, with comparatively light parts, is more easily kept in repair, but the labor cost (which is one-third of the operating expense) is the same as for a 70,000-yd. dredge. The increase in power (the cost of which is another third of the operating expense) is

[18] *Mining and Scientific Press*, Vol. LXXXVIII, 1904, p. 260.
[19] THE ENGINEERING AND MINING JOURNAL, Vol. LXXVII, 1904, p. 476. *Mining and Scientific Press*, Vol. LXXXVIII, 1904, p. 260.

relatively less than the increase in capacity, and the cost of repairs does not increase in greater proportion. The larger dredge is therefore the greater net producer. There must be, however, a limiting capacity of a dredge, beyond which the first cost will increase out of proportion to effectiveness, while the heavier parts will make repairs more difficult and costly, with an attendant greater loss of time. Although the tendency is towards still larger sizes, the economical limit is probably 70,000 or 80,000 cu. yd. At present, the maximum depth to which a dredge will dig is about 60 ft. below water line, and it will handle a bank 20 ft. above the water.

Cost of Dredging.[20]—The average cost with a dredge of 40,000 cu. yd. capacity is about 6¼c. per cu. yd., made up as follows:

	Cents.
Labor	2.10
Power	2.00
Dredge supplies	0.34
Taxes and insurance	0.18
Maintenance and repairs	1.20
Sundries	0.43
Total	6.25

With a 70,000-yd. machine, this cost may be reduced to less than 5c. per cubic yard.

The Oroville Gold Dredging and Exploration Company,[21] in its report for 1903, gives in detail the total costs and the cost per ton for dredging. In 12 months, with lost time amounting to 30.6 per cent, 474,610 yd. were handled, or 40,000 yd. per month, at an average cost of 6.48c. per cu. yd. The first cost of the dredge was $45,000, and the company intended to build three of them. They have now decided to put in only one more, a $67,500 machine, and with these two they expect to handle 100,000 cu. yd. per month at an average cost of 5.7c. per cubic yard.

Gold Dredging in California.[22]—At Oroville, the former center of hydraulic mining, there were 27 dredges working in May, 1904, some of them in and along the river and some of them a mile or two inland. Many orchards are giving way to dredges, the land being the more valuable for mining, having brought as high as $3,000 per acre. The latest type of dredge is the Bucyrus, with a daily capacity of 2,500 cu. yd., or the work of 1,000 men with pick and shovel. The average worked depth is 30 ft. below water. A Bucyrus dredge requires 3 men on each 8-hour shift. Electricity is the power. The average yield is 27c., and the cost of working from 5 to 6c. per cu. yd. It seems probable, with the increasing investments in gold-dredging in California, that the returns from this industry will soon

[20] *Mining and Scientific Press,* Vol. LXXXVIII, 1904, p. 260.
[21] *Ibid,* Vol. LXXXVIII, 1904, p. 93.
[22] The Engineering and Mining Journal, Vol. LXXVII, 1904, p. 834.

exceed annually the former yield from hydraulic and drift mining combined.

Costs in New Zealand.[23]—The total cost of a modern dredge is about $50,000. The working expenses, including salaries, repairs, etc., may be taken at $200 per week. At the end of 1903, about 100 dredges were working in New Zealand, producing 2,405 oz. gold per week.

Dredging in Oregon.[24]—The Allis-Chalmers Company has built a dredge for very heavy work at Gold Hill, in southern Oregon. The buckets have 8 cu. ft. capacity and are designed to work in hard-packed, cement gravel containing heavy boulders. The steam plant is of 150 h. p., and the daily capacity is from 2,500 to 3,000 yd. It is to dig 45 ft. below water or 60 ft. from surface to bed-rock. Its cost was $60,000.

The greatest activity in Oregon has occurred along the Snake river.[25] The gold is thin and scaly, and difficult to save. A dredge belonging to the Moraine Mining Company, having a capacity of 2,000 yd. in 24 hours, is working near Ontario on gravel worth from 17 to 35c. per cu. yd. On the John Day river, the Empire Company, of Portland, has a large 250-h. p. plant working on gravel containing 30c. per yard.

Combined Suction and Bucket Dredge for Idaho.[26]—Samuel S. Wyer describes a dredge he has designed for work in Idaho. Its principal features are low center of gravity and short length of ladder, the latter being reduced nearly one-half for a given digging depth. On the other hand, the gold-bearing material, after passing through the screen, must be elevated to a tank for distribution to the tables. In addition to the chain of buckets, a sand-pump handles the fine sand loosened by the buckets, its suction being placed just behind the buckets.

Dredging During the Winter in Montana.[27]—The Conwey Placer Mining Company, in Madison county, Montana, kept two dredges running through the winter of 1903-4. The usual temperature was from 32° to 0° F., with two drops for short periods to 6° and 17° below zero. The frost did not reach a greater average depth than 24 in. The frozen sod could be handled by the buckets to a depth of 12 to 15 in.; beyond this it was blasted with giant powder. The sluice-box was carried on an independent scow, and was 125 ft. long. It was built of ¼-in. sheet iron and the gold was saved by riffles. The constant flow of water prevented freezing on the surface. To prevent freezing from beneath, a light wooden casing, 12 in. deep, was built under the bottom of the sluice and the enclosed air space was warmed by a steam pipe.

Dredging at Atlin, B. C.[28]—Dredging has here become an important industry, although drifting and sluicing are still done on individual claims. On

[23] The Mining and Engineering Journal, Vol. LXXVII, 1904, p. 32.
[24] *Ibid*, Vol. LXXVII, 1904, p. 525.
[25] *Ibid*, Vol. LXXVII, 1904, p. 525.
[26] *Ibid*, Vol. LXXVII, 1904, p. 925.
[27] *Ibid*, Vol. LXXVII, 1904, p. 846.
[28] *Mining and Scientific Press*, Vol. LXXXIX, 1904, p. 324.

the large holdings suited to dredging, much bore-hole prospecting took place preliminary to dredging. The British American Company has built a dredge on Gold Run creek and installed a 500-h. p. electric plant on Pine creek. More dredges are expected next season. Large hydraulic properties are worked on both Pine and Gold Run creeks, but on account of spring freshets and scarcity of water in the early fall, the operating period is reduced to 120 or 130 days.

The Klondike District of Yukon.[29]—A dredge was built at great expense to operate a large concession in this district. The managers then abandoned work in their own territory and accepted a contract on the Klondike river at 50 per cent royalty. The inference is that the company considers the lease more profitable than its own concession.

Dredging in the Urals.[30]—Five bucket-dredges for use on the Tura river were to be completed in 1904. Besides these, many dredges were ordered for the Northern Ural. The earliest dredges in the Urals were imported; they were too frail for their work and were unsuccessful. They showed, however, what was needed, and the first dredge built by home works was erected in 1901 at the Neviansk Iron Works, in the Ural district. Since then there has been a steady advance in their construction.

Dredging in Siberia.[31]—Siberian placers are well suited for dredging, this having begun five years ago. Most of the dredges are imported, although good machines are built in Russia. The cost of a dredge installed and put in operation in Siberia is about $50,000. From practice and calculation the least values that will pay costs are found to be: By hand labor, 23.8c. per cu. yd.; by dredging, 8.4c.; by excavator, 6.2c. per cu. yd. Quartz veins have been but little worked in Siberia, and the future field seems to be for the dredge and the excavator.

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[29] *Mining and Scientific Press,* Vol. LXXXIX, 1904, p. 304.
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Cyanidation in the United States.

BY CHARLES H. FULTON.

While no startling innovations are to be recorded, gener progress has been made, while experiments are being conducted which promise decided improvements.

Electrical Precipitation.—At present there are two such plants in the United States and one in Mexico. This method of recovery does not compete with zinc precipitation as applied to ordinary gold-bearing cyanide solution; it finds its application to foul solutions carrying much base metal, such as are obtained from weathered tailing, or from silver ore, where the bulk of the precipitate becomes very great. The Malm process is in use by the Gold Cord Mining Company, treating the old tailing of the Empire mine, near Marysville, Mont., and is described by Matt. W. Alderson. The precipitation takes place in boxes 9 by 19 ft. in cross-section and 5 ft. deep, divided longitudinally into three compartments. In this box are four main anodes and three main cathodes, each anode and cathode being in three sections, one in each longitudinal compartment. The connection between the parts of each section is made by a copper wire or jumper. The arrangement is a 'series system,' very similar in design to the Hayden system of copper refining, formerly much used. Between each pair of sections of main anode and cathode are hung 36 'sub-plates', 3 by 5 ft. in size, placed 1 in. apart. They are set in grooves formed by strips nailed on the bottom and sides of the boxes and have no connection with the current except through the electrolyte. All electrodes are No. 18 iron. The sub-plates are coated on the positive side with graphite. The current density is 0.25 ampere per square foot of cathode surface, and the fall of potential between electrodes is 3 volts. In each box are 675 plates. The solution does not circulate through the boxes, but is permitted to stand in contact for 1.5 to 2 hours, when it is drawn off and replaced by fresh solution. The deposit forms in flakes on the negative side of the sub-plates, adhering to them loosely. It consists on the average of 51 per cent copper, 3.2 per cent gold and silver, some arsenic, antimony, lead and considerable lime.

Mr. E. M. Hamilton[1] describes electrical precipitation in the Butters plant at Minas Prietas, Mexico; this process is also used at the Butters plant at Virginia City, Nevada. The Mexican plant treats 9,000 tons of old tailing per month. The value of the tailing is mainly in silver, with some copper, derived from the sulphate used in the pan-amalgamation process by which the ore was originally treated. The precipitation occurs in 6 boxes, 30 by 11 ft. in cross-section and 5 ft. deep; the bottoms slope to one side to facilitate the clean-up. At Virginia City the precipitation boxes have spitzkasten bottoms. Each box has 12 compartments and contains 18 anodes and 17 cathodes, placed 1 in. apart. The solution circulates through 2 of these boxes in series. The current density is from 0.2 to 0.25 ampere per square foot of anode surface, and the tension between electrodes is 3 volts. The anodes are 0.185-in. lead plates, coated with lead peroxide, and not enclosed in any way. The cathode is tin plate, with an iron strip riveted at the top for support. The precipitate is deposited as a mud on the cathode and falls to the bottom of the box. Squeezers are used to clean the cathodes every two days. The rate of flow of solution from sand is 216 tons per twenty-four hours over 6,950 sq. ft. of anode. The anodes are coated with peroxide by immersion in a 1 per cent solution of potassium permanganate, the anode being attached to the positive pole. The current density for this coating is 1 ampere per square foot. The advantage of this over the Siemens method is that the anode and cathode are practically indestructible, the precipitate being collected as a mud, which can be refined in the same manner as the zinc precipitate.

Crushing of Ore.—For ore amenable to direct cyanidation and requiring coarse crushing only, dry reduction by rolls has not been improved upon; if it requires to be finely comminuted, crushing at once in cyanide solution is becoming a standard method in the Western States for ores suitable to this procedure; that is, for ores which normally are not heavy cyanide-consumers.

Even where amalgamation precedes cyanidation, crushing in cyanide solution may be adopted. At the Hidden Fortune mill, at Deadwood, S. Dak., this practice has been in successful operation for a year. The ore is crushed by stamps in a 1.5-lb. solution, amalgamation being effected inside the mortar by means of chuck-blocks and outside by silvered copper plates. No difficulty has been experienced, the plates keeping clean, although a little harder than usual, but efficient in saving free gold. Before amalgamation was tried, lime was added to the battery to coagulate the slime; but with amalgamation the lime seriously interfered. It is now added to the elevating pump which raises the pulp to the classifiers. From 1 to 3 per cent of mercury is found in the pre-

[1] *Journal*, Chemical and Metallurgical Society of South Africa, February, 1904.

cipitate from the zinc-box, but this does not interfere with the clean-up. Chilean mills are finding increased application, both for large and small units, even replacing stamps. This is true both for mills which cyanide direct and also for those which amalgamate previous to cyanidation. That the Chilean roller mills present any decided advantages remains still to be proved. The first cost of installation is possibly somewhat less; but, when it is considered that an extra crusher must be provided (in most instances coarse rolls) to prepare the ore for the mill, this advantage practically disappears.

Treatment of Slime.—The ordinary decantation process, or some modification of it, is still standard in this country. But its imperfection, involving the loss of soluble gold and cyanide, is becoming recognized, and experimentation points to filter-pressing. La Lustre mill, in Mexico; Tres Amigos mill, in Costa Rica; the Confidence mine, in California; the Greenback mine, in Oregon, all use presses. The Echo mine, at Mojave, Cal., is installing a 5-ton Perrin press, with hydraulic closure. In South Dakota the Horseshoe mill has made experiments with a small press, and is installing a large 5-ton hydraulic-closure press (similar to the Dehne presses used in Western Australia), to give the method a more thorough trial. The Hidden Fortune Company, at Deadwood, is also experimenting. The Homestake Company, at Lead, is experimenting extensively on its low-grade slimes ($0.80 to $1.10 per ton) with a special press (the design of C. W. Merrill), which is very large and is provided with a device in each compartment to sluice out the pressed cakes after washing, thus avoiding that big item in filter-pressing costs, namely, discharging.

The Moore slime filter is also in successful operation in South Dakota. Mr. J. V. N. Dorr, of the Lundberg, Dorr & Wilson Mill, at Terry, who has a plant in operation, in a private communication to the author gives the following facts:

The process has been in use somewhat over a year, during which time many changes and improvements have been made and the difficulties incidental to the working out of a new process overcome. The general plan of the plant has already been described.[2] The changes consist in an alteration of the hydraulic crane, whereby the frames are carried from four points of support instead of one; the re-modeling of the frames and the arrangement to discharge the slimes from the surface of the frames by means of water in place of compressed air, this change giving a much more perfect discharge.

It is as yet difficult to state operating costs, owing to the experimentation that has been going on during the year. Some figures, however, can be given. The mill treats about 35 tons of slime per day, by one Moore filter, containing thirty-five 4½ by 6-ft. frames, the filtering area being 1,836

[2] *Bulletin* No. 7, South Dakota School of Mines, p. 58. *Transactions* American Institute Mining Engineers.—'Crushing in Cyanide Solution in the Black Hills of South Dakota,' September, 1904. Pamphlet Black Hills Mining Men's Association, 1904, p. 61.

sq. ft. In the night shift the process is operated by the solution man, who also attends to his regular duties, which are manifold, so that the exact amount of labor which is to be charged to the process is difficult to arrive at. In the day shift a regular slime man is employed, who, with a solution man, handles the slime tailing from both shifts. The process is defectively installed, and the defects cannot at present be remedied. With a properly designed plant, containing provision for sluicing-out, it is quite certain that the solution men alone could satisfactorily attend the slimes, and the work would not exceed that of a well designed decantation plant of similar capacity.

The repair cost on all pumps connected with the process over an extended period of time amounted to $1.46 per ton of slime treated. The total cost of repairs would remain the same if the capacity of the plant were doubled, as the pumps have excess capacity. The life of the frames, being of wood and pipe, should be almost indefinite, as they are not subject to wear. The original canvas filters lasted eight months, equivalent to 2c. per ton of slime treated. The new filters with the improvements should last longer.

For agitation of the slime with solution, and for the Moore process proper, about 4 h. p. is required. This, at a cost of 40c. per horsepower-day, would be equal to a charge of 5.3c. per ton of slime. The total cost would not increase proportionately with the tonnage, as the vacuum pump used is much larger than is required, and the cost of keeping the slime in suspension in the loading vat would be about the same as with a larger vat, or with two sets of plates used in one vat. The consumption of cyanide at the mill is about 11.7c. per ton of ore treated, which is slightly under the average of the dry-crushing mills in the district operating on similar ore. This shows very favorably for the Moore process, for the loss in cyanide in the mills using the decantation process is rarely less than 20c. per ton. Tests made show that there is practically no consumption of cyanide during the air agitation of the slime pulp. The loss of cyanide in slime tailing will not exceed 0.15 lb. per ton.

The Moore process is intended only to recover the dissolved value in the slimes; but in the plant under discussion, owing to unexpected difficulties in dissolving the gold in the slime, it has to do both. This fact detracts somewhat from the efficiency of the process. For a period of four months the average loss in dissolved gold has been 8c. per ton, in handling $8 slime, and during this period the gold dissolved from the slime while passing through the Moore process has averaged 32c. per ton. This last fact explains in great part the 8c. loss.

The following results from a 13-day consecutive run show the possibilities of the process:

Slime going into the Moore process (sample washed free from dissolved value in the laboratory)	$1.154
This slime discharged as tailing (unwashed)	0.984
This slime discharged as tailing (washed)	0.984
This slime tailing cyanided again in the laboratory	0.956

Fine grinding for high extraction and quick solution of gold and silver has been emphasized recently; instead of prevention, the production of slime seems to be favored. In this connection, however, the question arises: What method of slime treatment is available? With most ores, the slime will have a higher value than either the sand or the original ore, and, unless the filter-press commends itself on the score of cost, excessive sliming presents a doubtful advantage, owing to the loss of dissolved gold inherent in the decantation process. In the Black Hills this loss in dissolved gold ranges from 3 to 6 per cent of the original assay value of the ore, depending upon the relative amount of sand and slime made in the crushing. This fact has cooled any ardor to crush finer, and with ore that is too low grade to permit filter-pressing, the production of an excessive amount of slime is to be avoided. It is probable, however, that the filter-press will be so modified in the near future as to reduce the cost of operation and make it available for low-grade slime.

The details of the Moore process are also being satisfactorily worked out, so that it promises to have quite a field. If it can be perfected—and there is good reason to suppose that it will be—it will certainly prove a strong rival of filter-pressing.

Precipitation and Treatment of Precipitate.—For large plants, zinc-dust recovery is finding increased application. It has the advantage of facilitating and shortening the clean-up with large amounts of solution. The precipitate is compact, the excess of zinc being small. The method, however, takes more skill than the ordinary precipitation by means of shavings. One of the most serious objections to the use of zinc-dust is the difficulty of obtaining a steady supply of pure dust, free from objectionable impurity, such as zinc oxide. Unless pure material can be procured, the method is sure to be a failure. G. H. Clevenger[3] proposes to distil the precipitate obtained by zinc in a retort under reducing conditions, leaving the gold and silver as a residue to be melted into bullion and collecting the zinc as dust to be used again in precipitation. Experiments on a small scale showed great promise.

Sodium Cyanide.—Sodium cyanide is replacing the mixed sodium and potassium salts. In cyanogen, pure sodium cyanide is equivalent to 132.6 per cent of potassium cyanide; the product now on the market has a strength equivalent to 120 to 125 per cent of potassium cyanide. The sodium cyanide is also purer, containing no soluble sulphides (which con-

[3] *Transactions* American Institute Mining Engineers, February, 1904.

taminate the mixed salts); it is also more soluble and gives more rapid action.

Review by States.—Arizona shows an increased application. Most of the cyanide mills are in Mojave and Yavapai counties, with a few in Maricopa. In Mojave county the Gold Roads mine, at Acme, has operated its dry-crushing plant; at Gold Basin the Gold Leaf mine is installing a 200-ton plant; the Great West mine has erected a 25-ton plant, and the Monmouth mine, at Burro creek, has a new plant in operation. The Jacobson mine, at Gold Basin, is successfully operating a 25-ton plant, and the Mojave Company and the Leland mines, at Milltown, have each erected cyanide plants. The Arizona and Minnesota Company will treat 5,000 tons of tailing in a 30-ton mill. The large plant of the Congress mines has also been in operation. In Yavapai the Iron King mine of the American Copper Company, near Blanchard, has a 20-stamp mill, treating its oxidized ore by amalgamation, concentration and cyanidation. The Monica mine, northeast of Yarnell, has erected a cyanide plant. In Maricopa county the Arizona Reclamation Company is operating a new cyanide process on slime from the old Vulture dump, near Wickenburg.

In California the number has increased, this being especially noticeable in the desert counties of Kern and San Bernardino. In the last named the Gold and Silver Extraction Company is enlarging its mill and cyanide annex, and the Southern Lone Star mine, 60 miles from Barstow, is erecting a plant. The Ivanhoe mine, at Dale, is constructing a 30-ton plant; the Supply mine, at the same place, has erected a 60-ton plant, and the Seal of Gold mine is erecting a 10-stamp mill and cyanide annex. The Chase and Bagdad mines have been treating some cupriferous ores successfully. This plant treats about 100 tons per day, from which about 8 lb. of copper per ton is recovered, aside from the gold and silver. In Kern county the Sunshine, Exposed Treasure, Queen Esther and the Echo mines have been in operation. A feature of cyanidation in the desert is the scarcity and expense of water, which costs 25c. per gallon. The consumption for stamp-milling and cyanidation is 75 to 90 gal. per ton of ore, at a cost of 20c. per ton. This is the figure for 30-mesh screens with the Godbe process of slime agitation.[4] In Mono county the Standard, at Bodie, is considering the installation of the Moore process, the tailing (sand and slime) to be hereafter directly treated as it comes from the plates, instead of settling it first in dams as heretofore. In Tuolumne the Vine Spring, near Columbia, and the Mount Jefferson mine, near Groveland, are installing new plants, using Chilean mills. In Inyo county, at Ballast, the Arondo company has put up a cyanide plant. In Plumas, the Five Bears mine, at Genesee, is erecting a cyanide plant, using stamps and a Kinkead mill for crushing. In Shasta the Midas company, near Harrison, has erected a plant, and the Sunnyside is erecting a stamp-mill

[4] Private communication from H. H. Ames.

with cyanide annex. In Lassen county the Golden Eagle is operating a large dry-crushing plant, and in Sierra the Sierra Buttes mine is putting in a cyanide plant.

Conditions in Colorado show little improvement. The most interesting development is the increased application to low-grade oxidized ore at Cripple Creek, the mills being placed at the mines. For higher-grade mill ore, chlorination is practically the only process employed. Only one cyanide plant—the Dorcas—is competing with chlorination. This cyanide plant receives about 2,800 tons per month, as against 40,000 tons per month treated by the chlorination plants. The United States Reduction Company has built a cyanide plant to treat the tailing of the old Colorado and Philadelphia chlorination mill. The cyanide process is also to be tried again in Clear Creek county. Here the Ward mine has erected a plant containing six steel tanks, 6 by 30 ft., crushing in a 10-stamp mill and amalgamating, with subsequent cyanidation. In Gilpin county cyanidation is also to be tried. The Gold Dirt has erected a 15-stamp mill, and will cyanide the tailing from five stamps. The Kokomo-Dumont Company, in the Russell district, will treat the tailing from amalgamation and concentration. At Ouray the Camp Bird Company has installed an additional 10 stamps and increased the capacity of its cyanide annex. In Summit county the Masontown, at Frisco, has erected a 20-stamp mill and cyanide plant. In Boulder the Wano has a cyanide mill, using stamps crushing in cyanide solution, treating the sand and slime in the usual way. The Nellie Bly mine, at Magnolia, concentrates ore and cyanides tailing. In San Miguel the Smuggler-Union and Liberty Bell mines use cyanide. At the latter, 83,373 tons of ore were milled, having an average value of $8.88 per ton; 51,994 tons were treated in the cyanide plant and 29,008 tons of slime were treated in the canvas plant; 50 per cent of the assay-value is recovered by amalgamation, 12 per cent by cyanidation, 11 per cent by concentration, and 5 per cent by the canvas plant. During 1903 interesting filter-press experiments were made by F. L. Bosqui; the slime, which is treated unsatisfactorily by the canvas plant, constitutes 38 per cent of the ore crushed, and has a value of from $3.90 to $4.87 per ton, being richer than the sand. The slime has a dense, clayey nature, and a great part of the value is in silver. Filter pressing was found to be of doubtful application, owing to the large equipment required; the time of washing in the press was long, and for successful pressing a cake only about 1 in. thick could be made.[5] The Liberty Bell mill has recently installed a tube-mill plant for fine grinding and the Moore process for the treatment of slime. The fine grinding is especially essential where high recovery is wanted on material whose value is principally in silver, as is the case with the Liberty Bell slime. In La Plata county the Bonnie Girl mine has erected a small stamp-mill and cyanide plant. In the Cripple

[5] *Transactions* American Institute Mining Engineers, October, 1903.

Creek district there are five coarse dry-crushing cyanide mills, of which two have been but recently completed; these are the Homestake, the R. E. & A., the King & Craig, the Cripple Creek Cyaniding Company and the Lois. The total daily capacity of these mills is 750 tons. The Homestake is constructing a 1,000-ton addition to its plant. The treatment is simple, the crushing coarse (between 4- and 8-mesh), the cyanidation being carried on by percolation with weak solution.

In Idaho there has been more activity. In Blaine county, near Hailey, the Nooksack company has erected a 200-ton mill and cyanide annex. In Idaho county, at Buffalo Hump, the Hogan mine has purchased the cyanide plant of the Republic mine, in Washington. The Mayflower, near Warren, is erecting a concentration and cyanide plant, and the Hawkeye group is being equipped with a cyanide plant. In Washington county the Gold Coin company is installing a 200-ton plant. In Canyon the Dewey, at Thunder Mountain, is installing a 100-ton plant. In Lemhi county the Kittie Burton mine has a 30-stamp mill in operation, cyaniding the concentrate from Wilfley tables. In Custer the Valley Creek has a 20-stamp mill and cyanide annex in operation, and will enlarge its cyanide department. In Boise county the Golden Rod, near Placerville, operates an 80-ton amalgamation, concentration and cyanide plant.

A number of new mills have been erected in Montana. In Madison county, at Norris, the Revenue-Montana Company has erected a 75-ton dry-crushing plant. It was on this property that the first cyanide plant in Montana was erected. At Virginia City the Alder Mining Company has erected a 60-stamp mill at the Kearsarge mine, the ore being treated by amalgamation, followed by concentration on Wilfley tables, the sand of the tailing being cyanided. Near this plant is the new plant of the U. S. Grant mines, similar in design, but with a capacity of only 30 to 40 tons. At the Easton and Pacific mines a cyanide plant is in operation on silver, the only ore of this type in Montana. At the Surprise mine, at Parrot, a 30-ton plant has been erected, using a Chilean mill as a crusher, de-sliming on a Wilfley table, and treating the sand by percolation. In Granite county, in the Red Lion district, the Milwaukee Gold Extraction Company has installed a 60-ton mill, crushing in a 6-ft. Chilean, and treating the sand in 12 steel vats by percolation. A slime plant is also to be installed at once. Near Cable the Southern Cross mines have put in operation a 90-ton dry-crushing plant, roasting the ore in Brückner furnaces. In Beaverhead the Watseka mine, at Rochester, is operating on a novel scheme, namely, crushing dry with rolls, cyaniding by percolation, then re-crushing the tailing, and amalgamating and concentrating. This mill has a capacity of 100 tons per day. The Green Campbell mine, at Silver Star, is erecting a 50-ton dry-crushing mill. In Park county the 120-ton cyanide annex of the Kimberley-Montana was in operation until interrupted by litigation. In Lewis and Clarke the Montana Company is treating old slime by agitation and decantation, precipitating on zinc-dust. The Belmont mill has installed a plant to treat slime, which was previously run to waste. The slime, after separation from the sand, is run over 20 ft. of amalgamated plates to the agitators. The Gold Cord, at Empire, is treating old tailing and using electrical precipitation. The Gloster, near Marysville, has erected a cyanide mill to treat tailing, and the Umatilla mine has also installed a plant. Most of the cyanidation of the State is done in Fergus county. The Barnes-King and the Kendall properties have been very active, as has also the Gold Reef, at Gilt Edge. The New Year has been operating intermittently.

The following data (supplied by E. W. King, superintendent of the Barnes-King Mining Company) are of interest. The mining districts of Fergus county, Montana, are situated mainly in the Judith and North Moccasin mountains. The center of mining here is the Barnes-King Mining Company's 230-ton cyanide mill, built in 1901, which is 20 miles in a northerly direction from Lewiston, the nearest railroad point; the Kendall 300-ton mill is three-quarters of a mile from the Barnes-King mill. The mining center in the Judith mountains is the Gold Reef Mining Company's 300-ton cyanide mill, 15 miles east from Lewiston. The other mills in this district are those of the Chicago-Montana Mining Company, 200 tons capacity, deriving its ore from the Whisky Gulch and Big Six properties, two miles west of the Gold Reef mill, and the Mammoth 100-ton mill, one mile east of the Gold Reef. All three of these mills are on the same ore zone. The New Year Gold Mining Company's mill is four miles in a northerly direction from the Gold Reef mill.

The ores of the district are a product of the alteration of limestone and sandstone. The ore consists of silica in the form of fine sand, limonite and fragments of limestone and chert.

At the Barnes-King Mining Company's mill the ores show only a slight latent acidity, which is neutralized by the addition of 2 lb. of lime to the ton of ore, the lime being added by a riffle box as the solution goes on the ore. The ore assays between $7 and $8 per ton, and an extraction of 93 per cent is obtained. The ore is crushed coarse, the final screen being ½-in. aperture, inclined at 45 degrees. The ore is charged into the tanks by a flexible spout from a 12-in. conveyor in five equal layers, no walking on the ore being allowed during the filling. The tailing is sluiced out through 10-in. circular gates with a water pressure of 180 lb., using a ⅝-in. nozzle. The plant has ten tanks for leaching—five 110-ton tanks, three 120-ton, and two 220-ton. All tanks are 6 ft. deep.

The system of crushing at the Barnes-King mill is as follows: A belt-conveyor carries the ore from the 200-ton bin to a grizzly with 1-in. spaces. The oversize is crushed in a No. 3 Gates crusher and joins the fine at the foot of an elevator which carries the product to a rotary screen. This trommel is in two sections, one with 1⅛-in. and the other with ½-in perforations. The fine material, less than ½-in., is carried by a belt-conveyor to the leaching tanks; the oversizes from the two sections of the screen are crushed in separate rolls, are delivered to the elevator, and returned to the same screen.

Two leaching solutions are employed; the strong one contains 0.3% of cyanide and is stored in a 16 by 6-ft. redwood tank; the weak solution contains 0.2% of cyanide and is stored in two other tanks of the same size. The first wash-water is stored in a tank of the same size and the second wash-water is fresh. A charge is saturated by upward percolation until the ore is covered; after standing for three hours, continuous downward percolation is begun, the weak solution following the strong and running for five days. During this time the solution goes to gold-tanks, from which it passes through zinc-precipitation boxes and thence to sump tanks. This treatment is followed by the first wash-water, which is handled in the same manner as the solutions. The second wash-water, after passing through the leaching vats, goes to a special gold-tank and through a special zinc-box, after which it is returned to a storage tank to serve as the first wash-water.

The labor schedule at the Barnes-King mill is:

DAY SHIFT, 8 HOURS		NIGHT SHIFT, 8 HOURS.	
1 Foreman (also zinc shaver)	$5.00	1 Foreman	$4.00
1 Crusher feeder	3.50	1 Crusher feeder	3.50
1 Rolltender	3.00	1 Roll tender	3.00
1 Sluiceman	3.50	1 Sluiceman	3.50
1 Tankman	3.00	1 Tankman	3.00
3 Solution men, who also tend heating plant, at $4.00.			

The cost of cyanidation is 75c. per ton. The bullion produced is 87 per cent gold and 10 per cent silver. The consumption of cyanide is 0.35 lb. per ton and of zinc 0.25 lb. per ton.

The mill of the Kendall Mining Company and the mills in the Judith mountains are very similar to the Barnes-King plant, both in design and treatment. An interesting development in the Butte district is the experiment of treating tailing from the Lexington mill by cyanidation. The writer is indebted for information concerning Montana to P. C. Waite, of Bozeman, and to Matt. W. Alderson, of Bald Butte.

In Nevada the Bambereger-De Lamar mill, in Lincoln county, has been in operation, treating 300 tons per day. The ore is crushed in 12 Chilean mills with weak cyanide solution, and a separation of sand from slime is made by classifiers. The practice resembles that of the Black Hills. Zinc dust was employed for precipitation until recently, when shavings were substituted. The Shawmut-Nevada crushes 60 tons per day in a Chilean mill, amalgamates the pulp and treats the tailing by cyanidation. Zinc dust is used in precipitation. The Newport-Nevada mill crushes the ore in a Chilean with cyanide solution. In Esmeralda county cyanide tests have been made on the Goldfields ore by F. L. Bosqui. At Virginia City the Butters tailing plant has been in operation.

In Oregon some new mills have been erected. In Baker county, near Sumpter, the Blue Bird and the Alamo mines will install cyanide plants.

The North Pole, at Bourne, one of the oldest cyanide plants in this country, has been in operation, crushing 120 tons per day with 30 stamps, amalgamating, concentrating and cyaniding. The Columbia has its mill in operation, crushing 60 tons per day, and treating in the same way as the North Pole. The Bourne Company is operating the Excelsior and Eureka mines; it operates a 20-stamp mill and treats the ore as above. The Greenback is dropping 40 stamps and operating its cyanide annex. In Josephine county, at Grant's Pass, the Oro Fino is installing a cyanide plant.

In Washington little cyaniding has been done. In Ferry county the Hendryx process has been tried at the Mountain Lion mine, with what results is not known. It avoided electrolytic precipitation, zinc shavings being used. The Bodie mine has erected a small cyanide plant. In Whatcom county the Nooksack is erecting an 80-stamp mill with a 200-ton cyanide annex.

No new mills have been erected in Utah. In Piute county the Annie Laurie mill, in the Gold Mountain district, has enlarged its capacity to 300 tons per day, additional crushing and roasting facilities having been installed. The Sevier Consolidated has put its new mill in operation. The Godbe slime process is used. In Iron county the Johnny mine, at Stateline, has operated a 10-stamp cyanide mill, crushing through a No. 9 slot screen, amalgamating over plates, making a separation of sand and slime, percolating the sand, and treating the slime by decantation in conical bottom slime vats. In Tooele county the Consolidated Mercur has discarded the Moore process after several months' trial; the former method has been resumed, but some change has been made in charging the vats, giving a product leaching more evenly. The tailing now runs 85 to 90c. per ton, whereas a year ago it carried $1.40 per ton. The mill at the Overland mine was put into operation in September. The Manning mill is to work on the dump again under lease.

Cyanidation has been very active in South Dakota. Eleven cyanide plants have been in continuous operation; nine of these have operated on refractory silicious ore, and two on Homestake ore. The two Homestake tailing plants have been enlarged, and now treat approximately 2,800 to 3,000 tons of sand per day. The recovery of bullion by cyanidation is close to $2,600,000, with a total production of $7,090,000 for the year. Two new cyanide plants have been erected: the Gilt Edge Maid, of 150 tons, recently put into operation, and the Branch Mint mill, in the Galena district, not yet completed. Several new mills are projected.

In North Carolina the cyanide process is beginning to find successful application on low-grade gold ore. In Montgomery county the Iola mine has erected a 50-ton plant and is producing bullion. In Randolph county the Southern Homestake has a 100 ton mill and cyanide annex ready to begin work. The Colossus Company, 20 miles north of Charlotte, has a 100-ton plant in successful operation on the tailing of the Howie mines.

Metallurgical Progress in Africa and Australia.

BY ALFRED JAMES.

The most noteworthy event of 1904 has been the stimulus to re-grinding due to H. S. Denny's work. Dissatisfaction with existing methods, coupled with definite improvement in concentrate treatment by re-grinding, have been far-reaching, and now there is apparently no one at Johannesburg who defends the long percolation treatment of spitz-sand (concentrate), although at the time of Mr. Denny's writing this was generally followed.

Re-grinding.—At the Robinson Deep the extraction on spitz-sand is 73.5 per cent by the long treatment, at a cost of \$2.50 per ton; on this basis, Mr. Caldecott says that re-grinding shows an extra profit of \$2,400 per month; or, in other words, by re-grinding 30 per cent of the mill product, the total extraction can be increased from 90 to 95 per cent (50c. per ton on 10 dwt. ore), at an increased cost of only 25c. per ton, leaving a clear 25c. profit. If it is assumed, however, that the increased cost of 25c. refers only to the tonnage actually re-ground, then the total profit would be increased accordingly. At the Glen Deep the re-grinding of the coarse sand was found to yield an increased recovery of 3 dwt. per ton on the plates alone, apart from any higher extraction obtained from the final sand in the cyanide vats. Speaking generally, re-grinding, apart from yielding an additional 5 per cent extraction, should lessen the equipment for the same tonnage by 20 per cent; by doing away with the vats at present used for the long treatment of concentrate, the shortening of the time required for the extraction of the finer sand would permit the treatment of the re-ground concentrate with the sand. Thus at present the usual 100-stamp installation is provided with 20 cyanide vats, of which two pairs are given over to the treatment of concentrate. It is estimated that future plants for the same tonnage need not have more than 14 or 16 large vats.

An examination of the Glen Deep results shows that, with a normal output per stamp, through 28-mesh, of 4.9 tons per diem, the duty was increased to 6.5 tons with 15-mesh, 7 tons with 12-mesh, and 10 tons with 8-mesh screening. Normally, 10 per cent of the sand is separated by the spitz as 'concentrate' and 25 per cent is classified as 'slime,' the balance being cyanided; but by re-grinding the coarse sand, 96 per cent passes 60-mesh, as against only 6.6 per cent before re-grinding. Curiously enough, the substitution of coarser screening did not materially modify the percentage of fine (all passing 60-mesh). In each case this was about one-half the total output, so that, taking 60-mesh as the standard of efficiency for cyanide work, it appears that one-half of the output must be re-ground, no matter what the size of screening used; but closer examination shows a material difference in the coarseness of the rough particles. Thus, with 15-mesh, 3.6 per cent of the product was too coarse to pass 20-mesh; with

12-mesh the proportion of rough was 9.9 per cent. This was increased to 15.3 per cent with 10-mesh, and no less than 25 per cent of rough remained on the 20-mesh when the 8-mesh was used on the battery; it is this rough product which increases the wear and tear of re-grinding.

It follows from these experimental data that, apart from wear and tear and subsequent extraction, the stamp capacity can be doubled by the use of one tube-mill, using 40 h. p., per 20 stamps. Assuming the stamp to crush normally 5 tons per diem (that is, 100 tons for 3 h. p. per stamp), then 40 h. p. additional gives a further 100 tons at a saving of 20 h. p.—less the amount used for returns, if the return system is practiced; and, as the tube-mill is cheaper in first cost, requires less supervision, is cheaper to run, and requires less repair and renewal than a stamp, the recent enthusiasm is not difficult to understand.

But, despite this enthusiasm, it is not probable, at present, that serious attempts will be made to double the mill output. The cost of grinding the very coarse particles is relatively too great. Tube-mills are not crushers, but grinders, and large quartz particles are not an economical or suitable feed; under such conditions one has to contend with abnormal cost and wear. Normally, with quartz sand one can usually calculate on fine grinding 1 ton of 12- to 20-mesh sand down to, say, 60-mesh with ⅓ h. p., and at a cost of 2c. for wear of flints and 1c. to 6c. for liners. Of course, in England or America, with cheap flints and liners, the figure would be much less than this. Labor and supervision is but a small item, one man attending a number of machines. The variation in the cost of different liners is extraordinary. Flint has so far proved the cheapest and most durable, lasting six times as long as iron. Steel and chilled-iron liners wear as smooth as glass, diminishing somewhat the duty of the mill.

The total cost of grinding (60-mesh) normal sand with horsepower at 50c. per diem comes to: Power, 12c.; flints, 2c.; liners, 2c.; labor, 0.5c., and repairs, 0.5c, making 17c. per ton. Fine sliming at Kalgoorlie (200-mesh) comes to more than double the above figures.

At Kalgoorlie there has been practically no development in tube-mill work in 1904. It has even been claimed that pans with wear-compensating shoes are superior as slimers. That pans may grind coarse particles more economically is admitted in certain quarters, but the mere fact that the claim for superiority in sliming should be put forward proves that Kalgoorlie tube-mill work must be capable of further improvement; and in this connection I ask why is it that Hannan's Star mill, the first one laid down, should be still doing the best work, while the Ivanhoe mill has been thrown out? The Australian theory of short tube-mills—they cut lengths off their 16-ft. mills to reduce them to 13 ft., with the object of getting off their slime as soon as it is formed—has apparently much in its favor, but it has yet to be proved correct. The longest and oldest mills, those at the Hannan's Star and the old Brownhill, exhibit the best results. With all mills working under precisely similar conditions, there should be no difficulty in settling the question.

Slime Treatment.—The completion of recent slime-plants at Johannesburg, and the appearance of Mr. Laschinger's paper on the subject of decantation, mark possibly the culmination of this method. The Robinson plant is an example of the fulfillment in practice of theoretical possibilities. I was impressed by the extraordinary simplicity of these huge plants working silently and almost automatically. It is now possible on the Rand to obtain an extraction of 80 per cent and upward at a working cost of but little over 50c. per ton; or as high as is being obtained on the sand at a less cost. At the low-grade Langlaagte Deep, an extraction of 85 per cent has been obtained at a cost of 45c. per ton. This is probably a record, and one of which the father of decantation—Mr. J. R. Williams—may justly be proud. When, however, one is confronted with the first cost of these huge installations, the inclination is to find some cheaper method of treatment. Thus, the Robinson plant cost $143,000, and was treating 160 tons of current slime per day. With a slightly less even extraction, the same plant would probably treat 200 or 240 tons per day; but even at this figure the redemption of capital alone amounts to no less than 25c. per ton of slime treated. And this to recover, under the best circumstances, only 90 per cent of the gold dissolved, that is, to leave in the residue 10 or 12 per cent of unrecovered gold which has been actually dissolved, in addition to the unextracted gold still left in the residue!

Improvements have been tried in two directions. Denny has sought to secure a more simple plant at the Van Ryn by continuous settlement, solution and decantation in conical vats. So far, however, it appears he will have to resort to some direct method of recovering his gold-bearing solution, an unduly large proportion of which would flow with the slime to the dam, did he not partially recover this by settling and pumping back. The other direction in which improvement is sought brings us to filter-pressing. It is calculated that a complete filter-pressing installation could be erected at Johannesburg for two-thirds the cost of the present decantation equipment, and that such a filter-pressing installation should recover 98 per cent of the dissolved gold—a total extraction of over 90 per cent, or 10 per cent better than the decantation process. As the cost of filter-pressing in Western Australia has been reduced to 40c. per ton (omitting cyaniding), it is not surprising that in South Africa increased attention is being paid to the process, and that Messrs. Denny, Williams, Robertson and Darling should be either working or preparing to work filter-press plants. At the Nigel, Mr. Williams appears to be obtaining extractions of over 90 per cent, while his costs have proved to be less than estimated.

At Kalgoorlie, pump-filling of filter presses has now come into general use; besides being more economical it is found to possess the advantage of filling the cakes more evenly than montejus. Filling presses by montejus costs 11.5c., against 5c. per ton for pump-filling. In this connection Mr. Sutherland, of the Golden Horseshoe, has some cause for congratulation, not only in having been the first to fill his presses by pumps, but also for adhering to this method throughout the montejus-filling boom prevailing later at Kalgoorlie. Mr. Marriner, of the Great Boulder Main Reef, has carried out some interesting investigations as to the method of formation of filter-press cakes and their thorough washing; he shows clearly that the uneven content of the residue is owing, not to insufficient washing, but to the action of the montejus, in which the heaviest particles settle so as to be first blown up the pipe and form the bottom and outside of the cakes.

The evolution of a continuous method of pressing, or one which shall not require the opening of the frames, has attracted much attention, and efforts in this direction are apparent all round. The most notable are:

1. The Argo, or continuous-belt-over-vacuum-box. This method does not yet appear to have been operated with success in practice, owing to mechanical difficulties.

2. The Moore, or grouped-frame-filter method. Success has been claimed at the Consolidated Mercur and elsewhere, but on investigation the inventor does not appear yet to have overcome the numerous difficulties inseparable from this type of machine. Sloppy cakes, which have to be scraped from the interstices of the frames, scarcely make for successful work.

3. The continuous machine at the Treasury (Johannesburg). This was on the type of a Moore filter enclosed in a heavy casting. By increasing the pressure it was hoped to force the cakes off the frames and to let them fall into the lower part of the casting, from which the pulp would be forced by a screw. In practice this has not proved successful.

4. The Prichard method is to force slime through a cylinder with a regulated impeded discharge. The walls of the cylinder support a filtering medium, the slime being forced through with a screw. Wash-water and compressed air are supplied from the opposite ends of a perforated tube running through the axis of the cylinder, with a block conveniently placed in the tube interposing between the air and water. Baffle-plates are added, to prevent the sludge from rotating. This scheme also fails to overcome the mechanical difficulties.

5. Finally, another similar method is being exploited at Kalgoorlie, the gold solution being extracted by centrifugal force. Details are not yet available.

In spite of the ingenuity and labor expended, it is only too evident that the filter-press is not yet displaced.

Residue Treatment.—The Stark process at the Crown Reef is said to be yielding good results. The process consists in pumping on the top of the tailing heap a solution of niter cake, potassium, sulpho-cyanate and potassium chlorate, deep channels being prepared to catch the drainage, which is conducted to precipitation boxes containing old iron screens and wire rope. Precipitation is by no means complete, and probably will be improved. At the Pioneer, a site has been carefully prepared with asphalt, and the tailing has been transferred to this from the old dump. Three hundred tons of water are pumped daily, containing 400 lb. niter cake, 40 lb. potassium sulpho-cyanate, and 40 lb. potassium chlorate. The Crown Reef latest returns show $49,920 for three months' run, of which $38,400 was profit.

Concentration.—The only novel feature of the year seems to be Caldecott's figures, showing that the gold contents of the sand and slime do not vary greatly in proportion to their pyritic content; and from this I assume that a concentration method of overcoming the slime-treatment problem is not likely to be successful in practice, for even a perfect separation of the pyritic particles themselves does not prevent the slime or sand from retaining a quantity of gold by no means negligible.

Handling.—Belt-conveyors are being more generally adopted for moving tailing. In designing these, care has to be taken to arrange for the proper distribution under the vat, otherwise it is apt to be flooded with tailing, which has to be dug out later. The 'tripper' is found to wear the belts rapidly; a more economical substitute is desirable. But, in spite of this, belts have proved much less expensive than the other methods. The long-looked-for Blaisdell excavator has at last arrived at the Robinson, but so far, complete details of results are not obtainable.

Roasting.—There has been very little new of interest. Simpson has improved the Merton furnace for concentrate work by increasing the size of the finishing hearth and adding two additional water-cooled rabbles. The three finishing rabbles revolve at a greater speed than those on the other hearths. The same authority has recently accomplished some interesting tests on the losses assumed to take place in roasting. Careful tests at Kalgoorlie have failed to prove any loss, even with the concentrate averaging nearly 20 oz. per ton. The matter has been investigated by careful assaying of the concentrate, weighed both before and after roasting, and also by condensing, in water, the waste gases from the furnace. The latter is not usually efficient, but the former method should be absolutely reliable. On the other hand, Mr. Simpson contends that the loss at the smelters in cupelling lead bullion containing tellurium is far greater than that of any possible loss in roasting furnaces. He claims that by the roasting process 98 per cent of the gold is recovered at a cost of not more than $5 per ton, whereas the expense of smelting is not less than $22.50 per ton for a recovery of under 94.2 per cent. While on this subject, one cannot but be amazed at the tremendous waste of tellurium which is volatilized at Kalgoorlie. It could be recovered quite cheaply, if there were only some commercial use for it.

Cleaning Up.—Tavener's method has not yet made the progress hoped for it. The drawbacks appear to be the large size of the smelting furnaces employed, which are peculiarly liable to expansion and contraction, owing to the intermittent nature of the operation; the difficulty of procuring suitable bottoms, and the liability of the melt to freeze in the cupel. It is suggested that smelting and cupelling in oil-burning furnaces (the former preferably tilting, or with crucible-hearth) would obviate this difficulty.

Costs.—South African tube-mills costs have already been given. West Australian costs, at first sight, do not appear to have come down as much as in previous years; the 1902 record was $4.94 per ton at the Great Boulder Main Reef; before Mr. Simpson left the Great Boulder Main Reef his costs were down to $3.54 per ton; at the Ivanhoe recent treatment costs are under $2.40 a short ton; at Lake View, $3.30, and at Oroya-Brownhill, $3.84. The following data represent two typical mines:

	Per ton.	
Crushing	$0.16	Oroya Brownhill
	0.08	Lake View Consols
Milling	0.54	Oroya Brownhill
	0.52	Lake View Consols
Fine grinding (per ton milled)	0.32	Oroya Brownhill
	0.64	Lake View Consols
Cyaniding by agitation (per ton cyanided, omitting bromo-cyanide and royalty)	0.66	Oroya Brownhill
	0.48	Lake View Consols
Filter-pressing (per ton pressed)	0.42	Oroya Brownhill
	0.46	Lake View Consols
Disposal of residue	0.08	Oroya Brownhill
	0.12	Lake View Consols

GRAPHITE.

The mining of graphite should attract great interest in the United States on account of the multiplicity of uses for which the mineral is indispensable. The growing consumption of graphite is mainly supplied by importations from Ceylon, India, Germany and Canada, the annual volume of which has usually been more than eight times the amount produced in this country. Graphite enters free of duty; for some purposes, however, foreign graphite, particularly that of Ceylon, cannot be replaced by the product of any of the domestic localities as yet discovered.

Varieties.—Graphite mined in the United States is classed as crystalline or as amorphous. The former is that which has a crystalline nature and is nearly pure carbon, although its occurrence may range from masses down to minute flakes. Amorphous includes all other graphite, which is apt to be more or less mixed with argillaceous matter. The crystalline is the more valuable because of the comparative ease with which it can be separated from its gangue, affording a more nearly pure graphitic product.

Crystalline.—The main supply of crystalline graphite is furnished by Essex county, New York, where the mines and mills of the Joseph Dixon Crucible Co. are in active operation. A description of these deposits has been given by Professor J. F. Kemp,[1] which was abstracted in Volume XII of THE MINERAL INDUSTRY. A feldspathic quartzite, through which graphite is disseminated to the extent of 5 to 15% of the whole, affords the most reliable and productive source of output, being worked at Hague, on Lake George, by the Dixon company, and at Dresden and Whitehall, Lake Champlain, by the Adirondack Mining & Milling Co. and the Champlain Graphite Co. respectively. The Ticonderoga Graphite Co., whose mines and mill are near Rock pond, west of Ticonderoga, was taken over by the Columbia Graphite Co., of Pittsburg, Pa. The only successful attempt to mine a graphite vein, which form is the richest of all the varieties of deposit, though pockety and of small size, is that of the Dixon company at Chilson hill, near Ticonderoga. In St. Lawrence county, on the opposite side of the Adirondacks, developments of graphite deposits have occurred; a mill has been erected at Macomb, and 500 tons of rock have been mined. New York, in 1904, produced 3,132,927 lb. of crystalline graphite, valued at $119,509, about the same output as in previous years.

The crystalline graphite of Chester county, Pa., was worked by the Philadelphia Graphite Co., of Philadelphia, and by the Federal Graphite

[1] *Bulletin* of the United States Geological Survey, No. 225, 1904, p. 512.

Co., of Chester Spring. Pennsylvania's output in 1904 was 623,131 lb., valued at $38,308, a slight increase over preceding years. Neither Alabama nor Montana reported any production in 1904.

In South Dakota, the mines at Custer, formerly owned by the Copper Cliff Mining Co., were sold in 1904 to the Chicago Graphite Manufacturing Co., which makes paint of its mine product.

Amorphous.—Graphite is found abundantly as an intimate constituent of the rocks in those regions that have suffered dynamic metamorphism, where it represents the last stage in the progressive elimination of volatile constituents from hydrocarbons. In Michigan the Baraga schist is graphitic, and is mined by the Detroit Graphite Co. and by the Hathaway Graphite Co., of L'Anse. The Wisconsin Graphite Co., of Pittsburg, Pa., operates at Stevens Point, Wis.

In the Turret mining district of Chaffee county, Colorado, graphite is being developed by the Ethel Gold Mining Co., of Detroit, Mich., and a mill is under construction. In Rhode Island, the graphitic anthracite, which has long resisted all attempts at utilization as fuel, is mined as graphite by the Rhode Island Graphite Co., of Providence; a new vein was opened at Tiverton during the year. Development progressed at the Sonora county mine in California, and a small output was reported by the Goshen Coal Mining Co., of New Philadelphia, Ohio.

In the South, Wake and McDowell counties, North Carolina, afford a graphitic schist carrying up to 25% and more of graphite; the presence of mica, however, hinders a clean separation. In Georgia, a graphitic shale or slate containing 13% graphite is mined at Emerson, Bartow county. With no cleaning, it is pulverized to 8-mesh, with 60% passing 24-mesh screen, and is sold to the fertilizer trade as a coloring agent.

Production.—The production of graphite in the United States for five years is sufficiently indicated in the adjoining table. New York was the heaviest contributor to the output of crystalline, the remainder being about equally divided between Pennsylvania and South Dakota. Of amorphous,

THE PRODUCTION, IMPORTS, EXPORTS (a) AND CONSUMPTION OF GRAPHITE IN THE UNITED STATES.

Year.	Refined Crystalline Graphite.						Amorphous Graphite.		Artificial Graphite.	
	Production.		Imports.		Consumption. (c)		Production.		Production.	
	Pounds.	Value. (b)	Pounds.	Value.	Pounds.	Value	Tons. 2,000 lb.	Value.	Pounds.	Value.
1900.	4,103,052	$164,122	32,298,560	$1.389,117	36,401,612	$1,553,239	1,045	$8,640	860,750	$68,860
1901.	3,967,612	135,914	32,029,760	895,010	36,997,372	1,067,921	809	31,800	2,500,000	119,000
1902.	4,176,824	153,147	40,857,600	1,168,554	45,034,424	1,322,401	4,739	55,964	2,358,828	110,700
1903.	4,525,700	164,247	32,012,000	1,207,700	36 537,700	1,371,947	16,591	71 384	2,620,000	178,670
1904.	4,357,927	162,332	25,350,000	905,581	29,707,927	1,067,913	19,115	102,925	3,248,000	217,790

(a) The exports of graphite from the United States were valued at $834 in 1901, $365 in 1902, $4,223 in 1903 and $455 in 1904. (b) Nominal. (c) Neglecting the small exports of foreign produce.

the Michigan-Wisconsin region supplied the most, followed by Rhode Island and New Mexico. The International Acheson Graphite Co., of Niagara Falls, the sole producer of artificial graphite, made 3,248,000 lb. in 1904, valued at $217,790, an increase of 628,000 lb. ($39,120) over the preceding year.

Uses.—American crystalline graphite is used in the manufacture of lubricants and pencils and in the preparation of electrotypes. Crucibles and refractory articles are best made of Ceylon graphite, for which purpose it is particularly adapted owing to its irregular fracture, which makes particles that are more strongly bound together by the clay cementing material than graphite which, when pulverized, assumes a flaky character. The American crystalline graphite is entirely of this latter description, and for that reason is especially adapted for use as a lubricant. The Dixon company obtains all its foreign crude material from Ceylon and uses it all in the manufacture of crucibles and polishes, devoting all its domestic product to other purposes. Other manufacturers, however, use American crystalline for crucibles. It is estimated that the American crystalline production is consumed in about the following proportions: 55% for refractory ware; 15% for polishes; 10% for foundry facings; 5% for paint; 15% in pencils, gunpowder glaze, electrotyping, electrical supplies, etc. The amorphous class is used exclusively for paints and foundry facings, except the Georgia material, as above noted.

Only the finer grades of flake graphite are suitable for lubricants, of which several forms are now on the market. It has an advantage in very heavy, slow-moving bearings, in which the more fluid oils will not remain, and in places subjected to high temperatures. It is neither decomposed by any agency, nor does it corrode metals, but by permanently filling the roughnesses creates a perfectly smooth and lasting surface. The modern tendency, however, to use solid lubricants indiscriminately, where fluid oils are applicable, is deprecated by the best authorities.

Manufacturers of Graphite Products.—Only the largest works are supplied by their own mines, the others obtaining their crude material from individual producers. The principal consumers of graphite, classified as to the nature of their finished product, are given in the following list:

Crucible Manufacturers and Grinders.—Joseph Dixon Crucible Co., Jersey City, N. J.; J. H. Gautier & Co., Jersey City, N. J.; Robt. Taylor Crucible Co., Callowhill St., Philadelphia, Pa.; Bridgeport Crucible Co., Bridgeport, Conn.; R. B. Seidel & Co., Philadelphia, Pa.; Taunton Crucible Co., Taunton, Mass.; Crucible Steel Company of America, Pittsburg, Pa.; Ross-Tacony Crucible Co., Tacony, Pa.; McCullough & Dalzell, Pittsburg, Pa.

Grinders.—Joseph Dixon Crucible Co., Jersey City, N. J.; Philadelphia Graphite Co., Philadelphia, Pa.; United States Graphite Co., East Saginaw, Mich.

Paint Manufacturers.—Joseph Dixon Crucible Co., Jersey City, N. J.;

Detroit Graphite Co., Detroit, Mich.; Chicago Graphite Manufacturing Co., Chicago, Ill.; Hathaway Graphite Co., L'Anse, Mich.; Wisconsin Graphite Co., Pittsburg, Pa.

Stove Polish Manufacturers.—Joseph Dixon Crucible Co., Jersey City, N. J.; Rising Sun Stove Polish Co., Canton, Conn.; Enameline Stove Polish Co., Passaic, N. J.; Nickel Plate Stove Polish Co., Chicago, Ill.

Foundry Facing Manufacturers.—Joseph Dixon Crucible Co., Jersey City, N. J.; Hill & Griffith, Cincinnati, O.; J. W. Paxson & Co., Philadelphia, Pa.; American Facing Co., New York, N. Y.; T. P. Kelly, New York, N. Y.; Springfield Facing Co., Springfield, Mass.

Grease and Lubricant Manufacturers.—Joseph Dixon Crucible Co., Jersey City, N. J.; Ilsey, Doubleday & Co., New York, N. Y.

Production of Graphite in Other Countries.

Austria.—During 1904, there were 21 enterprises, employing 1,300 workmen, in operation, giving a total output of 28,620 metric tons, a decrease of 967 tons from the previous year. Bohemia contributed 44% of the output; Styria, 27%; Moravia, 26%, and Lower Austria the remainder.

Canada.—The output of graphite in 1904 was 450 short tons, valued at $11,760. The Black Diamond mine, near Calabogie, Ont., was the largest producer. The McConnell mine, in Lanark county, Ont., was in operation the greater part of the year. Prospecting is active, and several promising discoveries have been made. Among the new mines, the Kinmount, in Victoria county, Ont., gives the best indications of becoming a large producer.

Iu Quebec, the only operator during 1904 was the Anglo-Canadian Graphite Syndicate, Ltd., of Birmingham, England, who took possession, in January, of the mines and mill of the North-American Company. Having installed new processes at this mill, it turned out a good grade of graphite, some of which was sent to England.

Ceylon.—Graphite has been mined in Ceylon for many years; it enjoys a high reputation for purity and adaptability to the manufacture of the best grade of pencils, and particularly of crucibles. The most important deposits are in the northern provinces and in Sabaragamuwa. The mineral area is about 95 miles in length and 35 to 50 miles in width. The graphite occurs in veins traversing a garnetiferous granulite, and varying from a few inches to 10 or 12 ft. in width. As a rule, the veins are irregular, and the graphite is obtained by natives who follow primitive methods. With one or two exceptions, the deposits are too small to be mined in a modern manner. The annual production of graphite in the island is about 25,000 metric tons; the industry gives employment to 10,000 persons.

Germany.—Extensive graphite deposits occur near Passau, in Bavaria. The graphite is in the form of large scales and is found in a gneiss formation. Near Schwarzbach, in Bohemia, a fine-grained graphite is found in a gneiss also; but its quality is inferior to the Bavarian. In 1904 Germany produced 3,784 metric tons of graphite, valued at $42,250, an increase of 64 tons ($5,000) over the previous year. Imports of crude graphite during 1904 amounted to 23,533 metric tons (20,953 in 1903), and exports were 1,815 tons, or about the average for several years.

WORLD'S PRODUCTION OF GRAPHITE.
(In metric tons.)

Year.	Austria.	Canada.	Ceylon.	Germany.	India.	Italy.	Japan.	Mexico.	Sweden.	United States. (b)	Totals.
1900.....	33,663	1,743	19,168	9,248	1,858	9,720	94	2,561	84	1.799	79,938
1901.....	29,992	2,005	22,707	4 435	2,530	10,313	88	1,473	(d) 56	1,800	75,399
1902.....	29,527	978	25,593	5,023	4,648	9,210	97	580	63	1,895	77,517
1903.....	29,590	670	24,492	3,720	3,448	7,920	114	1,952	25	2,053	73,984
1904.....	28,620	411	.....	3,784	3,800	(e)7,290	...	......	55	2,045	.....

(b) Crystalline graphite. (c) Statistics not yet published. (d) The production of crude graphite during 1901 was 1,727 metric tons, valued at $1,634. (e) Net exports.

India.—The graphite deposits of Travancore occur similarly to those of Ceylon, whose associates form a continuation of the charnockite series of South India. Like occurrences of graphite are found in Coorg, and in the hill tracts of Vizagapatam and the adjoining State of Kalahandi. The Indian graphite, like that of Ceylon, is regarded as of igneous origin. Prospecting for graphite has been carried out in the Godavari district, Madras Presidency, and in the ruby mining districts in upper Burma; but Travancore remains the only producing State.

New South Wales.—Graphite is being mined by the Walcha Graphite Syndicate, 26 miles northeast of Walcha. The mine lies on the sides of a steep spur overlooking the profound cañon of Bluc Mountain creek. The graphite occurs in a eurite dike, generally micro-pegmatitic, and crowded with spheroidal segregations of graphitic material. The dike sweeps across the main trend of the spur in such a manner that its contents are naturally proved to a depth of at least 400 ft. The country is an acid granite, and the dike is strongly marked over 250 or 300 yards of outcrop. It varies in width from 6 ft. at the northern end to 30 ft. on the southern side of the spur. The graphite in the spheroidal kernels is excessively fine. The kernels vary from ½ in. to 1 in. in diameter, and they occupy from 40 to 50% of the dike mass. The kernels contain from 20 to 25% graphite. The mineral is uniformly distributed throughout the dike, and large quantities are developed.

IRON AND STEEL

BY FREDERICK HOBART.

If a curve should be drawn, representing the course of the iron and steel industry in the United States for a number of years, it would strongly resemble the wave line as traced by a hydrographer, the crest of each wave representing a period of prosperity, followed by one of depression, as the wave loses its force and recedes. In the case of the iron diagram, however, it would be found that each wave of prosperity rises to a higher point than its predecessor. This is to be expected, not only on account of the national growth in population and substantial wealth, but also because of developments in metallurgy, improving the quality and reducing the costs, and of the rapid progress made in the substitution of metal for lumber and other materials in construction. The change in methods of building and in the size of structures, which is found in all our large cities; the almost complete substitution of steel for wood in bridge construction, and other changes of this kind, fully account for the tremendous growth in the demand for iron and steel in all forms. Even the receding wave never reaches as low a point as its predecessor.

The last half of 1903 appeared to be the beginning of one of these periods of recession. For nearly three years the iron industry had been extremely prosperous, and it looked to those who do not go below the surface as if no recession was possible. The check to business, which really began with the confusion caused by the great anthracite strike, became not only apparent but menacing. The over-confident feeling which prevailed began to be replaced by a vague sentiment of distrust. The assertions—which were really believed by many—that the great consolidations of the boom time would steady and equalize trade, proved to be largely without substantial base, and it was seen that the trust could do no more to create demand—perhaps less—than the companies which had preceded it, and which now form part of it. The year 1904 opened at almost the lowest point of depression. Furnaces had gone out of blast, mills were closed, and there were gloomy anticipations of still further decline in trade. Very soon after the beginning of the year, however, observers began to realize that matters were not as bad as they had for a short time seemed to be. There was still a substantial amount of wealth in the country, business was in fairly sound condition, and there was every reason to believe that even the traditional depression of a presidential year would have a far less unfavorable effect upon the trade than in 1896 and 1900. Matters at issue in the election were not such as to cause any real apprehension of business disturbance. Others began to realize that the depression had been exaggerated for the purpose of affecting speculation on the stock exchanges. Almost from the very first of the year there was an improvement, gradual and rather slow at first, but still perceptible, and by the time midsummer was reached, there was a considerable advance both in production and in prices. Furnaces were going into blast again, and mills resuming, in order to meet their contracts. This process continued, with very few checks, throughout the second half of the year, and 1905 opened with general anticipation of further improvement and activity.

Iron Ore.—The production of iron ore in 1903 was less than the maximum attained in 1902, though it is not believed that many of the furnaces entered 1904 with excessive stocks. The reserve in sight, however, was somewhat larger than is generally the case, and this proved to be a fortunate circumstance, as the various delays in the opening of Lake shipments made it impossible to bring forward new supplies until an unusually late date. The following table shows the production of iron ore in the United States for 1904, comparison being made with the figures for the preceding year given in Volume XII:

	1903.	1904.
Lake Superior shipments	24,099,550	21,822,839
Southern mines	5,889,000	5,450,000
Other States	2,483,000	2,190,000
Production	32,471,550	29,462,839

The Lake district furnishes over 70% of the iron ore used in the United States, and owing to the relatively higher grade of the ore it enters into from 75 to 80% of the pig iron made. In the other supplies the largest decrease was in the Southern States, where ore production keeps closely in line with the actual condition of the blast furnaces.

The following table shows the total shipments of Lake iron ore by ranges for three years, 1902 having been the record year:

Range.	1902.	1903.	1904,
Marquette	3,868,025	3,040,245	2,843,703
Menominee	4,612,509	3,749,567	3,074,848
Gogebic	3,663,484	2,912,912	2,398,287
Vermilion	3,084,263	1,676,699	1,282,513
Mesabi	13,342,840	12,892,542	12,156,008
Total	27,571,121	24,271,965	21,755,359
Baraboo	....	17,913	67,480
Total	27,571,121	24,289,878	21,822,839

The shipments for 1904 do not include the ore from the Michipicoten range in Canada, which were 117,153 tons, practically all of it from the Helen mine.

The notable point is the constantly increasing proportion of the Mesabi.

The shipments from that range for 1904 were 736,534 tons less than in 1903 and 1,186,832 tons less than in 1902; nevertheless, they constituted a higher production of the total, having been 55.7%, against 48.4% in 1903 and 48.4% in 1902. In the old ranges and on the Vermilion there was little change in proportion. The list of shipping mines in 1904 includes 135, which is seven less than in 1903, but two more than in 1902. On the Marquette range in 1904, 20 mines reported; on the Menominee, 30 mines; on the Gogebic, 22 mines; on the Vermilion, 6 mines, and on the Mesabi, 55 mines.

The record for shipments in 1904 is held by the Stevenson mine on the Mesabi, which shipped 1,652,021 tons. For the two previous years the record was made by the Fayal, also on the Mesabi, which shipped 1,919,172 tons in 1902, and 1,656,973 tons in 1903, but fell to 975,102 tons in 1904.

The total shipments of all the ranges from the first record of mining up to the end of 1904 were as follows: Marquette, 72,590,112; Menominee, 49,071,-686; Gogebic, 43,129,473; Vermilion, 22,020,718; Mesabi, 78,796,357; a grand total of 265,696,359 tons of iron ore.

The United States Steel Corporation's shipments in 1904 were 51.3% of the total, which compares with 55.5% in 1903, and 58.5% in 1902. The Corporation's shipments, however, were somewhat above the normal in 1902, since in that year it adopted the policy of accumulating a large stock of ore at its furnaces and at the Lake Erie docks.

Shipments from leading districts outside of the Lake Superior region were as follows:

	1902.	1903.	1904.
Missouri mines	65,645	54,477	38,420
Cornwall mines, Penna	594,177	401,469	174,331
New Jersey mines	399,984	472,490	502,506
Chateaugay, Lake Champlain	83,688	65,707	287,315
Port Henry, Lake Champlain	365,437	373,565	299,817
Salisbury region, Connecticut	23,276	24,255	15,092
Cranberry mines, No. Carolina	30,810	60,108	61,996
Tennessee Coal, Iron and Railroad mines in Alabama	1,276,969	1,302,207	1,162,369

Imports and exports of iron ore are shown in the following table:

From:	1903.	1904.	Changes.
Cuba	613,585	364,730	D. 248,855
Canada	169,681	77,882	D. 91,799
Newfoundland	86,730	5,400	D. 81,330
Spain	94,720	36,810	D. 57,910
Other countries	15,724	2,791	D. 12,933
Total imports	980,440	487,613	D. 492,827
Exports	80,611	213,865	I. 133,254

The decrease in exports was due partly to lesser production from the Cuban mines, but chiefly to a smaller demand from the furnaces on the Atlantic seaboard, which are the chief consumers of foreign ore. The increase in exports was chiefly in deliveries to Canadian furnaces, though there were also some exports of Lake Champlain ores to Germany.

The total estimated consumption of domestic and foreign iron ore in the manufacture of pig iron in 1904 was 28,870,000 gross tons, against 31,516,000 tons in 1903, 31,187,000 tons in 1902, 27,787,000 tons in 1901, and 24,131,000 tons in 1900. The mill cinder, scale, scrap, etc., consumed in the manufacture of pig iron in the census year 1900 amounted to 1,600,313 tons. The production of pig iron in the census year was 14,452,234 tons.

To the above estimates may be added the iron ore annually consumed in open-hearth steel furnaces and in rolling mills, etc., which amounted in the census year 1900 to 340,028 gross tons. Statistics of this consumption for other years have not been collected.

Limestone and Dolomite Flux.—The limestone and dolomite consumed for fluxing purposes by the blast furnaces of the United States in the production of 16,497,033 tons of pig iron in 1904 amounted to 8,195,036 tons. The average consumption of limestone per ton of all kinds of pig iron produced was 1,112.6 lb. in 1904, against 1,193 lb. in 1903, 1,192.8 in 1902, 1,186.5 in 1901, and 1,205.6 in 1900. The consumption in 1904 by the anthracite and bituminous furnaces was 1,128 lb. per ton of pig iron made, and by the charcoal furnaces it was 373.6 lb. Dolomite is used only in the Alabama furnaces.

Pig Iron.—We are fortunate in this country in the complete organization of the American Iron & Steel Association, which collects statistics of the industry more complete and reliable than are attainable in any other country. Moreover, the long experience of Mr. James M. Swank, general manager of the association, enables him to present these statistics clearly and promptly. The figures furnished by the association are used throughout the following pages.

The total output of pig iron, classified by the uses for which the iron was intended, is as follows, in long tons:

	1903.		1904.		Changes
	Tons.	Per cent.	Tons.	Per cent.	Tons.
F'ndry and f'rge..	5,281,200	29.3	4,358,295	26.4	D.922,905
Bessemer........	9,989,908	55.5	9,098,659	55.2	D.891,249
Basic............	2,040,726	11.3	2,483,104	15.1	I.442,398
Charcoal.........	504,757	2.8	337,529	2.0	D.167,228
Spiegel and ferro..	192,661	1.1	219,446	1.3	I.
Total........	18,009,252	100.0	16,497,033	100.0	D.1,512,219

Charcoal iron, which is given separately, includes some iron of bessemer quality, and some basic. The larger part is used either for conversion into wrought iron or for special castings where a high degree of strength is required. The marked feature in this statement is the increased proportion of basic iron made and used. In fact, this class of iron showed an actual gain in quantity in a year of generally declining production.

The total production in 1904, classified according to fuel used, with the number of furnaces in blast on June 30 and Dec. 31, was as follows:

	June 30.	Dec. 31.	Tons made.
Coke	170	206	14,931,364
Anthracite	28	38	1,228,140
Charcoal	18	17	337,529
Totals	216	261	16,497,033

It should be noted that a number of the anthracite furnaces use some coke mixed with the anthracite as fuel. The number of furnaces reported idle at the close of the year was: Coke, 94; anthracite, 35; charcoal, 39; total, 168. The list of idle furnaces always includes some which, for various reasons, are not likely to be put in blast again.

The production of pig iron by States for two years past is shown in the following table:

States.	1903.	1904.
Massachusetts	3,265	3,149
Connecticut	14,501	8,922
New York	552,917	605,709
New Jersey	211,667	262,294
Pennsylvania	8,211,500	7,644,321
Maryland	324,570	293,441
Virginia	544,034	310,526
North Carolina and Georgia	75,602	70,156
Alabama	1,561,398	1,453,513
Texas	11,653	5,530
West Virginia	199,013	270,945
Kentucky	102,441	37,106
Tennessee	418,368	302,096
Ohio	3,287,434	2,977,929
Illinois	1,692,375	1,655,991
Michigan	244,709	233,225
Wisconsin and Minn	283,516	210,404
Missouri, Col., and Wash	270,289	151,776
Total	18,009,252	16,497,033

Three States, it will be seen from this table, showed an actual increase in production. These were New York, where the gain was due to the large furnaces of the Lackawanna Steel Co., and New Jersey, where at least one new furnace contributed to the production. West Virginia also showed a considerable gain. The decrease was very generally distributed over the other States.

For the production for two years past, by districts, see top of p. 240.

In this classification Maryland is placed by itself, because its production is mainly from imported Cuban ores in a single group of furnaces. West Virginia is included in the South, owing to the proximity of its iron-making

	1903.	1904.
N. Eng., N. Y. and N. J.	782,350	880,074
Pennsylvania	8,211,500	7,644,321
Ohio and Illinois	4,979,809	4,633,920
Mich., Wis. and Minn	528,225	443,629
Maryland	324,570	293,441
Southern States	2,900,856	2,444,342
West of Mississippi	281,942	157,306
Total	18,009,252	16,497,033

region to that of Virginia, although it is possible that it should be rather with Ohio and Illinois; but West Virginia depends, like most of the Southern States, upon local ores, rather than upon those brought from the Lake Superior region. The increase in the Eastern States was not due to any larger output from the New Jersey furnaces, or those in the Berkshire region which use local ores, but to the starting up of some of the great furnaces of the Lackawanna Steel Co., at Buffalo, which use Lake ores. Pennsylvania continues to lead all the States, with a production of about 46% of all the iron made in the country, and is likely to retain this prominence for some time to come, although the furnaces of Ohio and Illinois are slowly gaining. The Southern States showed a decrease, which would have been still larger had it not been for the fact that in West Virginia there was an actual gain in production.

This grouping of the output shows that last year fully 80% of the total pig iron produced was made by furnaces using Lake Superior ores wholly or in part. In Ohio the use of local ores has almost entirely ceased, while in Pennsylvania it is confined to the ore from a single important group of mines.

The production, closely classified by grades, was as follows:

Grades.	1903.	1904.
Bessemer and low-phosphorus	9,989,908	9,098,659
Basic pig made with mineral fuel	2,040,726	2,483,104
Forge pig	783,016	550,836
Foundry and high silicon	4,409,023	3,827,229
Malleable bessemer	473,781	263,529
White, mottled and misc	120,137	53,284
Spiegeleisen	156,700	162,370
Ferro-manganese	35,961	58,022
Total	18,009,252	16,497,033

The bessemer figures include low-phosphorus pig iron, that is, iron running below 0.04% in phosphorus. Pig iron containing from 0.04 to 0.10% of phosphorus is classified as bessemer. The basic figures are confined strictly to pig iron made with mineral fuel. A few thousand tons of castings direct from the furnace are included in the totals for white, mottled and miscellaneous grades of pig iron for 1903 and 1904. Ferro-silicon and high-silicon pig iron are included in the foundry figures.

The approximate consumption of pig iron in the United States in 1904 was as follows:

	Tons.
Production for the year	16,497,033
Imports	79,500
Stocks unsold, Jan. 1	598,489
Total supply	17,175,022
Exports	49,025
Stocks, Dec. 31	446,422
Total deductions	495,467
Approximate consumption	16,679,555

The decrease in production was 8.4%; that in consumption was 7.5%. The approximate consumption, ascertained in the same way, was as follows for nine years past:

1896	8,275,774	1901	16,232,446
1897	9,381,914	1902	18,436,870
1898	12,005,674	1903	18,039,909
1899	13,779,442	1904	16,679,555
1900	13,177,409		

In preparing these figures, the comparatively small quantity of foreign pig iron held in bonded warehouses at the end of each year has not been considered.

Steel.—The total production of steel ingots—including castings made directly from the furnace or converter—was as follows:

	1903.		1904.		Changes.
	Tons.	Per ct.	Tons.	Per ct.	Tons.
Bessemer	8,592,829	59.1	7,859,140	56.6	D. 733,689
Open-hearth	5,829,911	40.1	5,908,166	42.7	I. 78,255
Crucible and special	112,238	0.8	92,581	0.7	D. 19,659
Total	14,534,978	100.0	13,859,887	100.0	D. 675,091

The production of direct castings, included above, was as follows in 1904: Bessemer steel, 16,051 tons; open-hearth, 302,834; crucible and special, 11,326; total, 330,211 tons. It will be seen that 91.7% of these castings were made from open-hearth steel. The bessemer steel production decreased 8.5% and crucible 8.8%; the open-hearth steel output increased 1.3%. The reduction in the total steel made was 658,172 tons, or 4.6%. This decrease is somewhat less in proportion than that in pig iron. The ratio of steel to pig iron, which was 80.7 in 1903, was 84.1.

Practically all the bessemer steel made in the United States is acid steel. The division of the open-hearth steel, according to processes—acid and basic —was as follows:

	1903.		1904.	
	Tons.	Per ct.	Tons.	Per ct.
Acid	1,094,998	18.8	801,299	13.6
Basic	4,734,913	81.2	5,106,867	86.4
Total	5,829,911	100.0	5,908,156	100.00

The basic process in 1904 made an important advance. While the production of steel by the acid process decreased 293,699 tons, or 26.8%, there was a gain in basic steel of 371,454 tons, or 7.8%. Nearly seven-eighths of the open-hearth steel produced last year was made in the basic furnace.

An important incident in the production was the continued operation on a large scale of the basic open-hearth plant at Ensley, in Alabama, where steel is made from Alabama pig iron. Coupled with this last year was the manufacture of rails from basic steel, the first made in this country on a large scale. These rails have stood successfully the strictest tests on all points, except wear in service, and that can only be made by time. There is no reason to believe that they will not be equal in this respect to bessemer rails of the best quality.

Finished Products.—The production of rolled iron and steel of all kinds in 1904 was as follows:

	Steel.	Iron.	Total.
Rails	2,283,840	871	2,284,711
Structural shapes	941,127	8,019	949,146
Plates and sheets	2,353,685	67 713	2,421,398
Nail plate	42,182	19,419	61,601
Wire rods	1,697,862	1,166	1,699,028
Merchant bars, skelp, spike rods, splice bars, and other finished rolled products	2,934,601	1,662,896	4,597,497
Total	10,253,297	1,760,084	12,013,381

The production of rails, according to weight, was as follows:

	Under 45 lbs.	45 lbs. and less than 85 lbs.	85 lbs. and over	Total. Gross tons.
Bessemer steel	269,743	1,204,356	663,858	2,137,957
Open-hearth steel	21,269	116,321	8,293	145,883
Iron rails	871	....	....	871
Total for 1904	291,883	1,320,677	672,151	2,284,711
Total for 1903	221,262	1,603,088	1,168,127	2,992,477
Total for 1902	261,887	2,040,884	645,162	2,947,933
Total for 1901	155,406	2,225,411	493,822	2,874,639
Total for 1900	157,531	1,626,093	602,058	2,385,682

In addition to the rails rolled in 1904 there were imported 37,776 tons. During the same year there were exported 416,250 tons. In 1903 exports of rails amounted to 30,837 tons and imports to 95,555 tons. Virtually all imports and exports of rails are steel rails.

Other items of production in 1904 included 11,926,661 kegs (100 lb. each) of wire nails, an increase of 2,295,000 kegs; 1,283,362 kegs of cut nails, a decrease of 152,531 kegs. The production of tin-plates and terne-plates in the United States in 1904 is estimated as amounting to 458,000 gross tons, as compared with an estimated production of 480,000 tons in 1903, a decrease of 22,000 tons, or over 4.5%.

In 1902, 1903 and 1904 there were no forges in operation in the United States for the manufacture of blooms and billets from the ore. In 1901 the blooms and billets so made amounted to 2,310 gross tons, against 4,292 tons in 1900 and 3,142 tons in 1899. All the ore blooms produced since 1897 were made by the Chateaugay Ore & Iron Co., of Plattsburg, N. Y., at its Standish works, which were, however, idle in 1902, 1903 and 1904. All the Catalan forges in the South have been virtually abandoned; none are now active.

The iron blooms produced in forges from pig iron and scrap in 1904, and which were for sale and not for the consumption of the makers, amounted to 5,743 tons, against 9,940 tons in 1903, 12,002 tons in 1902, 8,237 tons in 1901, 8,655 tons in 1900, 9,932 tons in 1899, 6,345 tons in 1898, 7,159 tons in 1897 and 6,494 tons in 1896, all made in New York, Pennsylvania and Maryland.

Exports and Imports.—The value of the iron and steel exported from the United States during the full year 1904 is estimated by the Bureau of Statistics as $128,553,613. As compared with $99,135,865 for 1903, this shows an increase of $29,417,748 over the previous year. These figures cover not only all forms of iron and steel, but also engines, machinery and tools. They do not include iron ore.

The quantities, in long tons, of the leading items for the two years were as follows:

	1903.	1904.	Changes.
Pig iron	20,379	79,025	I. 28,646
Bars	59,543	75,549	I. 16,006
Rails	31,137	416,250	I. 385,113
Structural steel	30,641	55,514	I. 24,873
Wire	108,521	118,581	I. 10,060
Nails and spikes	42,644	45,108	I. 2,464

The tremendous increase in the exports of steel rails will be noticed. The heaviest shipments, 216,801 tons, went to Canada; Japan and Asia received 101,738 tons; South America, 28,347 tons, and Mexico, 23,871 tons. Shipments to all of Europe amounted to only 17,581 tons.

Imports of iron and steel and their manufactured products during 1904 were valued at $21,621,970, showing a decrease of $19,633,894 from their valuation in 1903. For the principal items, in long tons, see table, p. 244.

In 1903 the pressure for material here caused large purchases abroad, especially of pig iron, billets and scrap. This pressure did not exist in 1904, and the imports, therefore, showed a large decrease.

	1903.	1904.	Changes.
Pig iron	599,574	59,500	D. 520,074
Billets, blooms, etc	261,570	10,801	D. 250,769
Scrap iron and steel	82,921	13,461	D. 68,460
Bars	43,393	20,912	D. 22,481
Rails	95,555	37 776	D. 57,779
Wire-rods	20,836	15,313	D. 15,523
Tin-plates	47,360	70,652	I. 22,292

The Iron and Steel Markets.

The course of the iron and steel markets during the year is sufficiently shown by the special reports which follow. Pittsburg is, of course, the great primary market, and Chicago the most important distributing point for the North and Northwest, while Birmingham represents the Southern industry. The New York market is only a distributing point for a limited territory in New York State and New England, and its variations in prices simply follow those of the more important centers.

The railroad demand—usually important in trade, though no longer the leader, as it once was—seemed conspicuously absent through the year. That this was partly a result of the deadlock over rail prices there is no reasonable doubt; but it was also due, in part, to diminished earnings and to apprehensions of a still greater possible reduction. It was not alone that track repairs were postponed; the construction of new lines was limited to 4,100 miles, the smallest mileage recorded since 1897. Orders for new locomotives and new cars were less than 60% of those reported in the previous year. Some large orders were placed late in December.

Pittsburg. (S. F. Luty.)—The year 1904 in the iron and steel trade had a weak opening and a strong finish. It was an unusual presidential year, in that business began to improve before the election, and at the opening of the fourth quarter there did not appear to be any doubt of continued prosperous conditions.

Early in the year pig iron began to drop, and strong efforts were made to keep up prices, but without success, although there were several temporary advances. Bessemer sold at the opening at $13.85, Pittsburg, and in December sales were made at $3 a ton higher. The outlook was not particularly bright, and many iron producers were prepared for a very dull and unsatisfactory year. Many predictions were made and few were verified. It was confidently stated that the ore movement would not amount to more than 13,000,000 to 15,000,000 tons. The shipments by lake in 1903 were 23,649,550 tons, and by rail, 632,045 tons, a total of 24,281,595 tons. The highest prediction for 1904, as will be seen by the official figures, was about 7,000,000 tons too low, and that with 50 days of the lake shipping season lost by the strike of masters and pilots.

Of the 41 blast furnaces in the Pittsburg district 15 were in operation early in January, and at the close of the year 37 were running. The official report of the Bessemer Pig Iron Association up to Dec. 1, showing the percentage of operation of furnaces tributary to the Lake Superior ore region, nearly 200 in number, is as follows: January 1, 35½%; Feb. 1, 62; March 1, 72; April 1, 85½; May 1, 89½; June 1, 80; July 1, 65; Aug. 1, 59; Sept. 1, 72; Oct. 1, 74; Nov. 1, 75; Dec. 1, 78.

The fluctuations in prices in several lines during the year were somewhat out of the ordinary. On Jan. 27 the American Sheet & Tin Plate Co. reduced the price of standard coke plates from $3.60 to $3.45 a box. In July another cut of 15c. was made, putting the price down to $3.30 a box. On Nov. 15 the $3.45 rate was restored, and on Dec. 22 the price was fixed at $3.55. Sheet prices were cut in May. Black sheets, No. 28 gauge, were reduced from 2.30c. to 2.20c. and to 2.10c. in June; in November the price was advanced to 2.20c., and a further increase to 2.30c. was ordered on Dec. 22.

The pool price of billets remained at $23 a ton until September, although there was considerable shading during the summer. On Sept. 19 the price of bessemer and open-hearth billets was cut to $19.50, f. o. b. Pittsburg, and sheet bars were reduced from $24 to $21.50. On Nov. 15 billets were advanced to $21 and sheet bars to $23.

Merchant pipe was advanced to $2 a ton on March 1, but the old price was soon restored, and reductions aggregating $8 a ton were made at intervals up to July 1. On Oct. 19 prices were advanced $2, and a further advance of $2 was made on Nov. 1.

Wire products were advanced $1 a ton in February, and no change was made until Aug. 4, when a cut of $2 a ton was ordered. Trouble in the wire trade began soon after, when the Pittsburg Steel Co., a large independent wire producer, made a contract with the Republic Iron & Steel Co. for 110,000 tons of billets on a conversion deal, deliveries to cover a period of 10 months. Under the contract the Pittsburg Steel Co. got the billets delivered at its works at $19.25 a ton, or $3.75 less than the pool price. The deal was not approved by the leading interest, which at once ordered further reductions in wire products, $4 a ton on wire nails, $5 on plain wire and $7 on barb wire. As the chief product of the Pittsburg Steel Co. is barb wire, it was believed that the heaviest cut was made to prevent that company from realizing any benefit from the conversion deal.

On Sept. 6 the beam pool cut prices of shapes $4 a ton. The plate pool also made a cut of $4 and the steel bar pool ordered a reduction of $1 a ton on bessemer and open-hearth bars.

Various prices prevailed for pig iron during the year, from $13.85 to $16.85 for bessemer, and at times foundry No. 2 sold at a higher figure than bessemer. The pig iron market in the first three-quarters of the year was very unsatisfactory. It had been strengthened in former years by the United States Steel Corporation making a heavy purchase. The corporation, however, did not enter the market until late in February, when it was announced that 187,000 tons of bessemer had been bought at $13.85, Pittsburg. The fact that the leading interest was buying outside iron had the effect of putting up prices to around $14, but this rate only held during March and April, when prices declined, the lowest rate being in July, when sales were made at a trifle under $12.50. The corporation took about 130,000 tons of bessemer iron up to March 10, and had options on a tonnage for April 10 which it did not exercise. It did not come into the market again until December, when 25,000 tons of bessemer were bought from the valley furnaces for the Carnegie Steel Co. at $16.35. The Jones & Laughlin Steel Co. and the Lackawanna Steel Co. also were heavy buyers of outside iron during the last half.

Prices of steel rails, established April 1, 1901, on a basis of $28 for standard sections, continued, and in December were renewed for 1905. The steel rail consumption in this country during 1904 fell considerably behind the two previous years. A large tonnage was exported, principally by the United States Steel Corporation.

Owing to the unfavorable outlook at the opening of the year a general reduction in wages in the iron and steel mills went into effect on Jan. 1, principally in the sheet- and tin-plate plants that are not governed by the annual scale of the Amalgamated Association.

On Jan. 1 the American Sheet Steel Co. and the American Tin Plate Co. were consolidated under the name of the American Sheet & Tin Plate Co., and the offices were removed from New York to Pittsburg.

MONTHLY RANGE OF PRICES IN PITTSBURG.

	Pig Iron.			Ferro-manganese.	Steel.					Nails.	
	Bessemer.	No. 2 F'dry.	Gray Forge.		Bessemer billets.	Rails.	Shts No 28	Tank Plate	Bars.	Wire per keg.	Cut per keg.
							Cts.	Cts.	Cts.		
January	$13.85	$13.60	$13.00	$46.00	$23.00	$28.00	2.30	1.60	1.30	$1.85	$1.70
February	13.60	13.25	12.75	44.00	23.00	28.00	2.30	1.60	1.30	1.90	1.70
March	14.35	13.75	13.25	43.00	23.00	28.00	2.30	1.60	1.35	1.90	1.75
April	14.10	14.00	13.25	42.00	23.00	28.00	2.30	1.60	1.35	1.90	1.75
May	13.60	13.35	12.50	41.50	23.00	28.00	2.20	1.60	1.35	1.90	1.75
June	12.75	12.65	12.15	41.50	23.00	28.00	2.10	1.60	1.35	1.90	1.75
July	12.50	12.60	11.85	41.50	23.00	28.00	2.10	1.60	1.35	1.80	1.65
August	12.85	12.85	12.00	41.50	23.00	28.00	2.10	1.60	1.35	1.60	1.65
September	12.85	12.85	11.85	41.50	19.50	28.00	2.10	1.40	1.30	1.60	1.60
October	13.60	14.00	12.85	41.00	19.50	28.00	2.10	1.40	1.30	1.60	1.60
November	16.35	16.35	15.85	42.00	21.00	28.00	2.20	1.40	1.30	1.70	1.70
December	16.35	16.85	16.35	42.00	21.00	.28.00	2.30	1.50	1.40	1.75	1.80

The most important deal made by the United States Steel Corporation was the purchase of the Clairton Steel Co.'s properties from the Crucible Steel Company of America, the negotiations having been concluded early in May. The properties owned by the Clairton company included about 150 acres of land 17 miles from Pittsburg, on which there are now in operation three blast furnaces, twelve open-hearth furnaces, one 40-in. blooming mill, and one 28-in. billet mill, also shops, power plants, etc.; 2,907 acres of coking coal lands, in Fayette county, Pa.; Champion Iron Co. properties on the Marquette range, including 20,000 acres in fee and a large tonnage of ore already developed; one-half interest in Clairton mine and other ore properties, and the total capital stock of the St. Clair Terminal Railroad Co.

Alabama. (L. W. Friedman.)—The fluctuations of this market during 1904 were very striking. The year opened on a declining market, with a curtailment of production, which followed the depression in the general situation throughout the country. In January the quotation for No. 2 Alabama foundry, which is accepted as the basis of prices, was $10 per ton at furnace, with a declining tendency. In sharp contrast to this, the year closed with No. 2 foundry close to $14, and with a very strong and active demand. A depressing influence, which was felt to a certain extent, was the strike of the coal miners in July, which chiefly affected the mines owned by the large furnace companies. Although this strike appears to have failed practically, it was necessary at various times during the year to bring coke from West Virginia, adding to the cost of iron making. Fortunately, the iron companies generally were in a strong position, having not only made many improvements, but also accumulated considerable reserve funds during the previous years of prosperity, so that they were enabled to tide over the depression without undue difficulty.

As to the quotations, January and February saw a declining market, and at the end of the second month of the year the base price was $9.50, and even $9.25 for No. 2 foundry. There was some improvement in March, No. 2 foundry being quoted at $10, a price which continued through April; but in May the market was very dull, and during that month and June No. 2 foundry sold at $9, while there were reports of drawbacks on large orders. During July and August business was still slow, but in the latter month there was a much firmer tendency. September saw a decided improvement—a much better demand—which was followed by an increase in production. The advance materialized in October, when No. 2 foundry ran up to $10.50, while in November the price passed $12, and in December it again advanced. The year closed with a firm quotation of $13.75 to $14 per ton at furnace. The net result is that production for the year was very little behind that of 1903.

Steel production was fairly good in the first part of the year, and much better in the second half. The steel plant of the Tennessee Coal, Iron & Railroad Co. at Ensley was run continuously, with the exception of a short stoppage for repairs. The monthly output was gradually increased until, at the close of the year, it amounted to 20,000 tons of basic steel per month. The rail mill at Ensley was in active operation. It is the first mill in this country manufacturing rails from basic open-hearth steel. The Alabama Steel & Wire Co. during the year completed its steel plant at Gadsden, the finished products being steel bars, wire rods, wire and nails, these finished materials being made in the company's mill at Ensley.

The rolling millls also saw their period of depression and of improvement, and at the close of the year five mills were in operation in the State. Foundry and machine shop trade for the year was fair, and most of the works kept a full complement of men employed. A good deal of sugar machinery for the South and for Cuba and Mexico is now made in Birmingham, and other heavy machinery is also supplied from the shops in the district.

Chicago. (E. Morrison.)—Considered as a whole, the year 1904 was very unsatisfactory to the local iron trade, with only two prosperous months, November and December. The ten months were probably the worst period of depression through which the Chicago trade has ever passed.

The year opened with a 50c. advance on Southern No. 2 pig iron, and a restriction of sales to the first quarter of the year, except on payment of 50c. to $1 premium for later deliveries. For No. 2 iron the prices were: Northern, $14.50@$15; Southern, $10@$10.50 Birmingham, or $13.85@$14.35 Chicago. Finished products were weak; bar iron brought 1.30c.@1.40c.; plates, 1.765c. (tank steel, ¼ in. and over), and other shapes correspondingly low prices. There was little demand for structural iron, outside of a few large buildings for Chicago.

January started with the usual boom, but by the middle of the month the desire for business caused the northern furnaces to cut their prices 50c., and Southern became weaker. Bars became active through the demand of the agricultural implement trade, and the price went up from 1.30c. to 1.50c. by Jan. 20. By the middle of February Southern pig iron dropped to $13.60, and declined by 25c. steps until Feb. 20 it reached $13.10. Northern producers met this with similar reductions, No. 2 Northern selling Feb. 20 at $13. The contest for orders at profitless prices lasted until nearly the end of October.

The great reaction from stagnation in the market for both pig iron and finished products came in the week ending Oct. 29. Without apparent reason, except a psychological one, consumers of iron began to buy freely. In a week the price of Southern iron advanced $2 and the price of Northern $1. By jumps of 50c. the quotations rose, until the last of December saw Northern selling at $16.50@$17 and Southern at $17.15@$17.65. Not only were prices advanced, but sales became heavier, for longer terms, and general conditions were greatly improved.

Highest and lowest prices for the year, with corresponding figures for 1903, are shown in the following table:

	1903.		1904.	
	Highest.	Lowest.	Highest.	Lowest.
Lake Superior charcoal....	$26.50	$16.50	$18.00	$14.50
Northern foundry No. 2...	23.50	14.25	17.00	13.00
Southern foundry No. 2...	23.15	13.10	17.65	12.65
Bar iron..................	1.865c.	1.30c.	1.65c.	1.25c.
Tank plates...............	2.00c.	1.75c.	1.865c.	1.565c.

Business in finished products followed the fortunes of pig iron, and could not be called good in comparison with years of recognized prosperity. Structural iron was weak nearly all the year, little business being done outside of Chicago buildings.

Coke followed the fortunes of iron, and at the close of the year was in strong demand, at $5.15@$5.40 for 72-hour Connellsville. Throughout the spring and summer there was great demoralization of the market through over-shipments, to avoid demurrage charges. Connellsville 72-hour was sold in May as low as $4.15, out of which came a $2.65 freight rate.

The Lake Ore Trade. (George H. Cushing.)—On May 1 there was more ore remaining on the Lake Erie docks than had ever been the case before, the total being over 4,500,000 tons. Under ordinary circumstances this amount was enough to meet all the demand from the furnaces until August. Moreover, the stocks included a balance of all grades, so that there seemed to be no probability of a shortage of any description.

Another circumstance which affected the trade was the fact that during the three years 1901 to 1903, inclusive, labor organizations on the lakes had been growing stronger and more inclined to assert themselves. In 1902 the Lake Carriers' Association was reorganized and prepared to fight the labor organizations, this step being compelled by the demands from the men. The climax was reached when masters and pilots, without whom no boat can be run, completed a union, and in the early part of 1904 demanded a re-classification of the vessels, which would increase the pay of most of them, besides insisting on certain privileges, which would place the hiring of labor entirely in the masters' hands. The vessel-owners realized that further increase of wages would probably absorb all the profits of the season, and that a fight must be made then or never.

A further factor in the lake trade was the amount of shipbuilding in the previous two years, and the fact that the new tonnage was mainly of large boats, which could handle a high proportion of the business, and which, moreover, would put the older and smaller vessels at a great disadvantage as regards expense. The total carrying capacity available in the spring of 1904 was estimated at 30,000,000 tons of ore for the season.

The strike of masters and pilots was an obstinate one, and the result was that May was entirely a dead month, and it was not until near the end of June that the ore-carrying industry showed anything like activity; even then the business was very light. The curtailment of production by the furnaces made matters look as if the tonnage required for the year would not be over 14,000,000 or 14,500,000 tons; that is, less than half the capacity of the available fleet, even in a short season.

In February and March, after the depression became apparent, several meetings of the Ore Association were held. Originally a power in the trade, this association had lost much of its influence, owing to the purchase and control of iron ore lands by the big steel companies, who handled their own ore and did not offer any for sale to outsiders. The association finally dissolved, and the market was left an open one, though subsequently some understanding was reached about prices, not in time, however, to prevent a considerable decrease from those of 1903. The general scale, on which outside ore was sold during the year, was substantially \$3.25 per ton for bessemer old range, \$3 for bessemer Mesabi, \$2.60 to \$2.75 for non-bessemer old range, and \$2.40 to \$2.50 for non-bessemer Mesabi. These prices were for ore on lower lake docks.

All these things combined made a bad situation for the vessel owners; and, when shipments really began, contracts were made on the basis of 75c. from Duluth to Lake Erie ports, 65c. from Marquette, and 55c. from Escanaba. Wild rates were about the same. These figures given above continued in force until navigation finally closed.

Port shipments from the iron region for the season of 1904 are reported as in the table below; in this only the shipments from mines in the United States are given, the ore from the Michipicoten range, in Canada, which goes to the Sault, not being included:

	1904.	Changes.
Escanaba	3,644,267	D. 633,194
Marquette	1,917,301	D. 100,045
Ashland	2,288,400	D. 534,719
Gladstone	480	D. 85,336
Two Harbors	4,566,542	D. 554,114
Superior	4,169,990	I. 191,411
Duluth	4,649,611	D. 706,862
Totals, Lake	21,226,591	D. 2,422,959
Rail	500,000	D. 132,045
Total	21,726,591	D. 2,555,004

Gladstone, in 1904, ceased practically to be a shipping port, having sent out only one small cargo. Superior was the only port which showed an increase.

The Lake Superior District. (Dwight E. Woodbridge.)—Closely associated as it is with the steel-making trade of the United States, the Lake Superior region suffered in common with that end of the business from the unnecessary depression of late 1903 and early 1904. There was a sudden cessation of mining in the fall of 1903, and in mid-November the last cargoes of the year were being forwarded. Mines had unexpectedly large stockpiles in consequence, and there were few sales of ore for delivery in the spring of 1904. Therefore, they did not operate extensively during the winter. Men were discharged, and every corner was cut all along the line. The mining companies, at least the larger and more stable of them, did not cut wages, but retrenched in every other way, and increased the length of day's labor. With all this, it was hard to make both ends meet, and it is a safe assertion that half the ore mined for sale during the year 1904 did not bring a profit to the operator. There was no improvement in conditions until late in the summer, and then merely along the line of a slightly better demand and accession to the number of buyers in the market. Prices did not advance till late in the fall, when belated buyers, alarmed at the sudden increase of inquiry for finished material, entered the ore market for additional tonnage for delivery during the season of 1904. They were accommodated, but at a higher price, and many of them paid 50c. a ton more than was offered only a few weeks earlier. Going prices for standard ores from Lake Superior for the better part of the year were from $2.25 for Mesabi non-bessemer to $3.10 and $3.20 for old range standard bessemers, with special fancy ores bringing a little higher figures. Large tonnages of standard Mesabi bessemer of good physical character were sold for $2.75.

With the drying up of every other channel of activity, that of exploration suffered. On the old ranges of Michigan, exploration during the year was in small volume, and confined to finding the extension of certain orebodies, the presence of which was known. In all there was little of this work. On the Mesabi range, where perhaps 200 drills had been busy the season before, three-fourths that number were laid by. A little work was maintained in the central part of the district, much of it for the purpose of determining the extent and character of orebodies previously discovered. On the western end of the range some exploration was maintained all the year among the dry and sandy ores of the section, in the hope of finding large bodies that may be washed and mined successfully. This work met with favorable response, and a large tonnage was proved there, much of it, to be sure, prior to 1904. These west Mesabi explorations, and the experiments that have been carried on in conjunction with them looking toward the elimination of sand, are to be ranked as easily the most important of anything done in the way of exploration and the extension of ore tonnage during the year. Baraboo, in south-central Wisconsin, was the scene of some work in the way of development of existing orebodies and in drilling new ground for others, and not a little of value has been determined. Baraboo, as the result of this exploration, and the mining carried forward by the Illinois Mining Co. throughout the year, has come to a defined and recognized position. The region is valuable chiefly for its effect on the manufacture of steel in the Chicago district. Its freights permit ore to be delivered in furnace stocks at Chicago for the same price as Mesabi ores can be delivered at Lake Superior ports. This is a great assistance, and, if the ore was of equivalent grade, would make it an important and welcome addition to Lake Superior reserves, in so far as its tonnage permits. But Baraboo, as shown by the work of the Illinois Mining Co., contains a lens of ore from 20 to 30 ft. wide that can be mined to an average of about 56% iron and non-bessemer. Some six or seven feet of this width is up to 60%, the rest lower. The ore grades away from these better percentages until it is far too low to be mined. So far the Illinois Mining Co. has had a pumping cost equivalent to 35c. a ton on its product, and, in the nature of the ground, this cost must be heavy for a long time. The size and formation of the orebodies are such that other expenses are not low, and the ore represents a considerable cost per unit when delivered to furnaces. But it is almost indistinguishable from a Marquette soft ore, and is excellent in its furnace properties. While drill-holes were sunk at other properties in the district, some of them showing ore in quantity, no actual development occurred elsewhere than in the Illinois mine. By the openings along the vein, by drill results showing its extensions, both on strike and dip, it is easy to say there are 9,000,000 or 10,000,000 tons available in this mine. While the probabilities are that the longitudinal extent of the district is much restricted, any region that has been so far developed that one mine can safely be estimated at such a figure, is not to be lost sight of or condemned.

Work was carried on with drills in what is known as the Deerwood, or Aitkin district, 100 miles west of Duluth, on the line of the Northern Pacific road. It is possible that ore of economic value may be shown there; it is certain that large bodies of lean ore and paint rock have been cut by drills; but it is too early to say these explorations have resulted or will result in any addition to the reserves of merchantable ore in the Lake Superior region.

A little drilling was done on the Vermilion range, but with scarcely as high success as had been hoped. A drill or two operated in the Canadian fields, west of Lake Superior, but with no more than results enough to encourage further expenditures.

The haul of ore to the Lake docks is an important matter to the railroads, several of them deriving an important part of their revenue from that traffic. The distribution of ore tonnage in 1904 was as follows:

	Tons.
Duluth, Missabe & Northern	4,649,611
Duluth & Iron Range	4,566,542
Chicago & Northwestern	4,333,493
Great Northern	4,169,990
Lake Superior & Ishpeming	1,051,329
Chicago, Milwaukee & St. Paul	867,283
Duluth, South Shore & Atlantic	855,972
Wisconsin Central	731,890
Minneapolis, St. Paul & Sault St. Marie	480
Ore not over docks	500,000
Total U. S.	21,726,590
Algoma Central & Hudson Bay	117,153
Total	21,843,743

The business classified as all-rail, or not over docks, is increasing. This is due to the new furnaces in the Lake Superior region, especially those at Duluth and the Sault.

Four of the railroads in the table above—the Duluth, Missabe & Northern and the Duluth & Iron Range, in Minnesota; the Lake Superior & Ishpeming, in Michigan, and the Algoma Central & Hudson Bay, in Canada—depend almost entirely on the ore traffic.

The shipments of the Oliver Iron Mining Co.—the United States Steel Corporation's mining organization—which amounted in 1902 to 57% of the total, and in 1903 to 53.9%, in 1904 were 51.1%.

Only three mines in the Lake Superior country produced more than 1,000,-

000 gross each in 1904, compared with five in 1903 and seven in 1902. These big mines were the Mountain Iron and the Burt, of the Steel Corporation, and the Stevenson, of Corrigan, McKinney & Co. The larger shippers after the Steel Corporation were Corrigan, McKinney & Co., the Cleveland Cliffs Iron Co., Pickands, Mather & Co., and Jos. Sellwood.

THE WORLD'S PRODUCTION.

The following tables show the iron and steel production of the world, the figures being given in metric tons:

PIG IRON PRODUCTION OF THE WORLD.
(In metric tons.)

Year.	Austria-Hungary.	Belgium.	Canada.	France.	Germany.	Italy.	Russia.
1900	1,311,949	1,161,180	87,612	2,714,298	7,549,665	23,990	2,296,191
1901	1,300,000	765,420	248,896	2,388,823	7,785,887	25,000	2,869,306
1902	1,335,000	1,102,910	325,076	2,427,427	8,402,660	24,500	2,597,435
1903	1,355,000	1,299,211	269,665	2,827,668	10,085,634	28,250	2,486,610
1904	1,369,500	1,307,399	274,777	2,999,787	10,103,941	27,600	2,978,325

Year.	Spain.	Sweden.	United Kingdom.	United States.	All Other Countries.	Total.
1900	289,788	526,868	9,003,046	14,009,870	625,000	39,599,457
1901	294,118	528,375	7,977,459	16,132,408	635,000	40,950,692
1902	330,747	524,400	8,653,976	18,003,448	615,000	44,342 579
1903	380,284	506,825	8,952,183	18,297,400	625,000	47,113.730
1904	375,250	528,525	8,699,661	16,760,986	633,000	46,058,751

The three chief producing nations in 1904 made 77.2% of the total output. The United States alone made 36.8% of the total. The pig iron made in the world in 1904 showed a decrease of 1,055,681 tons, or 2.2%, from 1903, the loss being due to the smaller production in the United States.

STEEL PRODUCTION OF THE WORLD.
(In metric tons.)

Year.	Austria-Hungary.	Belgium.	Canada.	France.	Germany.	Italy.	Russia.
1900	1,145,654	655,199	23,954	1,565,164	6,645,869	115,887	2,217,752
1901	1,142,500	526,670	26,501	1,425,351	6,394,222	121,300	2,230,000
1902	1,143,900	776,875	184,950	1,635,300	7,780,682	119,500	2,183,400
1903	1,146,000	981,740	181,514	1,854,620	8,801,515	116,000	2,410,938
1904	1,195,000	1,069,880	151,165	2,080,354	8,930,291	113,800	2,811,948

Year.	Spain.	Sweden.	United Kingdom.	United States.	All Other Countries.	Total.
1900	144,355	300,536	5,130,800	10,382,069	400,000	28,727,239
1901	122,954	269,897	5,096,301	13,689,173	405,000	31,449.869
1902	163,564	283,500	5,102,420	15,186,406	412,000	34,972,497
1903	199,642	317,107	5,114,647	14,756,691	418,000	36,298,414
1904	196,000	333,522	5,107,309	13,746,051	415,000	36,150,320

The total production last year showed a decrease of 150,998 tons, or 0.4%, chiefly due to the decline in the United States. The three leading countries—

the United States, Germany and Great Britain—produced in 1904 together 76.9% of the total. The United States alone made 37.3% of the world's steel.

Some details of the production of iron and steel in various foreign countries follow:

Belgium.—At the close of the year 1904, there were 34 blast furnaces in operation in Belgium, with six furnaces idle. The output of pig iron for the year is reported as follows, in metric tons:

	1903.		1904.	
	Tons.	Per ct.	Tons.	Per ct.
Foundry iron	99,902	7.7	105,830	8.1
Forge iron	268,498	20.7	243,287	18.6
Bessemer and basic	930,811	71.6	958,282	73.3
Totals	1,299,211	100.0	1,307,399	100.0

The total increase was 8,188 tons, or 0.6%, as compared with 1903. The average output per furnace last year was 38,453 tons.

The imports of iron ore in 1904 were 2,823,265 tons, an increase of 240,340 tons over 1903. The larger part of the imports were from Luxemburg.

The production of steel was 1,069,880 tons. The total output of finished iron and steel products was 1,430,400 tons. The exports of iron and steel were 642,324 tons, a decrease of 5% as compared with the previous year.

Canada.—The production of iron ore in Canada in 1904 amounted to 312,-286 gross tons, against 235,977 tons in 1903.

The following table gives the total production of all kinds of pig iron (including spiegeleisen and ferromanganese) in Canada from 1894 to 1904:

1894	44,791	1900	86,090
1895	37,829	1901	244,976
1896	60,030	1902	319,957
1897	53.796	1903	265.418
1898	68,755	1904	270.942
1899	94,077		

The unsold stocks of pig iron in Canada at the close of 1904 amounted to 35,119 tons.

On Dec. 31, 1904, Canada had 15 completed blast furnaces, of which eight were in blast and seven were idle. Of this total, 10 were equipped to use coke for fuel and five to use charcoal.

The total production of steel ingots and castings in Canada in 1904 was 148,784 gross tons, against 181,514 tons in 1903, a decrease of 32,730 tons. Bessemer and open-hearth steel ingots and castings were made in each year. Almost all the open-hearth steel reported in 1903 and 1904 was made by the basic process. The direct steel castings made in 1904 amounted to 6,505 tons.

The production of bessemer and open-hearth steel rails in 1904 amounted to 36,216 gross tons, against 1,243 tons in 1903; structural shapes, 447 tons, against 1,983 tons in 1903; cut nails made by rolling mills and steel works having cut-nail factories connected with their plants, 99,000 kegs of 100 lb., against 118,686 kegs in 1903; plates and sheets, 3,102 tons, against 2,450 tons in 1903; all other finished rolled products, excluding muck and scrap bars, blooms, billets, sheet bars and other unfinished forms, 135,243 tons, against 118,541 tons in 1903. The total quantity of all kinds of iron and steel rolled into finished forms in Canada in 1904 amounted to 180,038 tons, against 129,516 tons in 1903. Of the finished iron and steel reported for 1904, about 126,850 tons were steel and 53,188 tons were iron.

On Dec. 31, 1904, there were 18 completed rolling mills and steel works in Canada. In addition, three plants were being built and two plants were projected. Of the completed plants, three are in Nova Scotia, five in Quebec, nine in Ontario and one in New Brunswick. The building plants are in Nova Scotia, Ontario and Manitoba, and the projected plants are in Ontario.

France.—Official returns place the production of pig iron in 1904 at 2,999,787 metric tons; of which 20,143 tons were made with charcoal as fuel, and 2,979,644 tons with coal or coke. The production of wrought iron in all forms was: Direct blooms in charcoal forge, 9,102 tons; from pig iron by puddling, 357,195 tons; re-heating and forging scrap, etc., 188,335 tons; total, 554,632 tons. The output of steel ingots was: Converter, 1,334,798 tons; open-hearth furnace, 745,566 tons; total, 2,080,354 tons. The production of steel in finished forms was 1,482,708 tons; this does not include steel sold by the makers in the form of ingots. There was a fair increase in all products.

Germany.—The iron industry of Germany was almost stationary in 1904. so far as the production of pig iron was concerned. In 1903 there was a gain over the previous year of 1,683,974 tons, or 20%; last year the increase over 1903 was only 18,307 tons, or 0.2%. There were, however, considerable changes in the proportions of the different kinds of iron, as shown in the following table:

	1903.		1904.	
	Tons.	Per ct.	Tons.	Per ct.
Foundry iron	1,798,773	17.8	1,865,599	18.5
Forge iron	859,253	8.5	819,239	8.1
Steel pig	703,130	7.0	636,350	6.3
Bessemer pig	446.701	4.4	392,706	3.9
Thomas (basic) pig	6,277 777	62.3	6,390,047	63.2
Total	10,085,634	100.0	10,103,941	100.0

Steel pig, in the German classification, includes spiegeleisen, ferro-manganese, ferro-silicon and all similar alloys.

The Rhenish-Westphalian district was the largest producer, making in 1904 39.8% of the total; while Lorraine and Luxemburg came next, with

32.3%, Silesia supplied 8.2 and the Saarbezirk 7.5%. The Rhenish-Westphalian furnaces are the largest makers of both foundry and Thomas pig, while Silesia is the chief source of forge iron.

The making of this iron required the consumption of over 30,000,000 tons of iron ore. The great majority of the German furnaces use ore having 35% iron, or less. The extra cost of fuel and handling with low-grade ores finds compensation partly in the fact that much of the ore is self-fluxing; but more in the attention given to by-products of the furnaces and to saving in every possible direction.

The report of the German Iron & Steel Union gives the production of steel in Germany in 1904 as below, in metric tons:

	Acid.	Basic.	Total.
Converter ingots	423 742	5,525,429	4,949,171
Open-hearth ingots	130,546	2,697,760	2,828,306
Direct castings	56,409	96,405	152,814
Total	610,697	8,319,594	8,930,291
Total, 1903	613,399	8,188,116	$,601,515

The production showed an increase of 128,776, or 1.5%, over the previous year. It will be noted that 93.2% of the total was basic steel; and that 55.4% was made in the converter.

The consumption of iron in Germany is estimated by the German Iron & Steel Union on a pig-iron basis. That is, in finding the totals, iron and steel finished products are reduced to the equivalent in pig iron, or to the pig iron consumed in making such products. The statement is as follows, for two years past:

	1903.	1904.	Changes.
Pig iron production	10,085,634	10,103,941	I. 18,307
Pig iron imports	265,422	288,726	I. 23,304
Pig iron equivalent of other imports	208,891	252,903	I. 44,012
Total supplies	10,559,947	10,645,570	I. 85,623
Pig iron exports	527,814	316,255	D. 211,559
Pig iron equivalent of other exports	4,269,464	3,628,056	D, 641,408
Total exports	4,797,278	3,944,311	D. 852,977
Consumption	5,762,669	6,701,259	I. 938,590

The average production per head was 171.4 kg. of pig iron in 1903, and 169.2 kg. in 1904, a decrease of 2.2 kg. The average consumption was 97.9 kg. per head in 1903, and 112.2 kg. in 1904, an increase of 14.3 kg. In ten years the average production has increased from 105.1 to 169.2 kg., and the consumption from 71.9 to 112.2 kg. of pig iron per inhabitant.

The movement of iron ores for the year was as follows, in metric tons:

	1903.	1904.	Changes.
Imports	5,225,336	6,061,127	I. 835,791
Exports	3,343,510	3,440,846	I. 97,336
Excess, imports	1,881,826	2,620 281	I. 738,455

The more important imports were from Spain and Sweden. The exports were chiefly of ores from Luxemburg to France and Belgium.

Imports of manganese ores were 223,709 metric tons in 1903, and 255,-760 tons in 1904; an increase of 32,051 tons. Exports were unimportant, being only 11,138 tons in 1903, and 5,536 tons last year.

Imports of slag formed a large item, being 877,394 tons in 1903, and 846,-738 tons in 1904; a decrease of 30,656 tons. These imports are chiefly from France and Belgium, and are basic slag, used in making fertilizer, on account of its phosphoric acid content.

Russia.—For the first time it is possible to give full and recent statistics of iron production in Russia. These figures were obtained from the Statistical Department of the Ministry of Finance of the Russian Government by the American Iron & Steel Association. The figures throughout are in metric tons.

The production of iron ore for this period was as follows:

1890	1,795,663	1898	4,536,217
1891	1,958,452	1899	5,890,900
1892	2,044,106	1900	6,112,090
1893	2,310,305	1901	4,723,983
1894	2,524,610	1902	3,987,303
1895	2,986,715	1903	4,218,600
1896	3,321,786	1904	5,272,300
1897	4,102,536		

The production of pig iron for the 15 years is reported as follows:

1890	927,214	1898	2,243,081
1891	1,005,570	1899	2 727,382
1892	1,072,651	1900	2,296,191
1893	1,147,391	1901	2,869,306
1894	1,348,615	1902	2,597,435
1895	1,453,529	1903	2,486,610
1896	1,607,490	1904	2,978,325
1897	1,881,670		

Russia is a large importer of pig iron, her production in some years being only slightly in excess of her annual production of steel ingots and castings.

The output of steel ingots made by all processes was as follows:

1890	278,422	1898	1,621,801
1891	440,212	1899	1,903,000
1892	516,315	1900	2,217,752
1893	633,120	1901	2,230,000
1894	726,017	1902	2,183,400
1895	880,451	1903	2,410,938
1896	1,023,118	1904	2,811,948
1897	1,225,526		

The make of steel rails for the 15 years has been as follows:

1890	166,156	1898	468,787
1891	166,503	1899	464,377
1892	193,338	1900	496,475
1893	230,954	1901	481,918
1894	250,190	1902	382,152
1895	302,428	1903	332,367
1896	398,848	1904	401,541
1897	444,062		

The maximum production of steel rails was in 1900. The rail mills in Russia are largely dependent on Government orders.

The proportion of steel to pig iron is larger than in most other countries. Over two-thirds of the steel now made annually in Russia is produced by the open-hearth process. The production of steel castings by the bessemer and open-hearth processes amounts to from 35,000 tons to 40,000 tons annually. About 2,000 tons of steel ingots and castings are also annually produced by the crucible process. In addition, from 5,000 tons to 6,000 tons of steel yearly are made by various minor processes.

Sweden.—According to the report of Director-General Richard Akerman, the production of iron ore, which was 3,677,841 metric tons in 1903, was 4,084,647 tons in 1904, showing an increase of 406,806 tons, or 11.1%. The production of coal in 1904 was 320,984 metric tons.

The output of pig iron was 506,825 metric tons in 1903, and 528,525 tons in 1904; an increase of 21,700 tons, or 4.3%. There were 133 furnaces in blast in 1904; the average active period was 263 days, giving an average yield per furnace of 3,974 tons for the year, or 15.1 tons per day. The Swedish furnaces all use charcoal as fuel. The quantity of blooms made from pig iron in charcoal hearths—an industry now almost peculiar to Sweden—was 189,246 tons in 1904.

The production of steel ingots and direct castings was as follows, in metric tons:

	1903.	1904.	Changes
Bessemer	84,229	78,577	D. 5,652
Open-hearth	232,878	252,832	I. 19,954
Total	317,107	331,409	I. 14,302

Last year there were reported, in addition, 1,162 tons of crucible steel ingots and 951 tons of blister steel; bringing the total make of steel of all kinds up to 333,522 metric tons. The ratio of steel to pig iron last year was 0.63, a high figure.

The production of finished iron and steel in various forms is reported as follows, in metric tons:

Bars	181,775
Nail-plates and wire-rods	102,976
Other shapes	9,020
Plates	16,331
Tube-blocks and hollow-blooms	23,594
Total	333,696

Adding the charcoal blooms made direct from pig iron gives a total of 522,930 tons of finished or semi-finished products. In this total, however, there is some duplication, as a part of the charcoal blooms is converted into bars and wire-rods, though a quantity is also sold and exported in the form of blooms.

The high quality of Swedish iron makes a strong export demand, not only for these blooms, but also for bars, wire-rods and other forms of iron and steel.

United Kingdom.—The British Iron Trade Association reports that the pig iron made in 1904 was 8,562,658 long tons, which is a decrease of 248,546 tons, or 2.8%, from 1903; but an increase of 44,965 tons, or 0.5%, as compared with 1902. Nearly two-fifths of this iron was made with imported ore. The production of iron ore in Great Britain was 9,161,588 tons, while the imports were 6,100,556 tons. Spain continues the mainstay of the British ironmasters. The Spanish ore was 4,648,335 tons, or 76.2% of the total imports. The average consumption of ore was 1.78 tons per ton of iron made.

The steel production for two years was as follows, in long tons:

BRITISH STEEL PRODUCTION.

	1903.		1904.		Changes. Tons.
	Tons.	Per ct.	Tons.	Per ct.	
Bessemer	1,910,018	38.0	1,781,533	35.4	D. 128,485
Open hearth	3,124,083	62.0	3,245,346	64.6	I. 121,263
Total	5,034,101	100.0	5,026,879	100.0	D. 7,222

The division of steel into acid and basic in 1904 was as follows:

	Acid.	Basic.	Total.
Bessemer	1,129,224	652,309	1,781,533
Open-hearth	2,583,282	662,064	3,245,346
Total	3,712,506	1,314,373	5,026,879

The proportion of acid steel last year was 73.8% of the total.

Exports of iron and steel, and manufactures thereof, from Great Britain are valued by the Board of Trade returns as follows:

	1903.	1904.	Changes
Iron and steel.........	£30,399,261	£28,082,692	D. £2,316,569
Machinery............	20,058,706	1,087,502	I. 1,024,296
New ships............	4,283,829	4,459,761	I. 175,932
Total............	£54,741,296	£53,624,955	D. £1,116,341

The total tonnage of iron and steel exported was 3,564,601 in 1903, and 3,266,648 in 1904; a decrease of 297,953 tons.

Imports of iron and steel for the year were valued at £8,662,481 in 1903, and £8,215,155 in 1904; a decrease of £446,926.

Other Countries.—Efforts have been made in other countries to extend the manufacture of iron and steel. In South America the Government of Chili has granted a concession to a French company to establish a plant on a large scale.

In Africa important discoveries of iron ore are reported in the Orange River colony, and promoters are trying to organize a company to work these and to build blast furnaces.

The efforts to establish an extended iron industry in India have made little progress. The present limited manufacture is fairly prosperous, but does not grow in the face of British and Belgian competition.

The Government of Japan has enlarged its steel works. Arrangements have been made to secure supplies of iron ore from Korea and China.

Utilization of Blast-Furnace Gas.—At the Metallurgical Congress at Liege, in a discussion on the utilization of blast-furnace gases, M. Victor Defays argued against the general practice in Germany and Belgium of using these gases to operate gas-engines. His theory is that the waste gases can be more advantageously used in raising steam, and his conclusions are presented as follows:

Now that ironmasters possess a gas very much improved in all respects, especially when freed of its humidity, there is reason to ask whether the utilization of this gas, or at any rate some of it, for firing metallurgical furnaces may not in many cases be more economical than its exclusive employment for generating motive power. M. Defays considers himself warranted in replying affirmatively, although he does not pretend to solve the problem, which presents itself under many different aspects, according to the circumstances of each case. And the following are his arguments in favor of this view:

1. Purification of the gas need not be carried to such an extent for heating as for motive power.

2. There is a better coefficient of utilization in the former than in the latter case, because in most iron and steel works the demand upon motive power is variable, while there are times when this demand greatly exceeds the mean; for instance, when several large motors have to start simultaneously. The utilization coefficient of gas for motive power in iron and steel works may be put, according to circumstances, at from 40 to 70%, if the blast furnaces themselves, with their blowing engines and other accessories, be left out of the question. But the question is very different with the firing of furnaces which nearly all work continuously. Open-hearth furnaces, for instance, consume day and night a constant quantity of gas, so that the utilization coefficient easily reaches 80 or 90%.

3. As regards the solid fuel burned, nearly all works comprising blast furnaces, steel works and rolling mills must consume, in addition to the furnace gas, a certain amount of coal, either for the production of motive power or for firing the furnaces. Blast-furnace gas for raising steam replaces coal of inferior quality, but when it is used for firing furnaces it replaces gas coal of higher intrinsic value, the gain in favor of the latter utilization being put at 12.5% at most Belgian furnaces.

LEAD.

The production of lead of all kinds in the United States, from domestic ores, in 1904, was 302,204 short tons, as compared with 276,694 short tons in 1903 and 280,524 short tons in 1902. Desilverized lead constituted about two-thirds of the total in 1904, being 200,858 tons, as compared with 188,943 tons in 1903; soft lead amounted to 90,470 short tons, as compared with 78,298 tons in 1903; hard, or antimonial, lead amounted to 10,876 short tons, as compared with 9,453 short tons in 1903. The prosperous condition of the lead industry is thus evidenced by a heavily increased output of all kinds of lead. In addition to the above total, 98,930 short tons of desilverized lead was obtained by refiners in the United States from ore and base bullion imported from foreign countries.

PRODUCTION, CONSUMPTION AND STOCKS OF LEAD.

(In short tons.)

	1903.	1904.		1903.	1904.
SUPPLY:			DEDUCTIONS:		
Total production desilverized....	281,737	299,788	Re-exports of foreign...........	81,915	83,887
Domestic production soft lead...	78,298	90,470	Exports of domestic lead........	56	37
Production antimonial lead......	9,453	10,876	Stock, domestic lead, Dec. 31....	21,000	10,000
Imports foreign refined lead.....	3,023	8,724	Stock, foreign in bond, Dec. 31. .	10,694	11,481
Stock, domestic lead, Jan. 1.....	30,500	21,000			
Stock, foreign in bond, Jan. 1....	23,909	10,694	Total deductions...........	113,665	105,405
Total supply.............	426,920	441,552	Apparent home consumption	313,255	336,147

STATISTICS OF LEAD IN THE UNITED STATES

(Short tons.)

Year.	Produced from Domestic Ores.				Imported in Ores and Bullion.	Total Production and Imports.	Exported in all Forms.
	Desilverized	Soft.	Antimonial. (a)	Totals.			
1900.........	221,278	47,923	9,906	279,107	114,397	425,824	100,288
1901.........	211,368	57,898	10,656	279,922	112,471	458,033	100,026
1902.........	199,615	70,424	10,485	280,524	107,715	458,456	82,238
1903.........	188,943	78,298	9,453	276,694	106,407	418,601	81,971
1904.........	200,858	90,470	10,876	302,204	112,852	415,056	83,924

(a) The entire production of antimonial lead is entered as of domestic production, although part of it is of foreign origin.

These statistics are based upon returns received direct from the smelters, who have in every instance cheerfully complied with our requests for information. The figures represent the exact amounts of pig lead actually produced and put upon the market; they do not pretend to account for the total lead contents of all the ore mined, nor to distribute the output among the ore-producing districts.

The sources of the lead imported into the United States during the past four years have been:

IMPORTS OF LEAD IN ORE, BASE BULLION, PIGS, BARS AND OLD. (a)

	1901.	1902.	1903.	1904.
	Short tons.	Short tons.	Short tons.	Short tons.
United Kingdom	201.3	396.3	776.4	247.3
Germany	335.6	476.4	704.9	365.6
Other Europe	1.2	671.1	225.7	82.8
Canada	26,065.0	9,732.5	9,600.4	8,951.9
Mexico	81,726.8	93,742.3	93,068.3	102,903.0
South America	4,108.7	2,690.1	1,947.8	290.0
Other Countries	32.5	6.1	83.2	11.0
Total	112,471.1	107,714.8	106,406.7	112,851.7

(a) Refined lead, i. e., in pigs, bars and old, is a small part of the total. It was, in 1901, 604 tons; 1902, 2,529 tons; 1903, 3,023 tons; 1904, 8,724 tons.

General Review of the Industry in 1904.

BY WALTER RENTON INGALLS.

No extraordinary features characterized the lead business in 1904. Its control by the American Smelting & Refining Co. is so firm that production can be closely regulated to the consumptive demand and price adjusted so as to get the maximum possible out of the business. This is profitable to the company, but is also profitable to the miners, who, so far, have escaped any such low range of prices as there used to be. This community of interest between the smelting company and the more important of the silver-lead mining companies is recognized in the long-time contracts between them. The existence of these contracts relieves the smelting company to a large extent from the danger of competition.

At the present time, the only silver-lead smelters outside of the trust, between the Mississippi river and the Pacific coast, are the Ohio & Colorado Smelting Co., of Salida, Colo., and the United States Smelting Co., of Salt Lake, Utah. The latter company, which is a branch of the United States Mining Co., erected in 1904 a lead-smelting annex to its copper smelter and entered the general market for ores, its position being fortified by the possession of galena, pyrite and silicious ores in the mines of the same ownership in the Bingham and Tintic districts. This materially increases the competition against the American Smelting & Refining Co. in the Salt Lake district, where the other copper smelters were already powerful bidders for certain competitive classes of ore.

The Cœur d'Alene has continued to be the largest lead-producing district of the United States; some promising new discoveries have been reported therefrom in 1904. Following the Cœur d'Alene, the second place is occupied by southeastern Missouri, as usual. The conditions in that district have been quite unsatisfactory as an aftermath of the recent labor troubles, and although the production continues to increase, the proportion of profit has been diminished and is not what it ought to be, considering the high price for lead, the character of the orebodies and the large investments in mining and metallurgical plants. However, the St. Joseph Lead Co. made extensive additions to its mining, milling and smelting plants during the year. The St. Louis Smelting & Refining Co. (National Lead Co.), which is the second largest producer of the district, completed its new smeltery at Collinsville, Ill.; this is of the Scotch-hearth bag-house type, which appears to be taking the lead for the smelting of these high-grade non-argentiferous ores. The Federal Lead Co., at Alton, Ill., which uses the same process, was a large buyer of ore in 1904, taking the products of some mines which shut down their own furnaces. At the Catherine mine, near Fredericktown, in Madison county, a valuable new deposit of galena disseminated in clay, overlying the limestone, was discovered early in the year. Later this property passed into new hands.

The producers of lead ore in the Joplin district received the full benefit of a high range of prices, galena concentrate fetching upward of $50 per ton throughout the year, and made an important increase in output. There were some noteworthy features in the lead business of this district, such as the advent of the St. Louis Smelting & Refining Co. as a buyer of ores, and the payment of $63 per ton for one lot of ore in December, which is said to be the highest price in ten years. Another was the purchase by the Picher Lead Co. of considerable ore from the Cœur d'Alene district in Idaho, this coming from a mine which produces ore high in lead and non-argentiferous in character.

At Leadville, Colo., and at some other camps in the same State, the producers of lead ore have been materially assisted by the increased demand for zinc ore, which they turn out as a by-product.

A matter of considerable interest during the year was the negotiation for consolidation of the United Lead Co. and the National Lead Co., a project which has been under consideration for a long time. The negotiations finally fell through, but it appears likely that they may be reopened in some form during 1905. It is only such a consummation as this that is necessary to perfect the control of the lead business into one of the most efficient industrial organizations of modern times.

Lead Mining in the United States During 1904.

Colorado.—The production of lead in Colorado during 1904, as reported by the Commissioner of Mines, was 53,773 short tons, valued at $4,624,515, a substantial increase over 50,757 tons ($4,301,123) in 1903 and 53,125 tons ($4,325,484) in 1902. The output during the last two years is given in the table on page 265.

Among the important events of 1904 may be mentioned the construction of the new Denver-Salt Lake railroad; rails have been laid across the Front range as far as Arrowhead, in Grand county, whence mineral products are now being shipped. This Moffat railroad, as it is best known, will stimulate prospecting in a part of Colorado hitherto handicapped by lack of transport facilities, and, among other benefits, it will render available the low-grade silver-lead ores of Middle Park.

LEAD PRODUCTION OF COLORADO.
(In short tons.)

County.	1903.		1904.	
	Short tons.	Value.	Short Tons.	Value.
Clear Creek	1,726	$146,255	1,981	$170,365
Hinsdale	230	19,467	521	44 773
Lake	18,177	1,540,287	23,590	2,028,777
Mineral	4,300	364,409	6,673	573,897
Ouray	1,675	141,964	1,022	87,915
Pitkin	16,63	1,409,644	9,441	811,965
San Juan	3,485	295,280	4,644	399,412
Others	4,529	383,817	5,901	507,411
Total	50,757	$4,301,123	53,773	$4,824,515

Leadville has acquired a new lease of life by the Reindeer and Coronado discoveries. The first, on a lease held by the Campion brothers, indicated the southwest extension of the Rock and Dome shoot. Shipments of 2,000 tons monthly were made at first, and later increased. The second important development was made by lessees in the 'downtown' territory, where the Coronado shaft penetrated a fine body of ore under the parting quartzite and below the Elk fault, apparently the western extension of the Henriett-Maid shoot. The wide bearing of this discovery has been confirmed by drill-holes. The ore is a typical silicious Leadville carbonate, but it carries copper. Among other promising events, the old Iron Silver mine came to the front with new discoveries of sulphide ore in the Moyer. The Yak Tunnel became a large producer, sending out 3,500 tons per month; enormous bodies of sulphide ore have been cut and A. R. Meyer began the erection of a 200-ton concentrator at the entrance of the adit. During the year the production of Leadville was at the rate of 50,000 tons per month, of which 30,000 tons went to the American Smelting & Refining Co., 15,000 tons of zinc ore and concentrate to Canyon City, Pueblo, Kansas, and abroad, while the Salida smelter secured the remaining 4,000 to 5,000 tons.

Idaho.—Lead continues to be the chief mineral wealth of this State. Since the lead discoveries in the winter of 1883, the mines have produced about 20,000,000 tons of ore, capable of yielding lead and silver to a value of $100,000,000.

The Coeur d'Alene. (By Stanley A. Easton.)—Returns from the several producers in this district show the production during 1904 to have been 108,954 short tons of lead and 6,247,795 oz. of silver.

This production surpasses that of any previous year, despite exceedingly low water during the entire summer and fall, so low that one of the largest individual mines—the Morning, at Mullan—nearly suspended production for several months, and other mines were compelled to reduce their output for the same reason. Excepting this unfortunate condition, the Cœur d'Alene region has just closed a year of much progress and of great financial prosperity to all.

The older mines have maintained their output and have spent large sums in improving and perfecting their operations, and the younger mines, notably the Hercules, Hecla and Snowstorm, have developed a great deal of new ore. The last named is a lode of peculiar interest; it is seemingly a member of the general vein system of the district, heretofore known only as lead- and silver-bearing; it is farther to the east than any of the demonstrated mines, and carries a silicious copper ore containing silver. The Snowstorm has produced 22,440 tons of 4 per cent copper ore carrying 6 oz. of silver to the ton, but the tonnage shipped was limited only by the capacity of the smelters to accept this class of ore. A leaching plant to treat the lower-grade material is now being erected. The shaft at the Hecla is being sunk to the 900-ft. level. The electric hoist installed late in 1903 has proved most satisfactory; electric pumps are used exclusively in this mine, and the mill also is operated by the same power. The further development of the Hercules, through the adit, and its equipment with electric locomotives for hauling have been pushed vigorously. This profitable mine continues to produce only high-grade ore, which is shipped without concentration. Of the older properties, the Federal Mining and Smelting Company continues to produce the usual tonnage from its four mines. The consolidation of operations at the Standard and Mammoth was completed during 1904, and these mines are now worked as one property. The Morning mine is installing an electric-driven air compressor which will relieve the older equipment when scarcity of water prevails. The Bunker Hill and Sullivan Mining and Concentrating Company has added to its fine concentrating machinery and power equipment during the year; in the mine, orebodies have been opened up on the Kellogg tunnel level 2,000 ft. below the surface, larger and of higher grade than heretofore known in this property. The 90-mile electric transmission line from Spokane Falls has been in successful operation, and is of great benefit; approximately, 2,000 h. p. is transmitted, furnishing almost all the power of the district. By this and some water power, steam is almost entirely superseded.

Labor conditions probably have been better than in any other mining district in the West. A high degree of efficiency is reached. Nearly 80 per cent of all the men employed are native-born Americans, the remainder being mostly English and Welsh, with a few Irish, Scandinavians and Germans.

It is estimated that the net earnings of all the mines during 1904 amount to $2,800,000. Dividends declared by the incorporated mines amount to $1,911,000.

Other lead fields in Idaho were actively developed in 1904. In the Wood River district, production was on an unusually large scale. The Minnie Moore mine was an important producer, and a number of old properties were re-opened and placed on the shipping list after a lapse of 10 or 12 years.

The big silver-lead-zinc ore zones of the South Mountain district, in Owyhee county, are being opened up. The most important development, however, was in the Gilmore mine, in the Texas district, Lemhi county. Here an ore-shoot 400 ft. long, at a depth of 175 ft., yields shipping ore for a width of 30 ft. Trial shipments averaged 45% lead and 22 oz. silver per ton. New mines in the Sawtooth range, near the head waters of the Middle Boise and South Payette rivers, give promise of becoming important producers of lead and silver.

Missouri. (By H. A. Wheeler.)—The output of pig lead in 1904 from the southeastern or 'disseminated lead' district of Missouri approximates 73,000 short tons, an increase of about 10 per cent over that of 1903, the previous maximum. With an average value of 4.4c. per pound, this gives an estimated value of $6,424,000 in the St Louis market. Of this non-argentiferous production, 88 per cent came from St. François county, about 9 per cent from the adjoining Madison county, and the balance from innumerable small scattered mines or 'shallow diggings' in Washington, Jefferson and Franklin counties, which fringe the 'disseminated' belt.

The year 1904 has not only been the best as regards output at excellent prices, but it also saw the complete defeat of the first miners' union organized in this district. While this proved costly to the company that overthrew the union, it is an event which will contribute greatly to its future prosperity. For this district had been exceptionally fortunate in successfully escaping from the labor agitator until some three years ago, when its placid record attracted the attention of the union leaders. Delegates were sent to organize lodges, at first with such discouraging results that the attempt was about to be abandoned; but a renewed, more energetic campaign finally won over a majority of the men, and then the remainder quickly joined the union like sheep. As wages were the highest and hours the shortest ever enjoyed by the district before the union obtained control, the officers had to find a pretext for its existence and to maintain the loyalty of the men in paying their dues, as the latter was a new feature that was by no means popular. A trivial pretext was found at the Central mine in December, 1903, when the union determined to assert its authority by dictating as to the employment of the workmen; the result was a strike and a complete tie-up of this large property. The miners' union would not even permit the pumps to be operated, and in consequence the principal mine, which makes about 1,000 gal. of water per minute, was soon drowned. The underground mules were only saved from drowning by the outcry raised by the Society for the Prevention of Cruelty to Animals, which resulted in the union officials' permitting the engineers to return to work long enough to hoist them out. But while this society saved some fifteen mules, worth about $2,000, it did not attempt to prevent the flooding of a $500,000 mine that threw 500 men out of employment in midwinter. After nearly three months' idleness, in which the men had ample time to discover that they had no grievance and had been duped by agitators, they gladly left the union and returned to work under the old conditions. Since then the union has been rapidly disintegrating, and it is to-day one of the most unpopular institutions in the district—with workingmen as well as employers—thanks to the firmness, grit and clear head of the manager of the Central Lead Company.

No new discoveries or new shafts have been reported in 1904; the increase in production is due to greater activity in the old mines, which have more than offset the shrinkage resulting from the strike at the Central and the shutting down of the Columbia mine. Nor has the limit of production been reached, as the output in 1905 is likely to be at least 80,000 tons of pig lead, or another increase of about 10 per cent.

The old St. Joe mines, which are now thirty-five years old, have greatly increased their output. Part of this is due to the enlargement of their old Bonne Terre mill and an increase in the underground force at the old mine, and part is due to the completion of a new mill at the Hoffman shaft. One-half of this new plant, with a capacity of 500 tons per day, has been utilized, and 1905 will undoubtedly see the entire plant completed and in full operation. This new mill treats the ore from the Hoffman and Hunt shafts, or No. 11 and 12. The smelting facilities have been enlarged at Herculaneum, where several new roasting furnaces have been added, and a large, modern, water-jacket furnace is now being erected that will nearly double the smelting capacity. Many other improvements have been made at the mines and smelting plants. The closely related Doe Run Company has had a quiet but busy year, and more than maintained its usual large regular output. The Desloge Lead Company increased its milling capacity about 50 per cent, and is now receiving a large tonnage of ore from the new No. 4 shaft; this shaft, though close to Big river, is not proving very wet. The Central Lead Company lost about three months from the strike last winter, and has not since attempted to pump out its large mine. It has been able to keep up a fair production from the Theodora shaft, which is a dry mine. By sinking two new shafts, this company could triple its present production, and this is now under consideration. The National Lead Company completed its new smelter at Collinsville, Ill., where its concentrate is now shipped. The mine enjoyed a very steady, successful year. The Federal Lead Company has begun to be an important producer and its output is growing under more efficient management. The Columbia Lead Company's property was operated on a small scale under lease in the early portion of 1904, but when the lease was abandoned the company shut down the No. 2 shaft and continued work in a desultory way at the No. 1 shaft. Work has since been entirely abandoned, and the property is now lying idle. The old Mine la Motte property has barely maintained its moderate production, though the energetic advertising of its promoters promised much greater results. A small new mill was started on the western portion of the tract, and there has been talk of its becoming an important cobalt and nickel producer, but thus far on only the limited scale that has been characteristic of this property. The North American Lead Company made some improvements in its mill at Fredericktown, and has settled down as a steady producer. The Catharine mine closed down in the summer, from internal dissensions; it has since been sold to Eastern parties, who have re-opened the mine and again started the mill. Before the shutdown some very rich ore was produced.

The mines named above comprise all the producers in the 'disseminated lead' belt; the Union, Penicaut, Manhattan and Elizabeth properties, in St. François county, have not yet been developed to the producing stage.

Joplin. (By Jesse A. Zook.)—Lead began the year at $54 per ton, advanced to $60.50 three weeks later, and in three weeks more was down to $55.50, climbing back to $60.50 the second week in March. This price was maintained for three weeks, and in the succeeding three weeks it declined to $56; then went up to $58 for two weeks, to $56 for two weeks, and then down to $53, where it remained for six weeks. The last week in July it was down to $52, holding at this price throughout August. All through September and October it was $53.50, the next two weeks $54, hen $55.50. closing November at $60.50. It touched the top at $62 per ton the second week in December, after which $60 was paid.

The total lead shipment during 1904 sold for $1,886,150. Averaged by weeks, the lead shipment was 648 tons, selling at $35,587.73 per week. The average price of lead ore for the year was $54.80 per ton.

Utah. (By L. H. Beason.)—Tintic district, which comprises Eureka, Silver City, Mammoth and Robinson, has had a prosperous year, with increased output. Over 250,000 tons have been marketed from this camp. The heaviest shippers were the Centennial-Eureka, Gemini, Grand Central and Mammoth, the first furnishing about one-third of the total; the product went to the United States smelter at Bingham Junction. Other heavy shippers were the Yankee Consolidated, Eagle, Blue Bell and Uncle Sam Consolidated. The last is operating a mill on low-grade ore and paying a $5,000 dividend monthly. Important discoveries were made in the Victoria, May Day, Uncle Sam, Centennial-Eureka and Tetro. Victoria and Tetro paid their first dividend.

At Park City the output of ore has been about 150,000 tons, Daly-West leading, with Silver King a close second. In dividends the Silver King is first in the State; with the 'Christmas extra' of $100,000, the total reached $1,300,000. The Daly-West cut its dividend from $108,000 to $72,000 per month; the company is preparing to explore deeper, and to this end arrangements were concluded a few months ago with the Ontario Silver Mining Company for an extension of the Ontario adit. This work is now going forward, and when completed will give the Daly-West several hundred feet of additional 'backs'.

The Daly-Judge Mining Company explored its virgin ground with flattering results. The Ontario is operating a new concentrating mill at a small profit, but the cost of mining is excessive. The hoisting works were burned down during the summer; they were replaced in a little over a month. The West Quincy is to be developed by means of a crosscut from the main shaft of the Little Bell. Encouraging developments have been made in the New York Bonanza, Comstock, California, Scottish Chief and Wabash.

Virginia.—A small amount of lead occurs with the zinc ore in the mines in southwestern Virginia. The Bertha Mineral Co. is the most active operator. The 'Lead Mines' on the New river, at Austinville, Wythe county, were first worked for lead between 1750 and 1776. A shot factory was erected on the ground in 1851, which was worked by the Confederate Government until it was burned in 1864. The mines became the property of the Bertha Mineral Co. in 1902. They are being opened again, and will be worked principally for zinc.

Washington.—A promising new lead-mining district is being developed near Park City, in the northern part of the Colville Indian reservation, extending from the Sans Poil river westward to the Okanogan county line. During the last six or eight months of 1904 it was proposed to build a railway down the Sans Poil valley; the installation of a smelter at West Fork drew attention, and a wagon road up the west fork of the Sans Poil river to Park City has since resulted in greater mining activity in that vicinity. The mineral veins lie in limestone or at the contacts of igneous dikes.

The chief mines are the Midnight Mining Co., which owns the Mountain Boy group of claims, in which an ore vein from 3 to 8 ft. wide is under development. It had produced $2,700 net previous to occupation by the present owners. The shipping ore, sacked from a streak 8 to 20 in. wide, runs about $200 a ton. The Park Central Mining Co. owns a group of five claims, situated under Davis peak, the highest elevation in the Nespelem range. Between 400 and 500 tons of ore on the tunnel dump is reported to run from $60 to $65 a ton in silver and lead, with a little copper and gold.

Lead Mining in Foreign Countries in 1904.

Austria.—Of lead ore, Austria mined 22,514 metric tons in 1904, an increase of 317 tons over 1903. Bohemia contributed 933 tons; Styria, 43; Carinthia, 14,366; Tyrol, 222; and Galicia, 6,949 tons. Heavy fallings off in Bohemia and Galicia were offset by increases in Carinthia and the Tyrol. In lead mining, 3,683 persons were employed.

Of lead bullion, 12,645 tons were made, an increase of 483 tons over the output of 1903. Carinthia contributed 62% of it; Bohemia, 23%; Krain, 15%; and Galicia, one ton, as a by-product at two zinc works. Nearly all of Carinthia's output came from the works of the Bleiberger Bergwerksunion.

Australia.—The Broken Hill mines continue to contribute the greater portion of the Australian lead production. In 1904 they produced 1,342,276 long tons of lead ore. A noteworthy feature is the success that attended the efforts to turn to account the lead-zinc by-products that have accumulated in the past years. This enabled the mines almost to double their yields of the previous year, and good prospects for the next few years are assured.

The silver-lead mines at Yerranderie, New South Wales, contributed a satisfactory output, and some of the lead districts in the southern part of that State promise to develop well.

The Tasmanian mines annually produce about 60,000 tons of argentiferous lead ore, valued at $20 to $30 per ton. Besides the Oonah mine, the Zeehan-Queen mine is producing argentiferous stannite. The ore contains 72.4 oz. silver, 12.4% copper, 6% lead and 12.5% tin. At present it commands in the Australian market less than half the gross value of the metal contents, and it is proposed to invite the attention of European metallurgists to the treatment of stannite, since a satisfactory process of separating the various metals in the ore would enable greater returns to be obtained from it. This would lead to the reopening of other mines containing argentiferous stannite, and an increased lead production.

The production of lead in Queensland in 1904 was 2,079 metric tons, valued at $117,888, as compared with 3,856 tons, valued at $209,467, in 1903. Although lead ore is found over a wide area in Queensland, very little lead mining is carried on. Most of the lead produced is obtained as a by-product from gold and silver ore.

Canada.—The production of lead in Canada in 1904 was 19,000 short tons, valued at $1,637,420, as compared with 9,070 tons, valued at $768,562, in 1903. The mines in British Columbia, which enjoyed great prosperity in 1904, continue to furnish the bulk of the lead production. The lead output of this Province in 1904 amounted to 18,500 tons, valued at $1,500,000, as compared with 9,045 tons, valued at $689,744, in 1903. A slight increase in the value of lead and the bounty granted by the Dominion Government were stimulating influences in the lead industry in the past year.

The Frontenac lead mine in the township of Loughborough, Ontario, was first opened a generation ago and a small furnace for treating the ore was erected in Kingston. The mine and smelter were worked intermittently until 1882. Since that time no pig lead was produced in Ontario until 1903, although more or less galena was raised from several mines, including the Victoria mine, at Echo Lake, and the Katherine mine in Hastings county. In 1903 an American company purchased the old Hollandia mine near Bannockburn, in Hastings county, cleaned out and extended the workings, and constructed a small smelter. In 1903 this plant produced 25 tons of lead, valued at $1,500. In 1904 this mine was largely responsible for the revival of lead mining in the Province, and 3,210 tons of ore ($11,000) were mined.

LEAD PRODUCTION OF THE WORLD. (a). (In metric tons.)

Year.	Australasia.	Austria.	Belgium	Canada.	Chile.	France.	Germany.	Greece.	Hungary.
1898...	67,000	10,340	19,330	14,477	13	10,920	132,742	19,193	2,305
1899...	87 600	9,736	15,700	9,917	171	15,981	129,225	19,059	2,166
1900...	87 100	10,650	16,865	28,654	14	15,210	121,513	16,396	2,030
1901...	90,000	10,161	18,760	23,542	455	21,000	123,098	17,644	2,029
1902...	90,000	11,300	19,504	11,478	(e) 500	18,817	140,331	15,668	2,243
1903...	141 446	12,162	(e) 21,000	9,070	71	(e) 20,000	145,319	16,093	2,057
1904...	e 150,000	12,645	23,470	19,000	(e) 50	(e) 20,000	137,580	14,320	2,103

Year	Italy.	Japan.	Mexico.	Russia.	Spain.	Sweden.	United Kingdom.		United States.	Totals.
							Foreign Ores.	Domestic Ores.		
1898.	24,543	1,705	71,442	241	1981392	1,559	23,239	25,761	207,271	798,615
1899.	20,543	1,989	84,656	322	184,007	1,606	17,571	23,929	196,938	820,873
1900.	23,763	1,877	63,827	221	176,600	1,424	10,738	24,762	253,204	854,407
1901.	25,796	1,806	94,194	(e)250	169,294	988	19,639	20,361	253,944	892,955
1902.	26,494	1,644	106,805	(e)250	177,560	842	9,113	17,987	254,489	926,895
1903.	e 27,000	1,728	b 94,181	225	175,109	678	14,900	19,958	276,694	977,691
1904.	...	(e)1,700	....	....	183,000	589	6,888	19,838	302,204	1,020,612

(a) From official reports of the respective countries. (b) Net exports. (e) Estimated.

Greece.—There are two large smelters dealing with lead ore in Greece. Both are situated near the port of Ergasteria. One is owned by a local company, which for many years has been treating the accumulations of slag and slime—residue left by the ancients. The value of the material handled is low, and the average rarely exceeds 6% lead and 15 oz. silver per ton. The second lead smelter is owned by a French company. Its ore assays up to 20% lead, 8 to 15% zinc, and a good deal of manganese. The export of argentiferous lead from Greece in 1904 amounted to 14,320 tons, as compared with 16,093 in the previous year.

Mexico.—The condition of the lead mines in Mexico is unsatisfactory. There is a large demand at the smelters for lead ores and every inducement is offered producers; but the lead shortage continues, and many believe it will be permanent. In Nuevo Leon, Chihuahua, Coahuila and other lead districts in northeastern Mexico, the mines are becoming less productive in depth, or the lead ore is giving place to zinc.

Rhodesia.—The Rhodesia Broken Hill mine, which is being developed by the Rhodesia Copper Co., promises to become an important lead producer.

Russia.—The Russian mines produce about 200 to 300 tons of lead annually. Lead mining centers are in the Tomsk, Transbaikal, Kirghiz Steppe, Caucasus and Turkestan districts.

The old lead and copper mines in the neighborhood of Kielce, in Poland, were reopened in 1904, and operations promise to result satisfactorily. The development of the Karczowka mine, from which much was expected, resulted in a yield of only 10 tons of galena.

Spain.—The producing lead mines in Spain are in the provinces of Almeria, Badajos, Ciudad Real, Cordova, Jaen, Murcia, and Tarragona. The Murcia mines are highly argentiferous. In 1904 the output of lead in Spain was on a larger scale than in the previous year, and amounted to about 183,000 tons.

The New York Lead Market.

The average price of pig lead during the year under review was only slightly higher than that for the preceding 12 months. Consumption has been very heavy, the demand for electrical purposes, cables, etc., especially showing a large increase. On the other hand, production has been fairly well under control, the American Smelting & Refining Co. exercising its influence to maintain an equilibrium between supply and demand. It has also continued its policy to centralize the smelting of lead ores and the refining of lead bullion. The independent producers, mainly in Missouri, again benefited largely by the high values ruling during the year, and the output in that producing center is still on the increase.

January opened at the same quotations as ruled at the end of 1903, 4.17½ St. Louis, 4.25 New York. A very heavy demand on the part of consumers caused the American Smelting & Refining Co. to raise its prices on January 13 to 4.32½ St. Louis, 4.40 New York, which was followed by another advance of $2 a ton a week later. On January 30, the quotations were reduced to those fixed on January 13.

The market ruled steady throughout February, but on March 1 the advance of $2 a ton was restored, the quotations standing at 4.42½ St. Louis, 4.50 New York.

No further change was experienced until May 20, when there was a reduction of $3 per ton, no doubt caused by the low prices ruling abroad, which brought the importation of foreign lead within the range of possibilities. The further drop of $2 per ton on May 24 was probably prompted by a desire to make assurance doubly sure and to work off some stocks which had accumulated in the meantime.

On June 14 and July 25, prices were again reduced $1 a ton each time, the quotations on the latter date standing at 4.02½ St. Louis, 4.10 New York. At these values, a good inquiry developed on the part of consumers, and prices were raised on August 29 to 4.12½ St. Louis, 4.20 New York.

During the fall, consumers were extremely busy, and in the course of a few months the Trust became swamped with orders. It tried to stem the tide by booking them only at the prices ruling at time of shipment, which, naturally, was taken as a sure indication of an impending advance in prices. This materialized on December 1, values being raised to 4.52½ St. Louis, 4.60 New York, which are the closing quotations of the year.

AVERAGE MONTHLY PRICES OF LEAD PER POUND IN NEW YORK.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
1900	4.68	4.68	4.68	4.68	4.18	3.90	4.03	4.25	4.35	4.35	4.58	4.35	4.37
1901	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.15	4.33
1902	4.00	4.075	4.075	4.075	4.075	4.075	4.075	4.075	4.075	4.075	4.075	4.075	4.069
1903	4.075	4.075	4.442	4.567	4.325	4.210	4.075	4.075	4.243	4.375	4.218	4.162	4.237
1904	4.347	4.375	4.475	4.475	4.423	4.196	4.192	4.111	4.200	4.200	4.200	4.600	4.309

Recent Improvements in Lead Smelting.

BY H. O. HOFMAN.

Analysis of Missouri Lead.—A recent analysis of lead from the St. Joseph Lead Company gave the following results: Pb, 99.91683; Cu, 0.06400; NiCo, 0.01600; Fe, 0.00100; Sb, 0.00130; As, 0.00080; Ag, 0.00007 per cent.

Solubility of Silicon in Lead and Zinc.—H. Moissan and F. Siemens[1] have investigated the solubility of silicon in lead and in zinc. They find that silicon begins to be dissolved by lead at about 1,200° C., and that the solubility increases with the temperature. Lead dissolves at 1,250° C., 0.024% Si; at 1,330°, 0.070%; at 1,400°, 0.150%; at 1,450°, 0.210%; and at 1,550°, 0.780 per cent of silicon. The solubility of silicon in zinc begins at a lower temperature and is much greater than in lead. Zinc dissolves at 600° C., 0.06% Si; at 650°, 0.15%; at 730°, 0.57%; at 800°, 0.92%; and at 850°, 1.62 per cent of silicon.

Influence of Impurities upon Lead.—O. Herting[2] begins his paper, on the influences of foreign metals upon the properties of lead and on the method of analysis of refined lead, with the statement that little is known about the amounts of foreign metal that lead may contain and still be suitable for the production of some of its chemical compounds. He quotes Boeckmann's and Lunge's works on technical-chemical analysis and has apparently not studied the original works of Hampe and others.[3] He gives the following analyses of refined lead, which, being new, are of interest even though the names of the refining works are not given.

No. 1 to 5 represent American brands, and No. 6 a European product; No. 1 to 3 are used for the manufacture of white lead, No. 4 to 6 for red lead and lead nitrite. The author says that lead with over 0.02 per cent bismuth is not suited for the manufacture of red lead. In his very brief

[1] *Comptes Rendus*, 1904, 138, 657.
[2] *Chemiker Zeitung*, 1903, XVII, 923.
[3] Hofman, 'Metallurgy of Lead,' 1899, p. 14.

No.	1	2	3	4	5	6
Insol	0.001400	0.000820	0.011700	0.000700	0.00520	0.001200
Sb	0.001240	0.000963	0.000950	....	0.00220	0.001026
Sn	....	....	....	0.003140	....	....
As	....	....	....	....	....	....
Ag	0.000150	trace	trace	0.000100	....	....
Cu	0.000920	0.000880	0.002080	0.000520	0.00035	0.000160
Bi	0.107460	0.077160	0.056200	0.018500	0.00124	0.000106
Fe	0.001140	0.001484	0.030500	0.003000	0.00851	0.005390
Ni	0.000173	0.000252	....	....	....	....
Zn	0.000880	0.000500	0.001280	0.000740	0.00045	0.000963
Cd	....	....	....	0.001920	....	....

outline of the method of chemical analysis he follows the example of Hampe in advising to start with 400 to 500 grams of lead.

Lead-Tin-Bismuth Alloys.—E. S. Shepherd[4] carried out a careful investigation on the constitution of alloys of lead, tin and bismuth. He finds (1) that no chemical compounds are formed between lead, bismuth and tin; (2) that from alloys containing lead, tin and bismuth, the tin crystallizes out in the pure state; (3) that lead and bismuth form two series of solid solutions, in each case with contraction; (4) that when these solid solutions are cooled fairly rapidly, the saturation concentrations (Pb with up to 5% Bi, and Bi with up to 4% Pb) are not reached.

Recovery of Tin and Lead from Their Alloys.—L. Peetz[5] carried on a series of experiments for the separation of tin and lead from their alloys, using as refining agents stannous-alkali chlorides, and a battery composed of lead oxide and lead alloy as elements with caustic soda as liquid.

In treating fused stannous chloride with lead, the latter is dissolved, replacing an equivalent amount of tin; in treating the stannous chloride with lead-tin alloy, a state of equilibrium is reached at which the above reaction ceases. The loss in tin by volatilization of stannous chloride was found to be too great to permit the process being even in part applicable on a commercial scale.

Treatment of lead-tin alloy with fused lead oxide or a mixture of lead oxide and alkali chloride causes some enrichment of lead and scorification of tin. An attempt to separate lead oxide (reduced at 185° C.) and stannic oxide (reduced at 380° C.) from resulting mixed oxides, by fractional reduction, proved a failure. Heating the mixture with caustic alkali in the presence of oxygen was more successful, as it gives rise to the formation of plumbates and stannates:

$$PbO + 2\,NaOH + O = Na_2PbO_3 + HOH$$
$$PbO + 4\,NaOH + O = Na_4PbO_4 + HOH$$
$$SnO_2 + 4\,NaOH = Na_4SnO_4 + 2\,HOH$$

[4] Thesis: Cornell University, Ithaca, N. Y., 1902.
[5] *Metallurgie,* 1904, I, 281, 336.

Sodium plumbate is decomposed when treated with water:

$$Na_2PbO_3 + HOH = 2\,NaOH + PbO_2$$
$$Na_4PbO + 2\,HOH = 4\,NaOH + PbO_2$$

while sodium stannate is simply dissolved. As the heating of lead-tin alloy with lead oxide is accompanied by many practical difficulties, and as the process involves the manufacture of lead peroxide, this second plan of separating the oxides was also given up.

Corrosion of Tin-Lead Alloys.—O. Sackur[6] tested the solubility of tin-lead alloys in acetic acid, stirring the solvent with compressed air at the rate of 1 to 2 liters air per min. He obtained the following results:

SOLUBILITY OF LEAD-TIN ALLOYS IN ACETIC ACID.

Per cent Lead in Alloy.	Dissolved in 1 Liter Acetic Acid.					
	1-20 Normal.		1-10 Normal.		¼ Normal.	
	Pb., mgr.	Sn., mgr.	Pb., mgr.	Sn., mgr.	Pb., mgr.	Sn., mgr.
0	....	....	....	....	....	42.3
10	7.2	0.8	1.9	15.5	4.8	81.8
20	14.6	0.7	7.7	14.7	5.2	86.6
30	27.8	3.8	23.0	41.3	6.2	100.6
50	48.5	6.1	17.6	43.1	7.2	72.0
70	82.7	10.3	31.9	36.0	14.3	64.8
90	112.5	12.9	83.0	22.8	86.2	36.6
100	173.7	....	....	....	162.5	.....

An electrolytic process for treating the alloy was then tried, the alloy forming the anode, lead oxide the cathode, and caustic soda the electrolyte. This proved to be successful, at least as a laboratory experiment, with alloy plates 1 mm. in thickness, in that, at a temperature of 35° C., the tin was dissolved from the anode in three days, leaving behind the lead in a more or less loose state, and the lead oxide was reduced to the metallic state. Plates thicker than 1 mm. became coated with spongy lead, which greatly retarded solution and caused lead oxide to be dissolved instead of tin. Scraping off the lead corrected this evil in part, but the final remedy lay in having thin plates.

Lead-Aluminum Alloys.—H. Pécheux[7] examined some alloys of lead and aluminum. He found that in cooling fused alloys, containing less than 90% aluminum, three layers were formed upon solidification: Lead at the bottom, aluminum at the top and alloy at the middle section. The last contained from 90 to 97% aluminum and remained unchanged upon remelting. Alloys with 93% (sp. gr. 2.745), 95% (sp. gr. 2.674) and 98% (sp. gr. 2.600) aluminum were prepared and subjected to some chemical and mechanical tests. These alloys do not become oxidized during casting and are not attacked by water at ordinary temperature or at 100° C. At

[6] *Berg- und Hüttenmännische Zeitung*, 1904, LXIII, 319; *Zeitschrift für Elektrachemie*, 1904, X, 522; *Electro-chemical Industry*, 1904, II, 315; *Electro-chemist and Metallurgist*, 1904, IV, 51.

[7] *Comptes Rendus*, 1904, 138, 1042; *Chemisches Centralblatt*, 1904, I, 1478; *Berg- und Hüttenmännische Zeitung*, 1904, LXIII, 348.

13° C., hydrochloric acid and concentrated sulphuric acid evolve hydrogen; hot concentrated sulphuric acid evolves sulphurous acid; hot concentrated nitric acid readily attacks the alloys, giving off nitrous gases; cold concentrated nitric acid hardly has any dissolving effect, nor has dilute nitric acid either hot or cold; concentrated caustic potash and nitro-hydrochloric acid readily dissolve the alloys in the cold. The alloys are easily flattened out by hammering, are cut without difficulty, can be readily bent, and show a granular fracture when broken.

New Lead Mineral.—A new lead mineral has been found[8] in the Binnenthal, Switzerland; it has been named Baumhauerite; its chemical formula is 4 PbS, As_2S_3.

Analyses of Laurium Lead Ores.—H. F. Collins,[9] in a description of the geology of the mines of Laurium, Greece, gives the following analyses of the ores that are mined:

	Soureza, Carbonate Lead Ore.	Camareza, Earthy Carbonate.	Calamine, Camareza.		Plaka, Heavy Sulphide.	Plaka, Carbonate Gangue.	Plaka, Manganiferous Iron Ore
			1st Class	2d Class.			
SiO_2	3.40	8.04	7.12	9.75	2.96	11.92	7.20
Fe	2.16	20.91	5.54	15.00	27.22	37.30	37.10
Mn	2.25	5.69	1.08	0.40	0.58	4.47	14.33
Al_2O_3	0.25	10.70	3.68	7.60	7.32	3.20	n. d.
CaO	19.42	2.20	8.33	10.00	5.71	0.70	trace
MgO	0.25	0.10	0.40	0.30	0.10	.....	.....
Zn	11.96	2.40	50.80	38.35	13.35	4.46	1.40
Pb	9.75	6.45	0.60	trace	9.35	11.85	0.80
Cu	.....	0.08	0.01	0.05	0.02	.....	none
Cd	.....	.....	0.18	0.07	.....	.....	.....
As	0.10	4.00	1.12	2.70	trace	.....	none
S	0.22	1.30	0.11	0.35	23.65	1.27	1.66
CaF_2	25.96	none	none	0.06	.....	.....	. .
CO_2	n. d.	16.00	n. d.	n. d.	n. d.	n. d.	.....
P	.....	.....	.....	.....	.....	.....	0.06
H_2O	.....	.....	.....	.....	.....	.....	0.90
Ignition loss	24.80	.....	.....	.....	.....	.....	.....
Ag	0.031 (10.5 oz.)	0.0152 (5.25 oz.)	.....	.....	0.0075 (3.5 oz.)	0.0185 (6.25 oz.)	.....

The two analyses of zinc ores of the table and the one of manganese ore have been retained, although they have no bearing on the metallurgy of lead.

Sampling.—H. H. Kimball and B. T. Wells[10] have brought together much valuable information on the current methods of sampling as carried on in concentrating and smelting plants of Western companies. They discuss briefly the leading methods and apparatus used with ores, including the sizes to which these should be reduced as the quantities are diminished. Taking samples from the leading concentrating machines receives considerable attention. The sampling of the products of smelting plants is described with much detail. The blast- and reverberatory-furnace slag and matte, calcines, briquettes, converter-slag, -copper and -lining, copper-lead,

[8] The Engineering and Mining Journal, October 6, 1904.
[9] *Ibid.*, November 10, 1904.
[10] *Bulletin*, Colorado School of Mines, 1904, II, 14-67.

gold bullion and pig iron, cathodes and electrolyte are treated separately. Under the heading of miscellaneous sampling, the sampling of limestone, sandstone, coal, coke, producer gas, gases and fumes from roasting and smelting furnaces are reviewed. The authors have read much that has been written upon the subject and familiarized themselves with the work that is being done at some of the leading plants of Colorado and Montana. The result is a piece of work that is of considerable value.

E. Juon[11] publishes a general article on the importance of correct sampling of ores and metallic products which forms interesting reading, but contains little that is new. A few examples of differences in results from sampling are given below. In taking grab samples from the surface of the ore in the mine cars and comparing them with samples from fractional selections taken when the ore was delivered to roast heaps, the following figures were obtained:

Mine.	Number of Heaps.	Number of Mine-cars Sampled.	Per cent Copper.	
			Mine-car Samples.	Fractional-Selection Samples.
A	9	225	3.65	4.18
B	12	484	4.36	4.84
C	11	341	5.07	6.18
D	3	84	8.13	9.45
	35	1,134	4.68	5.50

The uniformly low figures of the grab samples are of course to be attributed to the richer fine collecting on the bottom of the car.

Differences in the copper content of a matte while flowing from the blast-furnace are seen in the subjoined table:

Furnace No.	1	2	3	4	5
Sample taken at beginning of tap..........	31.77	31.23	31.20	34.96	29.51
First third of tap.....	31.98	31.85	32.06	35.08	30.16
Second third of tap...	32.06	31.86	31.89	35.31	30.23
End of tap..........	32.48	31.94	32.06	35.80	30.38
Average { Determined...	32.33	31.76	31.98	35.11	30.20
Average { Calculated.....	32.27	31.72	31.80	35.29	30.07

Samples taken from a section of a cone of copper converter-slag, 30.75 in. high, in distances of about 2.375 in., gave the data in table on page 279.

The richness of samples No. 13 is due to an admixture of matte (65% Cu) which passed over in pouring the slag from the converter ladle. The richness of the top samples in slags *b* and *d* is to be ascribed to pellets of matte which did not settle out. That the slag samples near the bottom should run generally higher in copper than those near the top was to be expected.

[11] *Zeitschrift für Angewandte Chemie*, 1904, 1544, 1571.

Sample No.	Per cent copper.			
	Cone a.	Cone b.	Cone c.	Cone d.
1 top.	0.22	1.12	0.18	0.76
2	0.36	0.46	0.18	0.16
3	0.24	0.48	0.19	0.18
4	0.30	0.36	0.22	0.18
5	0.16	0.37	0.20	0.14
6	0.34	0.34	0.16	0.16
7	0.20	0.44	0.26	0.20
8	0.44	1.40	0.20	0.12
9	0.48	1.20	0.20	0.12
10	0.74	2.03	0.26	0.60
11	0.78	2.89	0.22	2.73
12	0.28	3.63	0.36	7.05
13 bottom	46.95	42.61	53.08	57.69

F. Janda[12] discusses from a general point of view the question of sampling of ores and the further reduction of the samples, and then treats in detail the mode of operating at the quicksilver works of Idria, with which he is connected. The paper concludes with a brief dissertation on the limits of error according to the theory of probabilities.

A. Harvey[13] describes with two drawings a 300-ton automatic sampling plant with three Vezin mechanical samplers; it is designed to handle ore with the least amount of crushing, thus leaving it in a condition best suited for the blast-furnace. The ore arriving in cars on the ground level is dumped on to a shaking screen feeding a 20 by 10-in. Blake crusher. Undersize and crushed ore pass together into the boot of an elevator delivering to Vezin sampler No. 1, which cuts out as a sample one-tenth of the whole, discharging it into a pair of 36 by 10-in. rolls, while the rejected ore goes into a triangular storage-bin. The rolled sample passes through a chute into the boot of a second smaller elevator, is raised to the top floor of the mill, delivered to Vezin sampler No. 2, which again cuts out one-tenth and delivers to a pair of 20 by 12-in. rolls, while the rejected ore passes to the storage-bin; the rolled sample passes directly into Vezin sampler No. 3, which, for the last time, cuts out one-tenth. This forms one-thousandth part of the original ore and is delivered into a sample-car ready for the finishing department. The boots of the two elevators have drop-bottoms, which simplifies cleaning. Very close results are obtained with automatic sampling machines, such as the Vezin and the New Brunton. In the mill outlined, running in Colorado, a lot of gold ore worth $200 to $300 per ton was sampled, giving check results agreeing to 0.02 oz. per ton. The cost of sampling is $0.12 per ton.

W. L. Raht[14] patented an intermittent sampling machine which is to intercept at certain intervals the whole of a stream of dry pulp while it is being moved through a trough by a screw-conveyor. A section of the trough

[12] *Oesterreichische Zeitschrift für Berg- und Hüttenwesen,* 1904, 547, 561, 577.
[13] *Mining and Scientific Press,* January 30, 1904.
[14] U. S. Patent No. 751,340, February 2, 1904.

is replaced by a cylinder rotated by means of the conveyor. The cylinder has an opening which receives the sample at every revolution.

Laboratory Crushers and Grinders.—The Denver Fire Clay Company[15] describes, with photographic reproductions, the Case laboratory ore-crusher, which is to take the place of the Bosworth machine made by the same company. The jaw-opening is 2.5 by 3 in.; the adjustment for fine-and-coarse crushing is made by slotted steel shims inserted between the front jaw-plate and the frame; the adjustment varies from 0.25 in. to 30 mesh. When driven by power, the crusher has a capacity of from 100 to 200 lb. per hour, the pulley (9 in. diam., 2.75 in. face) making from 450 to 500 r. p. m.; 1 h. p. is sufficient to drive the machine.

The F. W. Braun Company[16], of Los Angeles, Cal., describes with illustrations the following laboratory apparatus which they have put on the market: The Chipmunk Crusher, claimed to reduce per hour 300 lb. granite to ¼ in., the Disc Pulverizer, grinding an 8-oz. sample in one minute to 100-mesh size, and the Umpire Power Sampler, which is of the continuous mechanical type.

F. J. A. King[17] has constructed a power-driven muller weighing over 50 lb. to grind samples on a bucking plate about 3 ft. long, which is to replace the ordinary hand-rubber. The muller is connected by a long rod to the crank-pin of a motor making 75 r. p. m.; it can be raised and lowered by a lever.

The Sturtevant Mill Company, Boston, Mass., has brought out a sample-grinder in which the size of the product is easily regulated. The construction is simple, the parts are readily accessible, hence easy to clean; the machine weighs 175 lb.; its grinding power is said to be large.

Assaying.—New Publications.—R. W. Lodge, 'Notes on Assaying and Metallurgical Laboratory Experiments,' J. Wiley & Sons, New York, 1904, pp. 207, ill., price $3. This book is the outcome of lithographed notes prepared for the students in the Massachusetts Institute of Technology. Part I, treating of the fire-assay, is divided into eight chapters dealing with apparatus; reagents; materials; sampling; assay of ores of silver, gold and lead; of silver and gold bullion; of ores of copper, tin and platinum, including iridium, palladium, osmium, ruthenium and iridosmium. Part II, treating of metallurgical experiments in the laboratory, discusses roasting, chlorinating, brominating, cyaniding and amalgamating gold ores, amalgamating silver ores, and melting and casting silver and gold bullion. While the book is intended mainly for students, it forms a valuable addition to the reference works of the assayer, as from beginning to end the essential points are all brought out and made clear by examples from the author's extensive practice, which tell their own story.

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[15] *Mining and Scientific Press*, Feb. 20, 1904. The Engineering and Mining Journal, Feb. 25, 1904.
[16] *Mining and Scientific Press*, Oct. 15, 1904.
[17] *Mines and Minerals*, 1904-05, XXV, 243.

E. W. Burkett[18] publishes a series of articles, 'Fire-Assaying,' in which he describes the apparatus commonly used and discusses the methods of assay, the reagents employed and some of the reactions that come into play. The articles form a short elementary treatise and are well illustrated.

L. and G. Campredon[19] have prepared a monograph on the assay of silver and gold in which they discuss apparatus, fluxes, ores, sampling, the assay proper, with extended tables of results. In a supplement are given some studies on the loss of silver in cupelling, and its causes; this is followed by an article by Loevy on the methods of assay and analysis in use in the South African gold districts. To the American assayer these articles are of special interest, as they represent advanced European practice. The use of the iron crucible in the lead assay is discussed with considerable detail.

P. H. Argall's 'Smelter and Mill Methods of Analysis in Use in the West,' Boulder, Col., 1905; 57 pages, price 50c., is published as a regular number of *The University of Colorado Studies,* Vol. 2, No. 1. It treats, with the necessary details, of the determinations usually made in lead and copper smelters and cyanide plants, and furnishes in a compact form a valuable general guide, especially for young men from technical schools entering upon the metallurgical profession.

Assaying Equipment of Laboratories.—Three valuable papers on laboratory equipments have appeared during the past year, giving information usually sought for, but not found, in books or in the periodical literature. For details the reader is referred to the originals. The papers describe the laboratory of the Lawrence Scientific School, Harvard University, by C. H. White;[20] the laboratory of the pyrite smelter at the Afterthought mine, Ingot, Shasta county, Cal., by H. Haas;[21] and the laboratory of the State School of Mines, University of Utah, by R. H. Bradford.[22]

Assay-Furnaces.—F. C. Bowman[23] describes the muffle assay-furnace shown in Fig. 1. This furnace, built for firing with soft coal, was changed for use of oil as fuel. The packing-nut N allows adustment of distance between the openings of the oil- and the steam-nozzle. The valve D V is left slightly open to drain off any condensed steam. In starting the furnace, oil-waste in sufficient amount is lighted in the fire-box just back of the nozzle of the burner, oil and steam are turned on together, the oil-valve is set and the length of the flame regulated by admitting more or less steam. There should be enough waste to kindle and keep burning freely the oil when this is turned on, as otherwise there is danger of an explosion. The muffle is red-hot 15 minutes after starting the fire. The amount of oil used varies from 4.2 to 5.3 gal. per hour. To compare oil-firing with other modes of producing heat, it is stated that a coke-furnace with single muffle

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[18] *Mines and Minerals,* 1904-05, 25, 77, 113, 193, 289.
[19] *Revue Universelle des Mines,* 1904, VIII, 145-229.
[20] *Transactions* American Institute Mining Engineers, 1904, XXXV, 117.
[21] *Ibid.,* XXXV, Sept., 1904.
[22] *Salt Lake Mining Review,* Feb. 29, 1904.
[23] *Proceedings* Colorado Scientific Society, through *Mining and Scientific Press,* Nov. 19, 1904.

11 by 16 by 7 in. and forced draft consumes 34 lb. per hour; a coal-furnace with single muffle 12 by 19 by 7.75 in., 34 lb. coal; a No. 31 Cary combination gasoline-furnace of F. W. Braun & Company, 0.65 gal. per

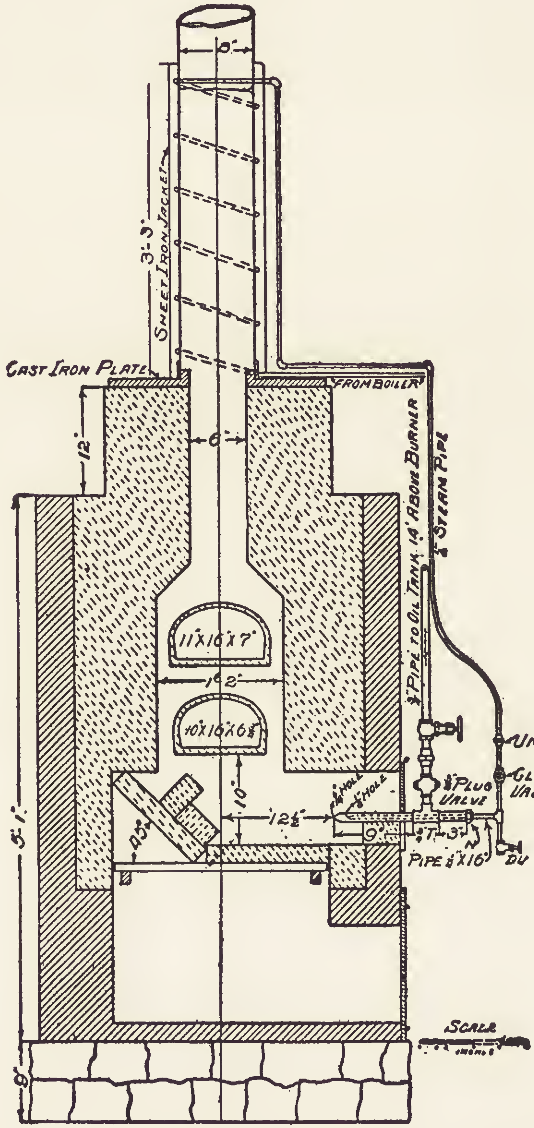

FIG. I.—CROSS-SECTION OF FURNACE.

hour; a No. 37 Cary furnace with two muffles 6 by 12 by 4 in. and 10 by 16 by 6.75 in., 1.30 gal. per hour.

Assay Implements.—E. Keller, A. Ferrell, K. W. McComas have patented[24] an assay-button dropper, a tool by which one or more rows of cupels in a muffle can be charged with scorifier or crucible lead-buttons at a single operation.[25]

J. C. Fox has patented[26] a new form of bone-ash cupel in which the bottom is convex, allowing the cupel to stand on the rim only and not on the whole base, thus facilitating movement of the cupel over the muffle-bottom; it must tend, however, to make the cupel top-heavy, especially as it is made slightly conical.

Wet Assay of Lead.—H. A. Guess[27] publishes a valuable paper on the use of potassium chromate for the volumetric determination of lead. In most Western lead-smelting plants, 90 per cent of all the wet assays are made by the molybdate and ferro-cyanide methods, while the former is in more general use than the latter. The molybdate method, however, suffers from the fact that the yellow tint at the end point varies sufficiently with different assayers to render unsafe an accurate determination (say, to 0.3% lead) in a silicious and especially in a calcareous ore. With the chromate method, the lead is precipitated by a slight excess of potassium chromate solution (9.4 gm. K_2CrO_4 to 1 liter; 1 c.c. = 10 mg. Pb) the lead chromate filtered off and washed. This filtrate is acidified with 25 c.c. dilute hydrochloric acid (1:1), potassium iodide (about 0.5 gm.) added and the liberated iodide titrated with a standard solution of sodium hyposulphite (36 gm. to 1 liter). There are two ways of carrying out an assay: In the sulphate-chromate method, the ore is dissolved in nitric and sulphuric acids, evaporated to white fumes, cooled, diluted with water, heated, filtered and washed; the filter and its content are returned to the original flask, slightly acid ammonium-acetate solution is added, the whole digested for a few minutes until the lead sulphate has passed into solution and titrated as shown above. This mode of operating is applicable to lead ores of varying tenor in the presence of all commonly occurring elements. The modified method omits the evaporation with sulphuric acid in order to avoid the formation of calcium sulphate. From 1 to 5 gm. ore is dissolved in a 250-c.c. flask in from 3 to 5 c.c. nitric acid and 15 c.c. strong hydrochloric acid; the solution is reduced to 8 c.c., partially cooled, slightly diluted, ammonia is added in small excess, then 80 per cent acetic acid until well acidified; the flask is well shaken, 5 c.c. of concentrated ammonium-acetate solution is given to insure perfect solution of all lead sulphate, and potassium chromate added as before. This short-cut is applicable to all ores free from antimony and low in bismuth and silver. Antimony causes slightly low results because of the imperfect solubility of lead sulphate in the presence of antimony oxides; bismuth falls out upon addition of am-

[24] United States Patent No. 777,421, Dec. 13, 1904.
[25] See also Keller, *Transactions* American Institute Mining Engineers, Feb., 1905.
[26] United States Patent, No. 777,725, Dec. 20, 1904.
[27] *Transactions* American Institute Mining Engineers, 1904, XXXV; *Mining Reporter,* July 28, 1904.

monia, and is not completely re-dissolved when acetic acid is added, but remains as a bulky precipitate which interferes with the washing of the lead chromate; silver forms an insoluble chromate, which remains on the filter with the lead chromate. The results with volumetric methods of Bull[28] and McElvenny-Izett[29] have been previously discussed.

E. J. Ericson[30] worked out a method for the determination of small amounts of lead in brasses, bronzes, bearing-metals, etc.

Silver Assay in General.—E. H. Simonds[31] discusses the accuracy of commercial sampling and assaying of silver and gold bullion, silver sulphides, copper matte, pyritic concentrate, silver-lead ore and silver-lead concentrate. True valuations of silver and gold bullion containing much base metal can be obtained only from dip-samples; high-grade bars can be sampled by taking chips from opposite corners. Fire-assays of silver bars are reliable to .002; closer results may be obtained by the use of proof-silver as a check. The fineness of the proof-silver, however, has to be determined, as ordinary test- or quartation-silver is only .997 fine. In assaying bars of .875 to .925 fineness, United States silver coins (.900 fine) may serve as a check. Assay results guaranteed to be accurate to decimals of one-thousandth can be obtained only in the wet way (Gay-Lussac, Volhard). Fire-assays of gold bullion are very accurate; they are reported to .000,25 and usually agree to .000,25; the surcharge, using proof gold, never exceeds .000,1; it usually varies between .000,04 and .000,07. The following table gives results of bars of various composition:

Bar No.	Weight, oz.	Sampled by	Seller.		Buyer.	
			Au.	Ag.	Au.	Ag.
1	225	dips.	722.25	268	722.50	265
			722.30	267	......	...
2	50	chips.	713.65	......	714	...
			713.88	......	......	...
3	600	borings	603.25	333.5	602.5	330
			603.00	333.0	......	...
4	600	borings	607.00	334.5	607.5	...
			607.25	335.5	......	...
5	...	dips.	81.00	595.5	81	594
			81.02	595.0	......	...
6	...	dips.	84.34	593.5	84.2	591
			84.35	592.5	......	...
7	780	dips.	0.04	314.86	trace	316
			0.04	314.76	......	...

No. 1 and No. 2 are mixed gold bars; No. 3 and 4 cyanide bars; in No. 5 and 6 the base metal is mostly lead; No. 7 is base Mexican silver bullion.

The silver sulphides from hyposulphite leaching plants contain from 3,000 to 20,000, average 10,000 oz. silver, and from 1 to 100 oz. gold per ton. The pulp is homogeneous if it has not been overheated in drying, and

[28] THE MINERAL INDUSTRY, 1902, XI, 432.
[29] *Ibid.*, 1903, XII, 245.
[30] *Journal* American Chemical Society, 1904, 26, 1,135.
[31] *Mining and Scientific Press*, Jan. 2, 1904.

therefore easy to sample. The loss by slagging (50 oz. with 10,000-oz. material) and cupel-absorption (150 oz. with similar material), not counting in the loss by volatilization, make the dry assay unsatisfactory, if slagging- and cupellation-losses are neglected, as is commercially the custom. The Volhard method for valuing soluble silver, supplemented by the scorification-cupellation method for the insoluble residue, gives data which agree to within a few ounces with 15,000-oz. material.

Assayer.	Method.	Au, oz. per ton.	Ag, oz. per ton.
A	Crucible	29.90	11293
A	Scorifier	30.00	11278, 11308
B	Scorifier	....	11323

Copper matte, as long as it is free from metallic copper, is homogeneous and therefore easy to sample. This is well shown by the following example: A 500-lb. lot of 1-in., 50% copper matte was quartered and each half further reduced in the same way to 50 lb.; the two samples were then treated separately. Each was crushed to pass a 4-mesh sieve, quartered down to 6 lb., the pulp dried, ground through a 60-mesh sieve and 0.5 lb. taken out by dips. The assays given below show a close agreement in gold and copper:

Sample No.	Seller.			Buyer.			Umpire.		
	Au. oz. p. t.	Ag. oz. p. t.	Cu %	Au. oz. p. t.	Ag. oz. p t.	Cu. %	Au. oz. p. t.	Ag. oz. p. t.	Cu. %
1	9.85	64.20	34.23	9.81	.....	34.00	.....	65.29	.....
2	16.47	91.20	50.15	16.47	91.70	49.90	.....	.....	.....
3	11.97	73.74	28.67	11.83	74.50	28.70	12.00	72.80	.....
4	13.39	69.20	35.65	13.33	69.80	36.90	13.33	.....	35.80
5	30.03	285.95	49.25	.....	.....	49.30	30.04	286.90	50.24
6	1.28	41.26	52.20	1.24	41.35	52.30	.....	.....	.....
7	1.45	35.15	55.70	1.47	35.30	.....	.....	.....	55.77
8	1.37	34.51	48.74	1.32	33.16	.....	.....	.....	48.73

Assays No. 1 to 4 (seller) were made for gold and silver by the crucible, and for copper by the iodide method, while in assays No. 1 to 4 (buyer) scorification and electrolysis were employed. In sample No. 5 the crucible and iodide methods were used by the seller and buyer. In samples No. 6, 7 and 8 (seller) scorification and iodide methods, and in samples No. 6, 7 and 8 (buyer) crucible and iodide methods were used. The contract between seller and buyer for samples No. 1 to 4 provided that "three samples are to be drawn, one for our joint assayer, one for the refiners and one to be reserved for an umpire in case the assays should vary 0.25% for the copper, 1 oz. for the silver, and 0.05 oz. for the gold; if the difference does not exceed the above splitting limits, the mean of the two assays to be taken for settlement, but if an umpire's assay should be made, the mean of the two nearest to be taken, and the party further away from the umpire's assay shall pay the umpire's charges for assaying."

Pyritic concentrates from gold mills ought to give results differing less than 0.05 oz. gold per ton, provided the sample has been ground sufficiently fine and is free from particles of amalgam or free gold. Thus, 100-mesh pulp often does not give concordant results, while 150-mesh material usually does, as is seen in the following examples:

Lot.	100-mesh samples.					150-mesh samples.		
A	2.36	2.44	2.30	2.30	2.80	2.24	2.96	2.26
B	4.18	1.22	....	58.20*	57.84*	1.32	1.32	57.74*

Values are ounces gold per ton, excepting those marked with an asterisk (*), which are ounces silver per ton.

An umpire assay is not called for when the differences in the values of a lot do not exceed $20.

In silver-lead ores and concentrates, the silver is usually determined by the scorification and the gold by the crucible method; lead values are generally ascertained in the dry way, although in many instances this has been replaced by the method of titration with ammonium molybdate. An ore free from readily reducible oxides will give, by the dry way, in skillful hands, results from 0.5 to 1 per cent below that from the molybdate method.

Dry Silver Assay.—A. Lachman[32] gives in detail a special method for calculating crucible charges for gold and silver ores. It is based on the principle of balancing the silica with the bases of the gangue by equivalents, fluxing the excess silica with soda and litharge, and adding some borax, the acid effect of which is also neutralized. The percentage of Al_2O_3 multiplied by 0.43 gives the equivalent amount of SiO_2; the factors for the other bases are: $CaO \times 0.27$; $Fe_2O_3 \times 0.57$; $Na_2O \times 1.00$; $K_2O \times 0.67$; $MgO \times 0.36$. In a quartzite of the composition—SiO_2, 77%; Al_2O_3, 13%; CaO, 0.7%; Fe_2O_3, 1.1%; K_2O, 4.3%; Na_2O, 0.7%; MgO, 1.0%—the bases will slag 10.4% SiO_2, leaving 67% in excess to be provided with fluxes. The silica excess to be fluxed in the leading silver- or gold-bearing rocks is: quartzite, 67%; granite, 57%; syenite, 40%; trachyte, 40%; porphyry, 31%; serpentine, 30%; clay, 23%; basalt, 19%. Now 1 A. T. silica is fluxed either by 50 gm. sodium carbonate or 100 gm. litharge. As two fluxes form a more fusible slag than a single one, the charge will contain 25 gm. sodium carbonate and 50 gm. litharge. Borax, besides having a solvent power on silicates, acts in part as an acid flux; 1 gm. requires 0.5 gm. sodium carbonate or 1 gm. litharge; it is customary to add 5 to 10 gm. borax glass to 1 A. T. of ore. In order to obtain a lead button of about 20 gm., it is necessary to give additional litharge (about 25 gm.) and the necessary re-

[32] *California Journal of Technology,* through *Mining and Scientific Press,* March 5, 1904.

ducing agent (starch, flour, charcoal). In making up a charge, you determine the character of the rock; multiply the excess silica, given above, by 0.25 for the sodium carbonate, and by 0.50 for the litharge required; add 25 gm. litharge with necessary reducing agent for the lead button; finally, give 10 gm. borax glass, adding 2.5 gm. sodium carbonate and 5 gm. litharge.

A. B. Chittenden,[33] referring to a note under the heading 'Concentrates,'[34] which states that the adhesions of lead to the slags in an assay may be due to a lack of heat, of reducing agent, or of fluxes, also to the presence of arsenic and antimony, says that in treating an ore (containing much graphite) which gave similar troubles, he fluxed in the usual way, neglecting the presence of graphite, and gave only just enough litharge to form a button of the desired weight. He fused and added, when the charge appeared to be ready for pouring, from 5 to 25 gm. litharge, allowed only sufficient time for it to melt and to settle, and then poured. The button was bright, and was surrounded by clean litharge, on top of which floated the brittle slag. The results were from 5 to 30 oz. per ton higher than by other methods.

Lay[35] discusses the scorification and crucible assay-methods for determining silver in ores of the Slocan district, British Columbia. These are sulphides with about 150 oz. silver per ton, ranging from pure galena to complex sulphides of lead, zinc, iron, antimony and copper. The author finds that the losses by the scorification method are large (although his table does not show it) and therefore prefers crucible-fusions. Roasting of ores previous to fusion is excluded on account of unavoidable loss by volatilization, and of the time and labor required; desulphurization by iron is undesirable (probably on account of the formation of speiss and matte; there remains oxidation by litharge with or without the addition of niter.

In the subjoined table are given the results of crucible and scorification assays with four classes of ore. Using 0.1 A. T. ore, sufficient carbon is added to reduce from the large excess of litharge enough lead to form a button of from 20 to 25 gm. With 0.5 A. T. ore, niter is necessary to oxidize part of the metallic sulphide if the resulting lead button is to weigh 20 to 25 gm. and be free from sulphur. In either case silica must be added to the charge in order to hold and slag the iron as ferrous singulo-silicate and prevent its being changed to ferric oxide, which makes slags pasty. Enough sodium bicarbonate is given to form sulphate, arsenate and antimonate of soda. The rest of the charge is made up of 100 gm. litharge and 15 gm. borax, the whole receiving a cover of raw borax. The charged crucibles are placed in a furnace which is at a bright red; the temperature

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[33] *Mining and Scientific Press*, July 2, 1904.
[34] *Ibid.*, June 18, 1904.
[35] *Transactions* British Columbia Institute of Assayers, through *Mining Reporter*, Sept. 15, 1904.

is held until the borax cover has melted, and is then lowered to prevent boiling over. When bubbling ceases, the temperature is again raised and the charge poured at incipient whiteness. The time of a fusion is 40 minutes.

Composition.	Silver, oz. per ton.		
	Crucible Assay.		Scorification Assay.
	0.1 A. T. ore, Carbon added	0.5 A. T. ore, Niter added.	
Type A, concentrates, Pb. 18-25; Zn, 15-20; Fe, 16-20; S, 30; As, 2; SiO_2, 10%	.....	108.0	100.2
	.....	108.0	100.2
	.....	98.5	97.8
	.....	109.2	108.6
	.....	91.6	90.8
Type B, Concentrates, Pb, 30-35; Zn, 10-12; Fe, 18-18; S, 30; As, 2; SiO_2, 6-8%.	.....	115.4	115.4
	.....	129.5	129.2
	.....	136.0	135.2
	144.6	145.6	145.0
	125.7	125.8	125.6
	117.6	120.1	119.4
Type C, ore, Pb, 45-55; Zn, 8-10; Fe, 9; S, 22; SiO_2, 7%	.....	269.0	268.5
	.....	324.6	324.2
	272.5	274.9	274.5
	232.5	234.2	234.2
Type D, Galena with 80 + % Pb.	101.1	103.4	103.1
	.....	142.2	141.5
	.....	144.4	143.3

Silver Assay of Zinc Ores.—E. J. Hall and E. Popper[36] experimented upon crucible charges for the determination of gold and silver in zinc ores. After making some 200 fusions, they settled upon the following charge: Ore, 1/3 A. T.; sodium carbonate, 1 1/3 A. T.; litharge, 4/5 A. T.; borax glass, 1/2 A. T.; argol, in amounts varying with the reducing power of the ore. One-third assay-ton of ore was chosen because the fusions were made in 20-gm. crucibles and larger amounts caused the charge to boil over, the boiling being due largely to the action of the soda upon the crucible. The amount of soda chosen is four to five times the weight of the ore; litharge is added in sufficient quantity to give a suitable lead button; the weight of borax added must be sufficient to prevent the charge from being basic, and to slag parts of the charge not sufficiently acted upon by the soda; argol finally is to reduce a sufficiently large quantity of lead. With ores rich in pyrites, 15 + %, an addition of a couple of nails prevents the button from becoming brittle; ores with as much as 7.5% copper give satisfactory results

[36] *School of Mines Quarterly*, 1904, XXV, 355; *Mining and Scientific Press*, Sept. 24, 1904.

with the above charge. The following table gives the results from the ordinary scorification assay and from the new crucible charge:

Ore No.	Zinc, per cent.	Oz. Gold and Silver per ton.	
		Scorification Assay, Ore, 0.1 A. T.	Crucible Assay, Ore, 0.1-3 A. T.
1	2.5	48.00	48.20
2	5.0	10.00	10.41
3	6.0	9.70	9.78
4	8.0	42.50	42.54
5	9.5	165.00	168.48
6	11.5	125.80	129.40
7	11.5	38.00	37.95
8	17.5	17.10	17.16
9	27.5	135.80	139.35
10	29.7	85.00	87.66
11	35.6	105.70	106.56
12	44.0	71.10	73.83
13	47.6	44.80	47.28
14	52.0	40.10	41.34

Silver Assay of Coppery Materials.—S. H. Sherman and G. J. Wackenhut[37] compared the scorification (single and double), the crucible (niter and nail) and combination methods, by assaying six copper-bearing materials, as follows: Two ores, Cu, 13%; SiO_2, 42%; Fe, 17%; S, 17%; and Cu, 6%; SiO_2, 31%; Fe, 21%; S, 29%; Zn, 10%; two mattes with Cu 30 and 34%; and two samples of ingot copper with 99% Cu. They found that with ore and matte, both crucible methods gave good results for silver and gold; the niter charge was: Ore or matte, 0.25 A. T.; litharge, 60 gm.; sodium carbonate, 20 gm.; potassium carbonate, 16 gm.; silica, 15 gm.; and niter to furnish a 20-gm. lead button. The nail charge: Ore or matte, 0.25 A. T.; litharge, 25 gm.; sodium carbonate, 30 gm.; borax glass, 8 gm.; silica, 10 gm.; salt cover; 3 nails. Scorification gave, with ore and matte, higher results for gold and lower results for silver than the combination method. With metallic copper, the single scorification is inaccurate for silver, while double scorification with correction gives values that check closely with those by the combination method.

Assay of Cyanide Precipitates.—R. W. Lodge[38] publishes an extended series of tests on the assaying of zinc-box residues from cyanide plants by the scorification and the crucible methods, making at the same time confirmatory tests in the wet way. The figures obtained point to higher results with the scorification method when the necessary precautions are observed. For details, the reader must be referred to the original paper.

Wet Assay of Silver.—F. Altneder[39] publishes a preliminary note on an approximate estimation, in the wet way, of silver in ores that contain little or no iron or copper. The procedure is: Dissolve 0.5 A. T. ore (5 to 10 gm. with ores or furnace products containing over 200 oz. Ag per ton and much

[37] *Bulletin,* Colorado School of Mines, 1904, II, 123.
[38] *Transactions* American Institute Mining Engineers, 1904, XXXIV, 432, 964.
[39] *Mining and Scientific Press,* Nov. 26, 1904.

Cu) in 40 to 50 c.c. nitric acid, evaporate nearly to dryness, take up with hot water, filter, wash, dilute to 100 c.c., add 5 c.c. strong nitric acid, cool, add starch solution and titrate with potassium iodide (1.535 gm. K I in 1 liter) standardized against a silver nitrate solution, of the same volume and acidity as the ore solution, containing 0.02 to 0.05 gm. silver.

Standard Solutions.—The following table of P. H. Argall[40] offers a convenient help for making up the standard solutions in common use at lead and copper smelting plants:

Name of Solution.	Amount of Salt in Liter.		Approximate Standard. 1 c.c.=	Used for Determining
	Theoretical.	Practical.		
Potassium bichromate	4.381	4.4	0.005 Fe	Fe
Sodium hyposulphite	19.59	20.0	0.005 Cu	As, Cu, I, Sb.
Potassium permanganate	5.643	5.8	0.005 Ca	Mn, Ca O, Fe, Sb
Potassium ferrocyanide	......	22.5	0.005 Zn	Zn
Ammonium molybdate	......	4.28	0.005 Pb	Pb
Potassium cyanide	......	44.5	0.001 Cu	Cu
Oxalic acid	11.25	11.46	1 c.c. $KMnO_4$, of which 1 c.c. = 0.1 Fe	Mn
Potassium sulphocyanate	8.981	10.0	0.01 Ag	Ag, As
Barium chloride	76.25	76.25	0.01 S	S

The difference between theoretical and practical is due to impurities.

Determination of Alumina.—C. E. Rueger,[41] referring to the uneven results obtained by the members of the New York section of the Society of Chemical Industry in the determination of alumina in portland cement and slurry, and to the difference of 3.92% alumina in similar coöperative work on a copper blast-furnace slag, published by R. Smith,[42] proposes the following direct method, based upon the precipitation of aluminum hydroxide by sodium sulphite: Pass hydrogen sulphide through the filtrate from the silica, filter, wash, add nitric acid or potassium chlorate to the filtrate and boil. Precipitate iron and aluminum hydroxides with ammonia and ammonium chloride, filter, dissolve the precipitate with a minimum of hot dilute hydrochloric acid, dilute to lukewarmness, neutralize with sodium carbonate (ammonia has not proved as satisfactory) until solution turns a slight brown, but still remains clear. Stir in and dissolve 10 gm. sodium sulphite (Mallinckrodt's is preferred), when a permanent precipitate should form (if not, add more of the salt); dissolve the precipitate by the addition of hydrochloric acid until the solution just clears (1 or 2 drops in excess do no harm). The solution emits a slight odor of sulphurous acid.

[40] *Mining Reporter*, July 28, 1904.
[41] The Engineering and Mining Journal, March 3, 1904.
[42] The Mineral Industry, 1903, XII, 248.

Cover the beaker with watch-glass, heat rapidly to boiling when red color of ferric iron disappears and bubbles of sulphurous acid are given off (in the absence of H_2SO_3 add more HCl) and aluminum hydroxide falls out; boil until all the sulphurous acid has been driven off (usually 10 minutes is sufficient). Set beaker aside (covered) and let the precipitate settle. Filter (filtrate will turn brown from oxidation of iron), wash three times with hot water (the H_3AlO_3 retains a little H_3FeO_3, necessitating repetition of solution and precipitation), filter, dry, ignite and weigh as Al_2O_3. Ti and P vitiate the result; Zn, Mn, Ni and Co have no effect; Pb, As and Sb, which interfere, are removed by the H_2S treatment. The following table gives the results obtained; the plus errors are due to dust in the sodium sulphite used. With 1 gm. of material the data are seen to be correct within 0.03 per cent:

Taken, gms.		Found, gms	Error, gms.
Fe.	Al_2O_3.	Al_2O_3.	
0.420	0.0093	0.0104	+0.0011
0.300	0.0145	0.0151	+0.0006
0.300	0.0172	0.0173	+0.0001
0.300	0.0291	0.0306	+0.0015
0.300	0.0355	0.0371	+0.0016
0.300	0.0460	0.0460	—0.0000
0.300	0.0763	0.0741	—0.0022
0.300	0.0761	0.0759	—0.0002
0.300	0.0761	0.0770	—0.0009
0.300	0.1035	0.1015	—0.0020
0.300	0.1438	0.1432	—0.0006
0.300	0.1902	0.1876	—0.0026

Determination of Lime.—C. E. Rueger* calls attention to the inaccuracy of the usual method of determining lime in a smelter laboratory, which often reaches an error of 2 and even 3 per cent. The usual method is to separate iron and aluminum hydroxides from the silica filtrate by a single precipitation with ammonia and ammonium chloride, and to throw down the lime in the resulting filtrate with ammonium oxalate. The following comparative tests made on a Butte, Mont., blast-furnace slag (SiO_2, 45.64%; FeO, 20.60%; Fe_2O_3, 1.20%; Al_2O_3, 7.12%; CaO, 21.78%; Cu, 0.36%; As, 0.33%; Zn, 0.66%; MgO, 0.93%; S, 0.22% Na_2O and K_2O, 1.08%; H_2O, 0.24%; total, 99.86%) show that an ammonia, followed by a basic-acetate separation, gives accurate results.

Precipitation Method.	CaO per cent.	Error, per cent.
Single Ammonia	19.65	2.13
Double Ammonia	20.19	1.59
Double Ammonia	20.26	1.52
Single Basic-Acetate	20.89	0.89
Ammonia and Basic-Acetate	21.81	.....
Ammonia and Basic-Acetate	21.76	.....

* The Engineering and Mining Journal, April 28, 1904.

The subjoined data from a second slag, with 19.4% Fe and 5.4% Al_2O_3, show similar results:

Precipitation Method.	CaO, per cent.	Error, per cent.
Single Ammonia	18.68	2.17
Double Ammonia	19.32	1.53
Single Basic Acetate	20.01	0.84
Ammonia and Basic Acetate	20.87	.....
Ammonia and Basic Acetate	20.84	.....

Huntington-Heberlein and Bradford-Carmichael Processes.—D. Clark describes with a photographic illustration the Huntington-Heberlein[43] and the Bradford-Carmichael[44] processes as carried out in Australia. Anticipating next year's issue of THE MINERAL INDUSTRY, the paper by Borchers[45] on these processes will be included in this review. Both processes are in operation at several lead plants in Australia; the Huntington-Heberlein has found much favor in Europe, and according to an editorial[46], it is being installed at the works of the Peñoles Mining Company, Mapimi, Mexico. Both processes have been repeatedly referred to in these reviews.[47]

The Huntington-Heberlein process, it will be remembered, embodies two operations: (1) Heating slowly in a reverberatory furnace a mixture of galena and burnt lime, with free access of air, to a temperature of 700° C., and then cooling to 500° C., air still having free access, when a further oxidation takes place, some SO_2 being expelled and a considerable amount of heat evolved; (2) transferring the partially desulphurized hot mixture into a converter and blowing air through it, with the result that nearly all the sulphur is removed as SO_2 and the temperature raised sufficiently to agglomerate the charge. The chemistry of the process has not been fully studied. The reactions usually given are:

1. At 700° C. : $CaO + O = CaO_2$
2. At 500° C. : $4\,CaO_2 + PbS = PbSO_4 + CaO$, or

1 + 2. $4\,CaO + PbS + 4\,O = PbSO_4 + CaO$

3. $PbS + 3\,PbSO_4 = 4\,PbO + 4\,SO_2$

This explanation can not be accepted, as CaO_2 is formed only at a low temperature and splits again into CaO + O on gently warming; further, in preparing CaO_2 it is essential that all carbon dioxide and moisture be excluded; but both are present in the operations of roasting and blowing. Clark holds that at first the reaction

$$CaO + PbS = CaS + PbO$$

takes place; the calcium sulphide is then oxidized to calcium sulphate, which acts upon lead oxide:

$$CaSO_4 + PbO = CaPbO_3 + SO_2$$

[43] THE ENGINEERING AND MINING JOURNAL, Oct. 20, 1904.
[44] THE ENGINEERING AND MINING JOURNAL, Nov. 3, 1904.
[45] *Metallurgie*, 1905, II, 1.
[46] THE ENGINEERING AND MINING JOURNAL, Oct. 20, 1904.
[47] THE MINERAL INDUSTRY, VII, 452; VIII, 399; IX, 254.

forming calcium plumbate and sulphur dioxide. The calcium sulphate in addition has an oxidizing effect upon galena in the presence of oxygen:

$$CaSO_4 + PbS + O = CaPbO_3 + SO_2$$

He further states that ferrous oxide and manganous oxide will serve to a certain extent the same purpose as calcium oxide, and expresses his belief that the oxidation of blende in zinc-bearing galena is due to the action of zinc sulphate upon zinc sulphide:

$$ZnSO_4 + ZnS = 4\,ZnO + 4\,SO_2$$

Borchers found by laboratory experiment that by blowing air through a charge of calcium plumbate (formed by gently heating a mixture of slacked lime and litharge) and galena in a warmed converter, the process proceeded along lines similar to those of Huntington-Heberlein, and that the preliminary roasting of galena became superfluous.

The theory that calcium sulphate is the leading oxidizing agent is substantiated by the Bradford-Carmichael process, in which air is blown through a heated mixture of dehydrated gypsum and galena, when the same phenomena occur as in the Huntington-Heberlein process.

A third process of a similar character is that of A. Savelsberg,[48] which is in operation at Ramsbeck, near Aix-la-Chapelle, Germany. Savelsberg places on the grate of the converter a bed of crushed limestone to protect the iron, charges some glowing coal or coke, gives a thin layer of a moistened mixture of galena concentrate and limestone, and starts the blast. When the mixture has attained a red heat, it is followed by a second layer of moistened charge, and this is continued until the converter is filled, the blast being gradually increased. At a certain pressure desulphurization begins, and is followed closely by agglomeration. The operation is finished when sulphurous fumes cease to be expelled and the charge begins to harden. The converter is tilted, and the desulphurized and agglomerated charge dumped. The limestone at first acts as a diluent, keeping the temperature low; it thus prevents the galena from sintering and at the same time keeps the charge open. Heat is absorbed by the evaporation of the moisture and the decomposition of $CaCO_3$ into CaO and CO_2; the lime, however, is quickly converted into calcium sulphate, which, being again decomposed by silica, sets free sulphur trioxide with its powerful oxidizing influence. The gases issuing from the process contain 10 per cent by volume of SO_2 and are utilized in the manufacture of sulphuric acid.

It seems therefore practically settled, although not as yet analytically proved, that in these blowing processes the sulphur trioxide of the calcium sulphate is the leading oxidizing agent, and that the reactions

$$CaSO_4 + PbO = CaPbO_3 + SO_2$$

$$CaSO_4 + PbS + O = CaPbO_3 + SO_2$$

cause the elimination of the sulphur and the agglomeration of the charge.

The Huntington-Heberlein process is carried out at four plants in Aus-

[48] United States Patent No. 755,598, March 22, 1904.

tralia. At the works of the Tasmania Smelting Company, Zeehan, there are two mechanical reverberatory roasting-furnaces with hearths 15 ft. in diameter, several hand reverberatory roasters, and 12 converters. The latter are sheet-iron cones, 5.5 ft. in diam. and 5ft. deep, swung from trunnions. A perforated plate closes the converter near the apex, leaving a conical space below serving as air-chest. The charge, made up of galena, limestone and silica (the latter added, if not present in sufficient amount), is roasted, whereby the sulphur content is reduced to 10 per cent and the limestone changed into calcium sulphate. The hot, granular, roasted charge is dumped into a converter and blast with a pressure of 17 oz. turned on. In from 2 to 4 hours the blowing is finished, the sulphur having been reduced to 1 per cent.

The data given as to the work of the Sulphide Corporation plant at Cockle Creek, N. S. W., supplement those of the Tasmania company. The galena concentrate is crushed through a 1.5-mm. screen, furnishing material of which 60 per cent is very much finer than 1.5 mm.; the limiting sieve for the limestone is a 10- or a 16-mesh sieve; silica is added in sufficient amount to furnish a blown ore containing 20% silica. The mixture contains Pb, 20 to 25%, and CaO, 6 to 9%; a higher percentage of lime causes the blown ore to remain powdery. The charge is roasted in a Godfrey furnace, which is built on the well-known Brunton model: a circular hearth revolving in a horizontal plane; the ore fed at the center is turned over and moved toward the discharge at the periphery by stationary blades fixed to a radial arm. The roasted mixture may retain from 6.5 to 12.0 per cent sulphur, but the sulphur content usually varies between 6.5 and 8.0 per cent. It is important that the converter charge shall be well mixed, as otherwise the blast will form blow-holes. A converter is started by running in some hot ore to form a bed; this is followed by warm or cold ore-mixture. In blowing, a small air-pressure is used at the start; it is gradually raised, reaching 20 oz. at the end of an operation which lasts 5 hours.

The largest plant is that of the Proprietary Company at Port Pirie. There are 5 Ropp straight-line mechanical roasting furnaces, each of which treats in twenty-four hours 100 tons of ore-mixture consisting of galena (Pb, 55%; Zn, 10%), limestone, iron ore and sand; one-half of the sulphur is eliminated, while lime and lead are said to be converted into sulphates. The hot roasted ore is blown in 17 converters. They are of cast iron, 8 ft. diam. and 6 ft. deep, and hold an 8-ton charge. The wind-box is 2 ft. deep; its top consists of a perforated ring which carries a perforated truncated cone closed by a shallower cone having a few holes. The mouth of the converter has a groove into which fits the rim of a conical, suspended hood that can be raised and lowered by block and tackle. The gases are carried off through a pipe, 1 ft. 9 in. in diam., fitted with a telescopic sliding arrangement. The cast-iron converters last well, two only having been lost in 18 months. The blast pressure is 24 oz.; the time of conversion, 4 hours; the blown charge retains 3 per cent sulphur.

In the Bradford-Carmichael process, as carried out at Broken Hill, 1 part dehydrated gypsum is mixed with 3 parts slime- and 1 part sand-concentrate showing the following composition:

	Slime.	Concentrate.	Calcium Sulphate.	Average.
Galena	24	70	..	29
Blende	30	15	..	21
Pyrite	3	..	..	2
Ferric Oxide	4	..	..	2.5
Ferrous Oxide	1	..	..	1
Manganous Oxide	6.5	..	..	5
Alumina	5.5	..	..	3
Lime	3.5	..	41	10
Silica	23.	..	..	14
Sulphur Trioxide	..	..	59	12

The mixture, with a sulphur content varying from 13 to 17 per cent, is moistened, allowed to come to a set, broken to a size not exceeding 2 in., spread out and air-dried. There are three small converters, two of which are working while the third is being filled. The hot gases, with 10 per cent by volume of SO_2, are conducted over niter-pots and pass into a sulphuric acid chamber. In starting a converter, fuel is charged and ignited by a gentle blast. When the temperature has reached 400° to 500° C., the converter is filled with the air-dried mixture and the hood lowered. As the charge warms up, water vapor passes off, which is soon followed by dense fumes of SO_2 reaching 14 per cent by volume, but the air-supply is regulated so as to reduce it to 10 per cent. The sulphur content of a blown charge is from 3 to 4 per cent.

Roasting Furnaces.—S. S. Sorensen[49] publishes notes on roasting in the eight Klepetko-Evans-MacDougall furnaces of the Highland Boy smelter near Salt Lake City, Utah. The furnaces, of which drawings are given, are contained in a building 100 by 64 ft; they are placed in two rows of four, 21 ft. apart and 18 ft. from center to center. The raw ore contains about 35% sulphur. A screen-analysis, after crushing through a 1⅛-in. hole, gave the following data:

On 0.8 in. screen 4%		
On 0.6 in. screen 15.5%		
On 0.4 in. screen 13.0%		22.5%
On 0.2 in. screen .13.2%		
On 0.07 in. screen 0.07%		29.3%
On 20-mesh screen 7.3%		
On 40-mesh screen 13.7%		
On 80-mesh screen 13.1%		
Thro 80-mesh screen 1.41		48.2%

The roasted ore retains 6 to 9% sulphur. A screen-analysis showed that 16.6% was held on a 0.4-in. and 19.3% on a 0.07-in. screen, while 64.1% passed through the 0.07-in. screen. From 25 to 30 tons ore are contained at one time in a furnace; the ore passes through the furnace in 2.5 to 3 hours, and 35 to 40 tons are roasted in 24 hours. The cost of roasting in

[49] *Journal* Canadian Mining Institute, 1903, VI, 306.

1902 was 34c. per ton, including power, supplies, repairs, tramming ore and calcines, and a proportionate share of all indirect and general expenses, but not interest on capital nor cost of crushing (5c. per ton). The repairs in 1902 were exceptionally large, so that the average figure is lower than 34c. The actual operating expenses, excluding special items and general charges, are about 23c. per ton. Besides the ordinary wear and tear, the parts especially attacked at this plant are the arms between the plows, which are gradually eaten away, probably by sulphurous gases combining with the moisture condensed upon the water-cooled arms.

L. T. Wright[50] patented some constructive details of the shaft and stirring-arms in a furnace of the MacDougall type. A re-issue, No. 12,254, of the original patent[51] was granted the inventor Aug. 2, 1904. O. Hofmann[52] patented an improvement in the construction of the horizontal stirring-arm with the vertical revolving shaft of a MacDougall type of furnace. The patent of M. Corcoran[53] has a similar object in view. A. P. O'Brien[54] patented a roasting-furnace of the MacDougall type. A second furnace[55] has 6 superimposed muffles, of which the two lower ones are heated with gaseous fuel, the waste gases passing off through part of the casing.

A. R. Meyer patented[56] a muffle-furnace resembling that of O'Brien. F. Meyer[57] patented a muffle roasting-furnace consisting of three units combined into a block which is heated from a single fireplace; the sulphurous gases from these furnaces are collected in a single main flue. Each unit resembles the MacDougall muffle-furnace, having four superimposed muffles. The patent of 1903,[58] granted the inventor, covers a similar idea.

W. H. Smyth[59] patented two mechanical roasting-furnaces embodying the same mechanical stirring device. The first furnace has two superimposed hearths, the second two hearths placed side by side. In both cases, infringement of Brown's patent of the chamber protecting the mechanism from heat and gases is avoided by placing the furnace upon a steel frame, consisting of vertical columns and horizontal beams, and leaving the mechanism in the open. In the first furnace, the roof of the upper hearth and the floor of the lower hearth (similar to the Ropp furnace) have a slot through which the arms carrying the stirring carriages pass. These travel on rails, placed above the upper and underneath the lower hearths, and are moved along by an endless chain forming a vertical loop. In the second furnace, the two hearths have slots in the floors; the arms are moved by an endless chain forming a horizontal loop.

F. J. Falding[60] patented a multiple-hearth, oblong, mechanical roasting-

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[50] United States Patent No. 760,510, May 24, 1904.
[51] United States Patent, No. 629,023, July 18, 1899; MINERAL INDUSTRY, 1899, VIII., 401.
[52] United States Patent No. 768,748, Aug. 30, 1904.
[53] United States Patent No. 769,689, Sept. 13, 1904.
[54] United States Patent No. 775,147, Nov. 15, 1904.
[55] Circular American Coke and Gas Construction Company, New York City.
[56] United States Patent No. 750,877, Feb. 2, 1904.
[57] United States Patent No. 761,691, June 7, 1904.
[58] THE MINERAL INDUSTRY, 1903, XII, 259.
[59] United States Patent No. 761,049 and 761,050, May 24, 1904.
[60] United States Patent, No. 756,485, April 5, 1904.

furnace which is perhaps best outlined by saying that it combines the general features of the Merton[61] with the air-cooling of the MacDougall-Herreshoff furnace.[62] A Merton roasting-furnace built by the Union Iron Works, of San Francisco, Cal., has been erected in a chlorination plant at Hodson, Cal.[63] It is fired with oil, the amount consumed being less than 4 bbl. @ $1.25 f.o.b. works. F. D. Tower[64] describes with two perspective drawings the Edwards mechanical ore-roasting furnace, of which Chisholm, Matthew & Co., Colorado Springs, Col., are the agents in this country. The leading features have been discussed with two illustrations in these reviews.[65] The following additional facts are of value: There are three types of Edwards furnaces. Type No. 1 is the tilting furnace, in which the slope of the hearth can be changed so as to vary the rate of discharge of the ore. The furnace is 69 by 9 ft., outside dimensions, and the hearth proper 58 by 6 ft. 5 in. The furnace has 15 rabbles; the speed of the first 13 is 1 r. p. m., of the 14th, 2, and of the 15th, 4 r. p. m.; the object of giving the last two rabbles an increased speed is to stir the ore briskly before it is discharged. Less than 1 h. p. is required for the stirrers. Over 60 furnaces are in operation in Australia, most of them for dead-roasting gold ores previous to chlorinating or cyaniding; some of them roast copper ores. A furnace dead-roasts 7 to 9 tons heavy concentrate and 21 tons ore containing about 6 per cent sulphur.

Type No. 2 resembles in general appearance the familiar single-hearth straight-line mechanical roaster with external fireplaces, only it has the Edwards stirring mechanism. It is built from 9 to 14 ft. in width and up to 300 ft. in length. Type No. 3 is the same as type No. 2, excepting that the space underneath the hearth is left open and, being divided by a longitudinal wall, forms two flues of a dust-chamber. J. Roger[66] patented a mechanical ore-feeder which is intended to be used mainly in connection with the Edwards mechanical roaster. The ore, dumped into the hopper in the roof, is discharged at the lower end and spread on the hearth by a mechanical rabble which enters from the side and is actuated by the same mechanism that drives the stirring apparatus of the furnace. S. D. Craig, G. E. Kelly, W. Turner[67] patented a single-hearth straight-line mechanical roasting-furnace with external fireplaces. The hearth forms an inclined plane, while the roof is built in horizontal sections. The ore is fed at the lower end and discharged at the upper end of the furnace. It is moved over the hearth with a rake carried by a truck running on rails. When the rake has arrived at the upper end of the furnace, the cross-arm, carrying the stirring-blades, is tripped, the carriage descends to the starting points and resumes its ascending trip after the cross-arm has been again

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[61] The Mineral Industry, 1903, XII, 254.
[62] *Ibid.*, 1897, VI. 237.
[63] The Engineering and Mining Journal, Oct. 24, 1904, ill.
[64] *Ibid.*, Feb. 11, 1904.
[65] The Mineral Industry, 1903, XII, 257.
[66] United States Patent No. 770,701, Sept. 20, 1904.
[67] United States Patent No. 754,199, March 8, 1904.

turned 90°. C. C. Wilton[68] patented a roasting-furnace similar in outward appearance to the Howell-White furnace. Inside, however, it contains a cylindrical muffle through which the ore fed at the head is made to pass down slowly, while any lack of sulphur in the ore to furnish the necessary heat is made up by having carbonaceous fuel on a grate.

The furnace of Shellaberger[69] is similar.

Primitive Smelting Furnaces.—H. F. Collins[70] describes with illustrations several primitive Mexican lead blast-furnaces, reverberatory-smelting and cupelling furnaces. The smelting furnaces resemble very much the old examples found in the metallurgies of Karsten and Rivot; the cupelling furnace appears to be an indigenous product.

Smelting at Münsterbusch and Stollberg.—An editorial[71] gives a brief outline of the two zinc and the two lead smelting plants of the Zinc-Lead Company, 'Zu Stollberg und in Westphalen.' The larger of the two lead plants, the one at Münsterbusch, near Stollberg, treats sulphide and oxide lead ores, also foreign silver and gold ores. In 1903 it employed 256 men and produced 12,599 met. tons of soft lead, 384 tons hard lead, 27,619 kg. silver, 97 kg. gold and 109 tons litharge. The Savelsberg process referred to above is in successful operation. The smaller lead plant at Ramsbeck treats the ores from its own mines as well as from other sources. In 1903 it employed 80 men, produced 2,962 met. tons of soft lead, 145 tons hard lead, 4,317 kg. silver and 0.54 kg. gold. The Savelsberg process is in operation here also. In the zinc-desilverizing department the desilverized lead is freed from zinc in an apparatus patented by Haber-Savelsberg.[72]

Crystallized Blast-Furnace Slag.—W. Stahl[73] illustrates and describes a beautifully crystallized specimen of a blast-furnace slag obtained at the nickel-copper works of Hettstedt, Mansfeld district of Germany. The slag has the usual blackish color and glassy luster; its hardness is 6, its specific gravity 3.05 at 15° C.; the crystals are well-developed hexahedrons, the powder is slightly magnetic. The anaylsis shows: SiO_2, 35.80%; Al_2O_3, 9.34%; CaO, 24.50%; FeO, 21.50%; ZnO, 4.00%; MgO, 2.74%; Ni, 0.19%; Na_2O, 1.36%; K_2O, 0.85%; (Cu_2Ni) S, 0.43%; Pb, trace; As, trace; total, 100.71. The formula derived from the analysis—R_2O, 29 RO, 3 R_2O_3, 20 SiO_2—proves the slag to be a singulo-silicate.

Rôle of Alumina in Slag.—L. S. Austin,[74] commenting upon Peters' view of pyrite smelting, discusses the rôles that zinc oxide and alumina play in the constitution of slag. His theory is that these two oxides with slags up to 36 per cent silica act neither as bases nor as acids, but are simply dissolved by the molten slag and act as stiffening ingredients; and that zinc

[68] United States Patent No. 760,941, May 24, 1904.
[69] United States Patent No. 765,997 and 765,998, July 26, 1904.
[70] Institution of Mining and Metallurgy, 1902-03, XII, 407, 414.
[71] *Metallurgie*, 1904, 1, 115.
[72] German Patent No. 133,975, Feb. 1, 1901.
[73] *Berg- und Hüttenmännische Zeitung*, 1904, 273.
[74] The Engineering and Mining Journal, Aug. 18, 1904.

sulphide behaves in a similar manner. In the first of the two subjoined three-quarter slags—

	I.	II.
SiO_2	35.4	30.8
Fe (Mn) O	31.8	27.7
Ca (MgBa)	24.7	21.5
Al_2O_3, ZnO, ZnS, K_2O, Na_2O	8.1	20.0

—the amounts of alumina and zinc oxide are small in comparison with the active bases, while in the second they are large; the former will form an easy-flowing slag, the latter will not. With highly silicious slags the case is different, as, for example, with a slag of 65% SiO_2, if the alumina did not form a base, it would be difficult to conceive of the remaining bases as sufficient in amount to dissolve the alumina.

Furnace-Site.—An editorial[75] takes up the question of flat *vs.* hillside mill-sites, in order to start a new discussion of the subject. Some of the leading points of view to be considered are: Ease of getting materials to the mill, economical disposal of waste products, water-supply, convenience in getting general supplies and ease of supervision. Having found a site in which these conditions are most favorable, be it on flat or sloping ground, it seems advisable to select it and adapt it to the proposed mill.

Blast-Furnace Feeder.—W. H. Freeland[76] patented a mechanical charge-feeder for an oblong blast-furnace with closed throat. The cover closing the top of the furnace is made to travel to and fro with the movement of the traveling carriage, beneath which it has a slot for the passage of the charge. When a charge is to be fed, the carriage is moved over the furnace by some mechanical means and with it the furnace-cover is set in motion. When the carriage has arrived over the furnace to be fed, the charge is dropped, and the carriage returns to its original position, when the throat of the furnace is again closed.

Smelter Stack.—I. John[77] calls attention to the importance of strengthening the base of a smelter stack by heavy brickwork to counteract the weakening at the entrance of the dust-flue. He illustrates his point by tracings from photographs of collapsing stacks which had been prepared for demolishment.

Waste-Slag Cars.—N. V. Fitts, of the Colorado Iron Works, Denver, Col., describes with illustrations the Mitchell waste-slag pot,[78] which has a capacity of 25 cu. ft. It differs from other pots in that it has a worm-releasing attachment. While the bowl is being filled, the worm is held at one end by a pivoted connection and at the other by a retaining latch. When the pot is to be emptied, the worm is released and the bowl turned over slowly so that the slag will fall out, but the skull remain behind. The

[75] *Mining Reporter*, Oct. 13, 1904.
[76] United States Patent No. 768,596, Aug. 30, 1904.
[77] The Engineering and Mining Journal, Feb. 4, 1904.
[78] United States Patent No. 76,525, May 31, 1904.

worm is now disengaged when the empty bowl, top-heavy when full and bottom-heavy when empty, will right itself at once. When the skull is to be dumped, the worm is thrown out and the bowl tilted quickly by a bar. B. H. Bennetts and L. J. W. Jones[79] patented a car for waste slag, the receiver of which is scoop-shaped to enable the trammer to dump the slag a greater distance from the track than is possible with the pots in common use to-day. A similar idea was put in operation many years ago by J. E. Hartman in connection with the iron blast-furnace; the details and combinations are, of course, very different.

Flue-Dust.—W. J. Russell[80] found that particles of dust, when allowed to settle upon a slightly warmed plate, produced clear and definite figures. These depend upon the form of the plate; if square, a cross consisting of four rays is formed; if triangular, of three rays starting from the angles; if octagonal, of a star of eight rays. On a flat circular plate no deposit was formed; when this was made concave, it became coated uniformly; when convex, the deposit was small and star-shaped. The character of the dust (whether spores of a fungus, magnesia, ash-dust, fumes of ammonium chloride) and of the plate had no influence upon the form of the dust-deposit. Changes in temperature, however, caused changes in form. If the temperature, for example, of a square plate was below that of the dusty atmosphere (19° and 24° C.), it would be wholly covered with dust; as the temperature was raised, the dust-deposit would decrease, assuming more and more the form of a diagonal cross, which would be fully developed when the temperature of the plate was 12° C. higher than that of the dusty atmosphere. With a difference of 100° to 120° C., the same cross was formed, but the amount of dust deposited was less than at a lower temperature. In order to obtain regular figures, it was found necessary to keep uniform the temperatures of the dusty atmosphere and of the plate. J. Aitken,[81] discussing the paper, believed that the formation of the figures was due principally to convection currents set up by the hot plate, to gravitation, and to the repelling action of the hot plate. He gave experimental evidence for his explanations of the phenomena.

Dust Chambers.—In view of the fact that flues and dust chambers in metallurgical establishments are being more and more built of concrete instead of brickwork, the paper by H. W. Edwards[82] on concrete in mining and metallurgical engineering is very timely. This review is confined to the part dealing with flues and dust chambers, and to the valuable discussions of Havard and Messiter. Flues constructed of concrete with embedded expanded metal usually have the forms shown in Fig. 2 and 3; the former is, however, more common, as it is more stable. In the construction of dust chambers, the author advises to build into the walls a number of stout con-

[79] United States Patent, No. 758,812, May 3, 1904; *Transactions* American Institute Mining Engineers, Feb., 1905.
[80] *Philos. Trans.* Royal Society, 1903, 301, A., 185.
[81] *Op. cit.*, p. 551.
[82] *Transactions* American Institute Mining Engineers, XXXV, Feb., 1904.

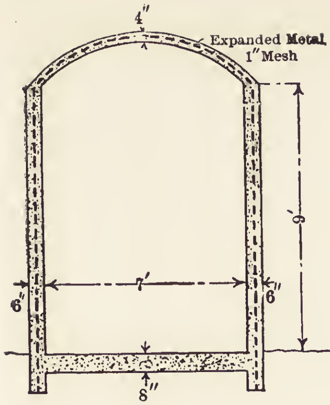


FIG. 2.

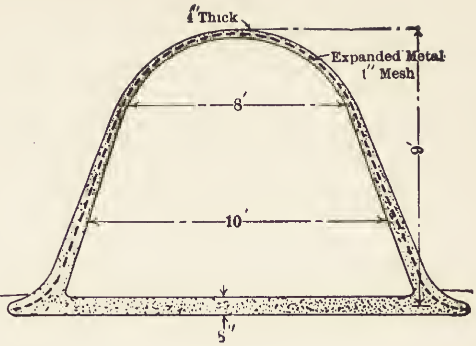
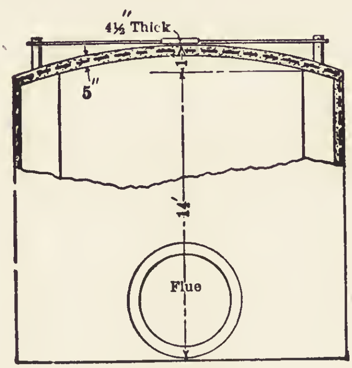


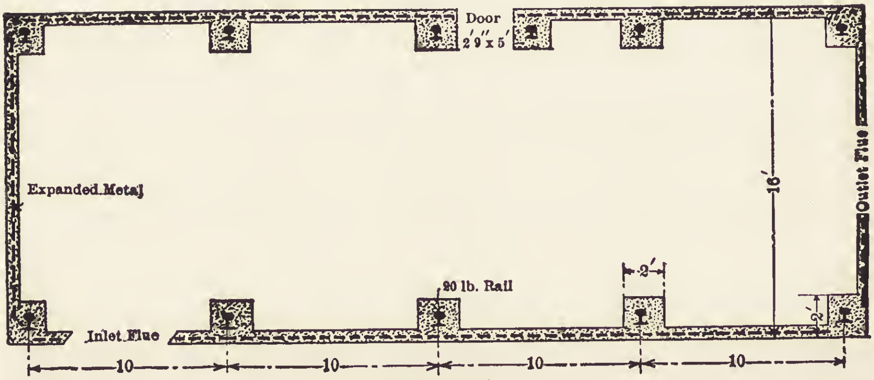
FIG. 3.

crete columns to prevent them from collapsing inwards or outwards, to which thin walls of embedded expanded metal show a tendency. The metal should be also embedded in the columns in order to prevent wall and columns from separating. Fig. 4 and 5 represent the dust chambers of the



End Elevation

FIG. 4.



Horizontal Section

FIG. 5.

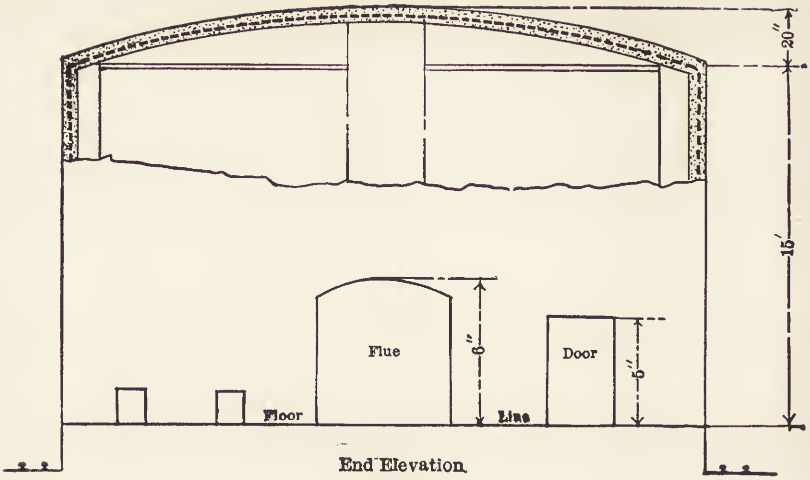


FIG. 6.

Don Guillermo smelting works, Palomares, Murcia, Spain; Fig. 6 and 7, those of the Murray smelter, Sudbury, Ontario; the columns are built hollow in order to economize in concrete.

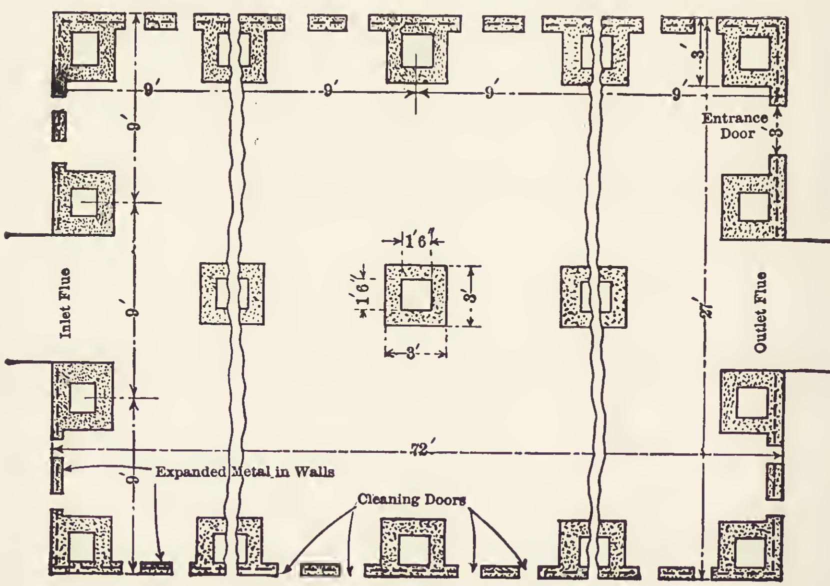


FIG. 7.

The author's experience that such flues are not attacked in any way by sulphurous and other gases is not entirely substantiated by that of other observers. The most unfavorable results with concrete flues are those by

Havard at the silver-lead smelting works of Anhalt, Germany.[83] The concrete, which was plastered inside and outside of the Monier wire-netting, consisted of 1 part cement to 7 parts of sand and jig-tailing; flues and smaller stacks were erected in this manner. For heavier structures, slabs were used, made of 1 part cement to 4 parts sand and tailing. A temperature above 100° C. caused this concrete to crack.[84] Flue-gases and moisture did not attack the concrete when this was protected on the outside by a roof and on the inside by an acid-proof paint consisting of water-glass and asbestos. When the concrete was left unprotected or was only coated with asphalt, it was corroded and cracked at the end of three years. The principal cause of corrosion appeared to be moisture which penetrated from the outside, forming, with the sulphur di- and tri-oxide, sulphurous and sulphuric acids. Soluble salts, especially zinc sulphate, penetrated into the floor, and, crystallizing in fissures, caused the concrete to crack and the floor to rise in places. Atmospheric air alone appeared to have no effect upon structures that were not exposed to heat, moisture, gases and chemicals. Edwards found that Monier flues 1.5 to 2.5 in. thick, built by plastering concrete upon a wire netting, were not durable when exposed to atmospheric moisture.

Messiter, referring to the bee-hive flues that he erected for the roasting-furnaces of the Arkansas Valley smelter, Leadville, Col.,[85] says that the walls, 2.25 in. thick in the smaller and 3.25 in. in the larger flues, built by plastering without the use of cribs, were satisfactory. Their labor-cost was $1 per sq. yd. of wall. In regard to corrosion by sulphurous and furnace gases, he found that there was no action as long as the temperature was sufficiently high to prevent condensation of moisture. Where the flue was sufficiently cool to allow water to percolate, it had to be painted on the outside with some impervious material. With long flues, moisture will condense on the inside during cold weather. This part of the flue must receive on the inside two or more coats of acid-proof paint. The first coat should contain no linseed oil, as the lime of the cement attacks the oil; ebonite varnish has proved satisfactory for this purpose, 1 gal. covering 100 sq. ft. of surface; for the other applications any durable metal-coating paint is sufficient. In order to reduce condensation, plastered flues have been built with a double set of laths, leaving an intervening air-space. In building thin plastered walls, it is essential to keep them from drying before the cement has completely set; to avoid this, they have to be sprinkled frequently with water.

M. J. Welch[86] discusses the constructive features of dust-chamber design, giving photographic reproductions of four forms of chambers while in the process of erection. Most old chambers have brick or stone side-walls, re-

[83] THE MINERAL INDUSTRY, 1893., II, 383.
[84] According to Edwards this may have been due to failure to provide for expansion and contraction in the construction.
[85] THE MINERAL INDUSTRY, 1900, IX, 455.
[86] THE ENGINEERING AND MINING JOURNAL, Sept. 1, 1904.

inforced by buckstays and tie-rods, with an arch roof. This type has been about abandoned because it is short-lived, expensive and difficult of repair. The materials of a modern chamber in most cases are skeleton steel, expanded metal and concrete. The first flue of this kind was that of the Arkansas Valley smelter at Leadville, Col.,[87] and it has given satisfactory service. The same plant enlarged its dust-chamber capacity for its 10 blast-furnaces and now has three types. The first, a chamber directly behind the blast-furnaces, has a cross-sectional area of 273 sq. ft. The back is formed by a sloping hillside paved with 2.5-in. brick; the front is built of ribbed cast-iron plates, expanded metal and concrete; the top is made up of 20-in. I-beams spanning 24 ft. with 15-in. cross beams and 3 in. of concrete. The construction is heavy because it serves as a foundation for the charging-floor. About 90 per cent of the flue-dust is collected in this chamber. It is removed through sliding doors into tram cars. To prevent dust from trickling out beneath the door, the bottom sill of the frame is horizontal for 1 in. outside the door-slide. The second type is a hopper-bottom flue, 274 sq. ft. in section, of very light construction. It begins 473 ft. from the furnaces, so that the amount of dust deposited here is small in comparison with that collected in the chamber. The hoppers are of concrete tamped in place around the frames made of 4-in. I-beams; their bottoms are closed by doors which slide in cast-iron frames with openings 12 by 16 in., the frames being placed on 5-ft. centers. The side-walls and roof are of 1-in. angles, expanded metal and 2.5-in. concrete. Pilaster-ribs of 2-in. angles, latticed and plastered, and placed every 10 ft., form the wind-bracing and the arch-roof support. The third type has the form of a parabolic arch and goes by the name of bee-hive construction. It has a sectional area of 253 sq. ft. The frame is made of 2-in. channels placed 16 in. apart and tied with 1 by ⅛-in. steel strips; to the inside is wired No. 27 gauge, expanded-metal lath, and the whole is plastered with 3-in. concrete. The inside coat consists of 1 part cement to 3 of sand, with 5 per cent lime; the filling between the ribs is 1 to 4, and the outside 1 to 3. Experience with the flues has shown that, whenever the temperature sinks sufficiently to allow sulphurous gases to condense, the concrete will be corroded unless it is protected by an acid-proof coating. Unprotected concrete will not be attacked by lead blast-furnace fumes within 6 to 8 ft. of the furnaces; with copper blast-furnaces having a hot top and with roasting-furnaces, the distance varies from 200 to 300 ft. The author gives the following outline of the materials to be used in the erection of a dust chamber: "Concrete foundation; tile drainage; 9-in. brick walls laid in adobe mortar, painted on the inside with lime mortar; occasional strips of expanded metal flooring laid in joints; the necessary pilasters to take care of the size of cross-section adopted; the top covered with unpainted corrugated iron, over which is tamped a concrete roof nearly flat; concrete to contain corrugated bars in accordance with light

[87] THE MINERAL INDUSTRY, 1900, IX, 455, ill.

floor-construction, the corrugated iron to have two coats of graphite paint on under side.'' It may be noted that the author has replaced expanded metal and concrete by 9-in. brick laid in adobe, thus doing away with thin walls, and has added a corrugated iron roof which is protected by a double coat of graphite paint.

Seemann[88] publishes a paper on devices for collecting dust in lignite-briquetting plants. His numerous sketches show many features which appear to be well adapted for settling dust from roasting and smelting furnaces.

A. Lotz[89] patented a means for observing dust-laden air-currents. It consists in placing, in a flue or pipe through which gases travel, a partition, and over it a transparent hood. The gases are forced to travel over the partition and can be observed through the hood. W. A. and J. Ridell[90] patented a device for the wet condensation of the solid matter in blast-furnace gases. It consists of a V-shaped water-tank with water-sealed inlets and outlets and gas-chamber. The gas-inlet pipe, entering the chamber close to the surface of the water, has an opening on its lower side only in order that the laden gases may be forced into contact with the water. The settled dust is to be discharged automatically from the bottom in a manner similar to that employed commonly with spitzkasten.

Briquetting.—A. Weiskopf[91] publishes a general paper on the briquetting of iron ores in which the different methods of working without bond and with organic and inorganic bonds are briefly reviewed. His conclusion is that no bond has yet been found which is effective, cheap and harmless.

J. C. Bennett[92] gives an illustrated description of the briquetting plant[93] at the works of the Selby Smelting & Lead Company, San Francisco, Cal. The machinery consists of a 7-ft. Chile mill, a Boyd 4-mould brick-press, a conveyor-elevator, and a 50-h. p. induction motor. The plant treats about 75 tons in 12 hours. The mixed charge for the Chile mill is made up by shoveling the constituents from a row of 7 bins (built of sheet steel to permit dumping of roasted ore while hot) into one of two hopper-shaped buckets of 7 cu. ft. capacity suspended from an overhead trolley, the lime bond being added last. From the mill the stiff mud is discharged at intervals into the boot of an elevator delivering to the hopper of the press.

H. F. Collins,[94] in a paper on concentrating and smelting of low-grade gold-copper ores at Santa Fé, New Mexico, discusses the bricking of middlings, which has points of interest. Into the middlings, of varying degrees of fineness, 10% of freshly slacked lime and 1 to 2% wood-ashes are incorporated by a mechanical mixer; the bricks are pressed in a hand-lever machine, transferred to 4-wheel drying trucks, 10 by 16 ft., and run to the

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[88] *Freiberger Jahrbuch*, 1904, A, 137.
[89] United States Patent No. 769,618, Sept. 6, 1904.
[90] United States Patent No. 755,244, March 22, 1904.
[91] *Stahl und Eisen*, 1904, 275.
[92] THE ENGINEERING AND MINING JOURNAL, Sept. 15, 1904.
[93] Hofman, 'Lead,' 1899, pp. 400 and 402.
[94] Institution of Mining and Metallurgy, 1902-03 XII, 58.

drying yard, part of which is covered with a shed, so that the loaded trucks may be protected from occasional rains; during clear weather they remain out in the open. The hand-press turns out 600 to 900 bricks in 24 hours; the bricks remain on the trucks 3 to 4 days, are then stacked in the yard 8 or 10 high to dry for a week, and lastly removed to the stock-pile on the feed-floor in heaps 30 or 40 bricks high. The breakage in handling amounts to about 10 per cent. The total cost of bricking is $1.50 per ton of bricks. G. R. Johnson[95] fuses flue-dust and salt at 1,800 to 2,000° F., and later breaks up the mixture by passing it through a revolving cylinder.

Harmful Effect of Furnace Gases and Fumes.—J. A. Widsoe,[96] of the Utah State Agricultural College, has investigated, during the past 18 months, the effect of smelter gases upon vegetation in six experiment stations between the Utah Consolidated and the American Smelting & Refining Company's plants near Salt Lake City. These smelting works treat daily about 5,000 tons of ore containing 30 per cent sulphur, which passes off into the air. He finds that sulphurous gases damage the vegetation and poison the water, but states, curiously, that animals fed from hay in the smoke-belt are not harmed and that the soil is not injured by the smoke. This is contrary to results obtained from other researches along this line.

Lead Poisoning.—E. Töth[97] discusses the poisonous effects of lead at the smelting works of Selmeczbánya, Hungary, and the means adopted to reduce them. The latter are of more local than general interest. They appear, however, to have been very effective, as with 204 workmen in 1885 there were 103 cases of lead-poisoning in some form, while in 1902, with 359 men, the number of cases diminished to 13, showing a reduction from 46.5 to 13 per cent.

R. Hoffmann[98] describes the ways in which operations have been changed at the Saxon silver-lead smelting works near Freiberg, so as to protect workmen from the evil effects of poisonous gases, vapors and dust particles.

Guillemain,[99] of Mechernich, Prussia, discusses the harmful effects of lead upon the human body and their preventatives, with special reference to 'akremine soap,' which is designed to convert lead compounds into lead sulphide, the latter, according to researches by F. Blum,[100] being less harmful than other lead salts. The author throws a doubt upon the deductions of Blum, which, he states, are based upon insufficient data, and thus discredits the value of this sulphurizing soap. The soap at first readily gives off hydrogen sulphide, but it loses this power in from 5 to 8 days, when exposed to the air, becoming relatively ineffective. Even while the soap is active as a sulphurizer it will be necessary to remove the lead sulphide when formed. The author therefore prefers to insist on plain scrubbing.

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[95] United States Patent No. 751,399, Feb. 2, 1904.
[96] *Mining Reporter*, Sept. 15, 1904; THE ENGINEERING AND MINING JOURNAL, Sept. 29, 1904.
[97] *Berg- und Hüttenmännische Zeitung*, 1904, 260.
[98] *Freiberger Jahrbuch*, 1904, A, 106.
[99] *Metallurgie*, 1904, I, 485.
[100] *Wiener Medicinische Wochenschrift*, 1904, 538.

T. Umbach[101] starts out with the doubtful proposition that lead sulphide is absolutely harmless to man and strongly recommends the use of the above soap.

Treatment of Zinc-Gold Slimes from Cyanide Plants.—G. H. Clevenger[102] carried on an extended investigation upon the refining of the precipitates obtained by zinc in the cyanide process. In this article only the parts relating to smelting with lead and recovery of zinc by distillation will be reviewed. Taverner's method—smelting direct with litharge and fluxes in a small reverberatory furnace and cupelling the resulting rich lead bullion—was discussed last year.[103] Merrill's method, developed at the Homestake works at Lead City, S. D., differs from it in some respects. The precipitate is treated with dilute hydrochloric acid, then with sulphuric acid, washed, dried, mixed with litharge, borax, silica and coke, sprinkled with lead acetate and briquetted under a pressure of from 2 to 3 tons per sq. in. The briquettes are melted on the hearth of an English cupelling furnace, the slag is drawn and the lead cupelled in the same furnace. The bars are .975 to .985 fine. Cupel-bottoms and slags are passed through a blast-furnace, the resulting lead is cupelled, and the litharge goes into the next charge of precipitate. The blast-furnace slag carries less value than $5 per ton, the total loss in refining is less than 0.1% and the total cost less than 0.75% of the value of the precipitate.

Clevenger carried out four experiments with distilling, in a graphite retort, a precipitate containing Au, 16.639%; Ag, 23.166%; Zn, 14.510%; ZnO, 10.060%. In experiment No. 1, the charge—300 gm. precipitate, 500 gm. test lead and 50 gm. charcoal—was heated for 6 hours; 85 per cent of the zinc was recovered and was found to contain 7.2 oz. Ag and 0.8 oz. Au per ton. In No. 2, the charge—400 gm. precipitate, 1,200 gm. lead and 100 gm. charcoal—gave off the first zinc at 671° C. after one hour's heating and the last at 1,414° C. after 5.5 hours. In No. 3, the proportions were: precipitate, 200 gm.; lead, 200 gm.; charcoal, 50 gm.; the first zinc appeared again at 671° C.; after 5 hours the temperature had risen to 1,281° C. and 99.1% of the zinc had been expelled. In test No. 4, which lasted 5 hours, lead was omitted, and 150 gm. precipitate, mixed with 40 gm. charcoal, formed the charge. The first zinc appeared at 750° C.; at 1,296° C., 99.6% of the zinc had been expelled; the residue was sandy. The experiments show that a charge must contain a considerable amount of carbon to reduce zinc oxide and insure an atmosphere of carbon monoxide; that the temperature is best raised quickly to the proper heat and then maintained there; that 90% of the zinc is expelled in the first 2.5 hours at a temperature of about 1,200° C.; that the remaining 10% requires a temperature of about 1,300° C., and that the loss in gold and silver is not excessive, especially as the blue powder can be used for precipitating gold. The author proposes the following

[101] *Electro-chemist and Metallurgist*, 1904, IV, 129.
[102] *Transactions* American Institute Mining Engineers, 1904, 34, 891.
[103] The Mineral Industry, 1903, XII, 25.

method of treatment: Drying of precipitate, mixing with lead and charcoal, retorting (any quicksilver present to be recovered at the beginning), condensing the zinc as powder (suitable for precipitating gold), smelting the residue in a cupelling furnace with the addition of fluxes, cupelling the rich lead bullion, and utilizing the litharge for subsequent charges.

F. L. Piddington[104] discusses in a general way the smelting of cyanide precipitates and other rich materials on a bath of lead in a water-cooled cupelling furnace. The cavity of the test should, of course, be deeper when smelting is carried on than when cupelling. The author gives the following mixtures as having formed a satisfactory hearth-material:

Material.	Values.			
Limestone	1	4	8	4
Cement	2	1	1	1
Fire Clay	1	1	1	1
Magnesite	.	4	.	2

Desilverization of Base Bullion (Parkes Process).—K. Friedrich[105] investigated the volatility of gold alloyed with zinc when subjected to different temperatures. He found that up to 1,500° C. the zinc fumes carried away very little gold, and that the losses at the temperature of the electric arc (3,000° + C.) are due to particles carried away by the violently boiling zinc. He concludes that any losses in heating finely divided gold-zinc alloys are due to mechanical causes and not to volatilization. In this connection the preceding review of Clevenger's work is of much interest.

Moulding Lead.—C. Vellino[106] patented a metal-pump for casting, from a kettle, lead plates for secondary electric batteries.

Electrolysis of Lead Chloride.—A. Appelberg[107] publishes the results of an extended investigation into the electrolysis of molten lead chloride.

[104] *Journal* Chemical, Metallurgical and Mining Society of South Africa, 1903, IV, 232, 389.
[105] *Zeitschrift für Angewandte Chemie*, 1903, 269.
[106] United States Patent No. 777,870, Dec. 20, 1904.
[107] *Zeitschrift für Anorganische Chemie*, 1903, XXXVI, 36-37; *Electro-chemist and Metallurgist*, 1903-04, III, 605.

MAGNESITE.

The production of magnesite in the United States in 1904 was 2,850 short tons, valued at $9,298, as compared with 3,744 tons ($10,595) in the preceding year. The output comes from near Porterville, Tulare county, Cal., although other deposits in Napa, Placer, Fresno and Kern counties have been worked or are now being opened. On Red mountain, Santa Clara county, the large deposits of magnesite are being developed by the American Magnesite Co., which, through its three subsidiary companies, has also embarked on the manufacture of carbonic acid gas, refractory brick and building material, at Oakland. The magnesite resources of California are extensive, and the annual production could readily be multiplied several times if a near-by market could be found for it.

Imports supply much the larger part of consumption of magnesite in the United States, as the following table indicates:

PRODUCTION AND IMPORTS OF MAGNESITE IN THE UNITED STATES.
(In short tons).

Year.	Production (a).		Imports.		Consumption.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
1900	2,252	$19,333	28,821	$216,158(e)	31,073	$235,491
1901	4,726	43,057	33,461	250,958(e)	38,187	294,015
1902	2,830	20,655	49,786	373,928	52,616	394,583
1903	1,361	20,515	54,776	461,399	56,137	481,914
1904	2,850	9,298	38,704	286,828	41,554	296,126

(a) Reported by the State Mining Bureau of California. (e) Estimated.

Market.—The whole domestic production of magnesite is consumed on the Pacific coast, being debarred from competition in the Eastern market with the material imported at Atlantic ports by freight rates ranging from $12 to $15 per ton. The only shipments to points outside the State are made to paper mills in Oregon. Imports comprise both raw and calcined magnesite, each admitted free of duty; calcined magnesite, pulverized into a cement, pays a duty of 20% *ad valorem.* Magnesite brick, according to a recent decision, are dutiable at $1.25 per ton as 'firebrick,' and not at 25% *ad valorem* as 'brick other than firebrick,' which the Treasury contended to include all brick not made of fireclay.

Austria and Greece afford the supply of imported magnesite, Austria exporting only calcined, and Greece mainly raw magnesite. Freights from Greece to the United States have fallen as low as $1.50 per ton, the rock being shipped as ballast. In the New York market, during 1904, the price of Greek crude rose from $5@$5.50 to $6.50@$7 per long ton, while calcined advanced from $15.50 to $16.50@$17 per short ton. Magnesite brick were quoted through the year at $160@$200 per thousand, according to size and shape.

Uses.—Magnesite is the material most commonly used for the generation of carbon dioxide, which gas is employed extensively in the preparation of artificial mineral waters. The gas is obtained either by calcination or by treatment with sulphuric acid. In the former case, the burned residue finds employment as a refractory, or it may be converted into magnesium sulphite by the paper manufacturers. In the latter case, magnesium sulphate, 'Glauber's salt,' is recovered as a by-product. The San Francisco gas-makers use about 1,000 tons of crude magnesite every year. To calcine one ton of magnesite, 500 lb. of best English coke is used; about 500 lb. of carbon dioxide is recovered, which is then liquefied and shipped in steel cylinders holding 25 lb. of liquid dioxide at a pressure of 850 lb. per square inch. Paper manufacturers then treat the residue with sulphurous acid fumes, and use the resulting sulphite as a digester of wood pulp. After it has served this purpose, a little lime is added to it to make 'pearl hardening,' used as a filler for the paper.

As a refractory lining for basic open-hearth furnaces, or for cement kilns, magnesite, either molded as a concrete or pressed into brick, possesses advantages over chromite, dolomite or silica. In the United States magnesite is used almost exclusively, while in England dolomite is still employed.

Magnesite is commonly calcined in ordinary kilns. Those of the Anglo-Greek Magnesite Co., on the island of Eubœa, were originally roughly built kilns fired with wood, but now modern shaft calciners are employed, fired with lignite coal. The temperature, however, is not sufficient thoroughly to shrink the magnesium carbonate, and it is even doubtful whether rotary kilns would do it satisfactorily.

E. Kilburn Scott[1] has made some experiments at Meraker, Norway, with a view to shrinking magnesite thoroughly in an electric furnace. The furnaces were of the Siemens and Halske type, built for the manufacture of calcium carbide on the intermittent system, and they were supplied with current from 900-kw. three-phase generators, driven by water turbines. The material on which he worked was crude magnesite, from Salem, in southern India, which is found in a remarkably pure state.

It was found possible simply to pass the magnesite down the chutes in the same way as the raw materials for making calcium carbide. When once the arc was fairly started the raw magnesite could be fed in at a rapid rate and completely shrunk, that is to say, all the CO_2 driven off, without the assistance of any carbon or other material. After a two hours' run with 3,500 amperes at 65 volts, a block about 15 in. square was obtained which

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[1] Contribution to the Faraday Society. Abstracted in *Electrochemical and Metallurgical Industry*, III, 4, p. 140.

was practically pure crystallized magnesite. When broken into pieces, the material showed a fine crystalline structure with a beautiful iridescent color, and it had evidently been in a semi-plastic condition. Attempts were made to mold the half-shrunk material into bricks and then treat these in the electric furnace, but with poor success.

This electrically shrunk magnesite has been tested as a wash over the firebrick lining of a calcium carbide furnace, and it was found that the bricks lasted for 200 hours without repair, whereas unprotected bricks required repair after a five hours' heat. There is no doubt that the crystallized material, without further preparation than being crushed to suitable dimensions, will prove of special value as a refractory material in metallurgical practice, and an important point in connection with its use as linings for electric furnaces is that magnesia, unlike lime, does not form a carbide with carbon.

Magnesite in Foreign Countries.

Austria.[2]—The only company operating magnesite mines in the Vienna district is the Veitscher Magnesitwerke Actiengesellschaft, which has its head office in Vienna. The works and the mines of the company are at Veitsch, about five miles from the Mittersdorf-Mürzthal railway station in the Province of Styria. This is stated to be the principal company in the world operating magnesite mines. The production of magnesite by this company in the year ended June 30, 1902, was 59,450 tons, and 71,016 tons in the year 1903. The average price of crude magnesite per ton at the mine is approximately $3.20, and for calcined magnesite $8. This company's exports of calcined magnesite to the United States during the years ended June 30, 1901 and 1902, were 30,000 and 35,000 tons, respectively. Only calcined magnesite is exported.

Greece.[3]—There are but two companies now operating magnesite mines in this country, the Anglo-Greek Magnesite Co. (Limited), of London, and the Society of Public Works, Athens. The first named operates the magnesite quarries of the Monastery Galataki, on the isle of Eubœa, about 10 miles from the port of Limni, where the magnesite is loaded upon vessels. The output of the quarries of Galataki during 1902 and 1903 was as follows, in tons:

Year.	Raw Magnesite.		Calcined Magnesite.		Dead burnt Magnesite.
	Output.	Exported to the United States.	Output.	Exported to the United States.	
1902	14,600	6,647	3,500	578	....
1903	26,300	3,200	3,550	125	1,200

[2] United States Department of Commerce and Labor. Daily Consular Report, No. 2276, June 6, 1905.
[3] *Ibid.*

The Society of Public Works of Athens is working the underground magnesite mines of Mantudi and Limni, on the island of Eubœa; the company invoiced shipments to the United States amounting to 7,390 tons of magnesite and 98 tons of firebrick in 1902, and 2,335 tons of magnesite in 1903.

Besides these two companies, B. Boudouris, ex-Minister of Marine, Athens, owns a magnesite deposit on Eubœa, which he does not operate.

Competition between the two companies named has reduced the prices of Greek magnesite, and at present they are $3.09 for raw and $12.55 for calcined magnesite per ton f. o. b. steamer in Greece. In 1899 the price of raw magnesite f. o. b. was $4.44. The freights from Greece per ton are as follows: To England and other European countries, about $2.70; to the United States, $2.90. In 1899 they were $3.28 to $3.96 to England, and $4.44 to America. England, Germany, Holland, and France are the leading purchasers of Greek magnesite.

Exporters of Greek magnesite have to pay harbor dues and 10% annually on the net profit obtained from magnesite exported.

Hungary.[4]—According to the firm of Alexander & Liebermann, forwarding agents and lessees of magnesite mines, the production of magnesite in Hungary in 1903 was only about 7,000 tons, while the productive capacity was 27,000 tons, as follows: Hungarian Magnesite Industry Co. (Ltd.) (formerly Paul Mansfeld), 15,000 tons; Alexander & Liebermann, 5,000 tons; Freund (formerly United Gömör County Co.), 4,000 tons; Friedmann, Grünfeld & Co., 3,000 tons.

The following is a list of magnesite mine owners in Hungary:

Budapest.—Alexander Liebermann; Magnesite Co. (Ltd.); Rimamurány Lalgótarján Iron Works; Hungarian Magnesite Products Manufacturing Co. (Ltd.).

Hacsava.—Magnesite Industry Co. (Ltd.).

Jolsva.—Aaron Friedman; Alexander Roth.

Kassu.—People of the city of Kassu.

Nyustya.—United Gömör Magnesite Co. (Ltd.).

Rathkó.—Martin Grünfeld; Dr. John Davis.

Szirk.—Hungarian Magnesite Manufacturing Co. (Ltd.).

The average price per ton of crude and calcined magnesite at the mines, which are in Gömör county, with few exceptions, varies according to the situation of the mine with respect to the railroad, the manipulation of the material contracted for, and the fee or per cent of the selling price demanded by the town controlling the mine. At Jolsva, for instance, the Hungarian Magnesite Industry Co. (Ltd.) pays 24.36c. to the town and charges 36.54c. per ton for its work in mining the ore—total, 60.90c. per ton. To this must be added 40.6c. for transportation from the mine to the company's works. From 3½ tons of ore one ton of calcined magnesite is

[4] *Ibid.*

prepared, which costs, delivered at the Jolsva railway station, $6.43. The value of Hungarian magnesite is $5.25 to $6.50 per ton f. o. b. cars.

South Africa.—In the neighborhood of Malelane and Kaapmuiden, 100 miles from Lourenço Marquez, close to the railway line, large deposits of magnesite that is said to equal the best Grecian magnesite have been found, and a company—Magnesite Mines of South Africa, with a capital of £200,-000—has been formed to work and develop them. The magnesite deposits are on the range of hills to the south of the railway line and the Crocodile river, the height of the hills above the railroad being 300 ft. From the top of the hills there is a gentle slope toward both the railway and the river, which will greatly facilitate the mining work and transport.

The veins of magnesite are of varied width, in many places being more than 100 ft. thick, but the central hill near what is known as Salt creek appears to be a vast deposit about 2,000 ft. long by 200 ft. wide, and upward of 300 ft. high. According to the estimate made by the consulting engineer, the deposits of magnesite at this particular point exceed a million tons. The topographical position of the magnesite hills is such that the deposits can be quarried at a very low cost.

Shipments to the United States should be made at low cost, since many vessels that now have to make the trip empty could benefit by a ballast load of magnesite.

MANGANESE.

The production of manganese ores in the United States for the past five years is shown in the subjoined table. No account is taken of the manganiferous silver ores mined in Colorado and used as a flux by the silver-lead smelters; the statistics of consumption include only those ores that enter into the production of ferromanganese and spiegeleisen. In 1904, there were 57,076 long tons of ferromanganese and 4,623 tons of spiegeleisen made in the United States; in 1903, the output was 35,961 tons and 156,700 tons respectively.

PRODUCTION OF MANGANESE ORES IN THE UNITED STATES. (a)
(In long tons).

Yr.	Manganese Ores.				Manganiferous Iron Ores.				Man. Zinc Ores. (b)	Total Production.	
	California.	Georgia.	Virginia.	Other States	Arkansas.	Colorado.	Lake Superior.	Virginia & N. Car.	New Jersey.	Long Tons.	Value.
1900.	131	3,447	7,881	312	Nil.	43,393	75,360	Nil.	87,110	217,546	$1,172,447
1901.	610	4,074	4,275	3,036	Nil.	62,385	512,084	20	52,311	638,795	1,644,117
1902.	846	3,500	3,041	90	Nil.	13,275	884,939	3,000	65,246	973,937	2,145,783
1903.	16	500	1,801	508	Nil.	14,856	566,835	2,802	73,264	660,582	1,670,349
1904.	60	Nil.	3,054	32	600	17,074	365,572	Nil.	68,189	454,581	789,132

(a) Reported by the Geological Survey. (b) Residuum from zinc oxide manufacture.

CONSUMPTION OF MANGANESE ORE IN THE UNITED STATES.

Year.	Imports.		Consumption.		Production of Man. Silver Ores (b).	
	Long Tons.	Value.	Long Tons.	Value.	Long Tons.	Value.
1900	256,252	$2,042,361	473,798	$3,214,808	188,509	$897,068
1901	165,722	1,486,573	804,568	3,130,690	228,187	865,959
1902	235,576	1,931,282	1,209,513	4,077,065	174,132	908,098
1903	146,056	1,278,108	806,638	2,948,457	179,205	649,727
1904	108,459	901,592	563,040	1,690,724	105,278	348,132

(b) Mined in Colorado and used as flux in silver-lead smelting. Not included in the statistics of consumption.

Manganese ore proper—that is, containing 50% or over of manganese—was mined during 1904 only in California, Utah and Virginia, the last State contributing 97% of the total. Iron ores carrying manganese up to 30% are mined in Colorado, Michigan and Wisconsin, Arkansas, and some Southern States. They are used for pig iron and low-grade spiegeleisen. A manganiferous zinc ore is obtained by the New Jersey Zinc Co. as a by-product in the treatment of its franklinite ore for the manufacture of zinc oxide. It is used in the preparation of spiegeleisen. Reducing the domestic production of all grades to the basis of 50% ore, foreign ores are found to supply more than half the manganese consumed in this country, and until recently to have supplied more than three-quarters.

Imports.—Manganese is imported either in the artificial form of ferromanganese (80% Mn) or spiegeleisen (20% Mn) or in ore, for subsequent smelting here. The relative proportions of the imports depend upon the foreign prices of the artificial material, since it may at times be cheaper to import the alloys than to smelt the ores here. Manganese oxide and ore, containing not less than 50% of manganese and not over 10% of iron, enters free of duty; ferromanganese and spiegeleisen each pay a duty of $4 per ton; manganese salts are dutiable at 25% *ad valorem.*

The sources of United States imports of manganese ore are indicated by the following table:

UNITED STATES IMPORTS OF MANGANESE ORE.
(In long tons.)

Country.	1901.		1902.		1903.		1904.	
	Quan.	Value.	Quan.	Value.	Quan.	Value.	Quan.	Value.
Brazil	48,029	460,024	102,550	$1,006,969	79,910	738,885	66,875	$589,089
Other South America	17,394	139,164	700	3,385	3,451	25,555	Nil.	......
Cuba	21,627	307,084	36,294	285,571	17,721	111,670	16,239	80,974
Canada	497	4,779	199	3,131	38	1,698	118	3,887
Germany	4,184	76,827	2,155	68,241	2,837	77,985	1,031	33,365
Russia	32,600	224,798	3,338	24,581	5,576	55,365	11,959	98,002
Spain	6,050	38,947	10,464	48,098	2,244	5,836	Nil.	......
Turkey	17,859	131,033	12,609	88,979	Nil.	....	Nil.	......
United Kingdom	468	10,563	451	10,814	893	23,138	993	22,533
Other Europe	29	763	165	1,962	26	587	108	2,456
British East Indies	11,000	40,148	64,170	352,487	35,960	226,796	10,200	58,635
Totals	165,722	$1,486,573	235,576	$1,931,282	146,056	$1,278,108	108,459	$901,592

Baltimore, Philadelphia and New York receive over 81% of the whole imports. Most of the rest enters at Mobile for use in the steel industry of Birmingham.

Production and Imports of Iron-Manganese Alloys.—Statistics collected by the American Iron and Steel Association as to production and imports of ferromanganese (80% Mn) and spiegeleisen (20% Mn) may be represented thus:

UNITED STATES PRODUCTION AND IMPORTS OF IRON-MANGANESE ALLOYS.
(In long tons.)

	1903.		1904.	
	Production.	Imports.	Production.	Imports.
Ferromanganese	35,961	41,518	57,076	21,813
Spiegeleisen	156,700	122,016	162,370	4,623
Totals	192,661	163 534	219,446	26,436

Market.—The demand for manganese keeps pace with the progress of the steel industries, which for the past few years has been extremely rapid.

Abundant supplies of manganese ores are available in many countries, in readily accessible localities, and the world's output has now attained about 1,000,000 tons, to which Russia, India and Brazil are the heaviest contributors. Consumption in America in 1904 was much impaired by the temporary depression in the steel and chemical industries. Only 108,459 long tons (against 146,056 tons in 1903) were imported from Russia, Spain, India, Brazil and the West Indies. These imports satisfied fully half the demand in this country, which in recent years has amounted to between 225,000 and 275,000 tons of manganese ore, calculated on the basis of 50% metallic content.

Review of Manganese Ore Production by States.

Arkansas.—No manganese ore was mined in this State in 1904, although an old dump yielded 600 tons of ore carrying 28% manganese. Mining used to be vigorous, and was centered at Batesville. The ore was rich in manganese, but was expensive to mine and ship, and contained too much phosphorus to be perfectly adapted to steel making.

California.—Small quantities are mined for use in chlorination works.

Colorado.—In the Leadville district, iron-manganese ores, carrying insufficient silver to be valuable, are used by the silver-lead smelters as a flux in their furnace charges. In 1904, 105,278 tons of ore of this character were disposed of. In this and other localities the manganese content sometimes reaches 30%, when the ores are used for making spiegeleisen; 17,074 tons were so used in 1904.

Virginia.—The supply of manganese ore comes mainly from the Crimora mine, in Augusta county. Most of the product is used in the chemical industry. In 25 years, Virginia has produced 195,922 tons of high-grade ore.

Manganese Mining in Foreign Countries.

Austria.—The production of manganese ore in 1904 was 10,189 metric tons, an increase of 4,010 tons over 1903. Bukowina contributed 7,342 tons, and Krain 2,847 tons. The latter was smelted at Servola. In manganese mining 242 men were employed.

Brazil is making rapid strides in the shipment of manganese, the total for 1904 reaching 205,000 long tons, as against 159,376 tons in 1903, and 62,000 tons in 1900; it was only in 1894 that the ores were first seriously mined. The ore of the Minas Geraes district is said to be a very pure black dioxide, containing from 50 to 55% of metallic manganese, and only traces of phosphorus. The best varieties occur between layers of impure earthy ores of iron and manganese, lying between beds of limestone, and it is the association with these beds that generally indicates purity in the manganese ore. The beds have been worked to over 120 yards from the surface, and show no material change in character. The ore is a hard mineral, interstratified with a softer and hydrated variety, the hard portion constituting about 80% of the whole, and being very pure.

The ore is first excavated by open workings, which, when no longer practicable, are superseded by levels in the hillside, small levels being first driven to locate the direction of the erratic bed of ore. All the levels and workings are dry, owing to their altitude, and the ore is simply thrown into shoots without picking, the cargoes showing a general uniformity in their analysis. The amount of ore in sight, and of easy extraction without motive power, is estimated at 2,000,000 tons on the present Usina Wig properties.

Cuba.—In the Province of Santiago de Cuba there are 88 manganese mines, covering 4,015 hectares. The deposits lie in the San Maestro range on the south coast, extending over a distance of 100 miles between Santiago and Manzanillo. Mining has been resumed with every prospect of continued increase and prosperity. The only mines worked in 1904 were those of the Ponupo Mining & Transportation Co., which shipped 15,516 tons in that year. The chief properties are the Macio, on the sea-coast, 35 miles from the port of that name; the Portillo, situated further westward, which produces ore that gives only 36% of manganese; the Boniato, Dos Bocas Margarita, Avispero (which yield ore of remarkably fine quality, running to 56% of metallic manganese), San Juan, and numerous other groups which, it is reported, could be made productive and profitable with the expenditure of a little capital. Considerable development has been done in the various districts, and substantial exports were made to steel plants in the United States at about $1.80 freight. This compares with an ocean freight from Brazil to Baltimore or Philadelphia of $2.50 to $3, and with about $4.20 from India and Russia. The output of manganese ore from Cuba in 1904 was 32,628 tons, of $163,000 in value.

France.—Manganese is produced by Las Cabesses mine in the Department of Ariège, and in the Romanèche and Grand Filon mines in the department of Saône-et-Loire. The output in 1903 was 11,417 long tons, of $56,742 in value.

Germany.—The production of manganese ore in 1904 was 52,886 metric tons ($147,750), as compared with 47,994 tons in 1903. The Prussian Province Coblenz contributed most of it—50,407 tons. All but 260 tons was consumed by the smelting industries. The Consolidated Schlossberg, Amalienshöhe, Concordia and Elisenhöhe are the largest mines.

Greece.—Manganiferous iron ore is mined in Greece in the Laurium, Grammatikon, Siphnos, Thermia and Milos districts. Exports of this ore amounted to 239,635 metric tons in 1904,[1] as against 275,232 tons in 1903. None of it comes to the United States.

India.—A remarkable development has recently taken place in the mining of manganese ore in this country. This industry began little more

* *Bulletin Trimestriel du Commerce Special de la Grèce avec les Pays Etrangers,* No. 4, 1904.

than ten years ago by quarrying in the deposits in the Vizianagram State, and from an output of 3,130 tons in 1893, the production rose rapidly to 87,126 tons in 1899, when the richer deposits in the central provinces were also attacked, and are now yielding a larger quantity of ore than the Vizianagram mines. The record of 171,223 tons reached in 1903 placed India second only to Russia as a producer of manganese ore. The production in 1904 was 138,733 tons, and exports were 154,880 tons. The ore mined in the central provinces has to be of high grade, ranging from 51 to 54% manganese, in order to pay the heavy freight rates over 500 miles of railway, besides the shipment charges to Europe and America, since the whole output is exported, mainly to the United States, Great Britain and Germany.

The principal mining districts are the Nagpur and the Vizianagram; prospecting is going on in Bhandara, Balaghat and Chhatisgarh districts and in the Jhabua State in Central India. The work hitherto has been little more than quarrying. The deposits are being worked for the highest grade of ore only. In the Nagpur area and in Vizianagram the ore occurs as lenses in the gneisses and schists, attaining in one instance a length of six miles, and a thickness, in the case of pure orebodies, of over 100 ft. In the Jubbulpur district the ore is of a lower grade, and is generally a manganiferous limonite. The most prominent, and sometimes the only, mineral in the purest orebodies is braunite, which is often accompanied by psilomelane.

ANALYSES OF INDIAN MANGANESE ORES.

	Manganese.	Iron.	Silica.	Phosphorus.	Moisture.
	%	%	%	%	%
Nagpur	51—54	5—8	5—9	0.05—0.12	less than 1.0
Vizianagram	45—50	7—13	2—5	0.12—0.27	1.10—1.80

Queensland.—Low prices and high ocean freights offer little encouragement for the development of the numerous manganese deposits found in the southern and central parts of Queensland. The only local market is the Mount Morgan mine, and the requirements of this company are supplied by the Mount Miller mine, at Gladstone, which in 1904 produced 830 tons of manganese ore, valued at £3,540. The mine has during the year opened up large bodies of ore, averaging 79% manganese dioxide, and is in a position greatly to increase its output if any inducement to do so arises.

Russia.—While new ore deposits are being opened in various parts of the world, it is likely that South Russia will continue to lead for a number of years. Its resources are ample, and improved means of transport between Schiaturi and Sharopan have facilitated shipments in recent years. Unfortunately for the producers, they are lacking in organization, their methods of mining are crude, and the state of the steel trade during the last year or two has been against them, while competition has increased.

Recent efforts have been made to form a home syndicate to control the output and price of the ore; so far nothing tangible has resulted. The Minister of Ways and Communications is to be asked to reduce the present railway rate between Schiaturi and Sharopan, which is now levied at 7c. per pood (36 lb.) for a distance of 22 miles.

The manganese mining district covers an area of 100 square miles, and is situated between the Caspian and Black seas. The beds outcrop in many places, and the mining of the metal is easy. In a report issued by the Council of the Conference of Manganese Producers the deposits are classified as medium, rich, and very rich; and it is stated that the poorest ore contains 20% of manganese. This district of Sharopan could supply the market with superior manganese ore for fully a century at the present rate of consumption.[2] The mines are dry, and are free from noxious gases; the work is done with pickaxes only, and instead of artificial supports solid pillars of ore six feet thick are left standing as props. The ore is, for the most part, removed in small wheelbarrows. Sorting is done in the open air, and only a few proprietors and contractors have sheds to protect the ore against rain. Excavations are partly filled up with siftings and waste. The work of extraction, as well as of transport to the surface, is done by occasional laborers; there are no professional miners. Owing to its superior quality the Caucasian manganese is not submitted to any mechanical operation of cleaning. In the mines in the region of Sharopan the work is confined to the simple sorting of the ore by hand and its separation from sandstone, chalk, or limestone.

Sundry attempts at organization by proprietors and small contractors have been unsuccessful. The large capitalists who tried to organize a rational exploitation of the mines did no better. They could not withstand competition with small contractors, who worked the mines without foresight or without any expense for the protection of the workings. Until now, large capital has appeared only as an intermediary between small producers and the markets of Europe. The railway facilities are utterly inadequate. Until 1895 the ore had to be transported in carts 25 miles along the most primitive roads. Since that time, a narrow-gauge railway has been opened up through the center of the mining district, but the management charges excessive rates, and the producers are paying an undue proportion of the cost.

The output of manganese ore in Russia for 1903, amounting to but 25,266,150 poods (= 413,860 metric tons), shows a further decline in the industry, due to the continuance of the depression which began in 1901. The output is but little more than half of the total recorded in 1900, and falls considerably short of the production of the previous year, which was 28,648,635 poods. In 1903 Russia exported 440,857 long tons, but in 1904 the amount was much less, owing partly to the war with Japan and to business

[2] For a description of the Nicopol district see THE MINERAL INDUSTRY for 1901, Vol. X.

depression. As usual, the Caucasus district contributed most of the country's supply, its output amounting to 22,974,603 poods. There were 251 mines under exploitation in this district, and the total number of employees was 2,004, as compared with 3,702 in 1902.

Spain.—In the province of Huelva, manganese has been produced for half a century, but it is only during the last ten years that the increase has been rapid. M. V. Sevoz was the first to direct attention to the manganese deposits of Huelva, and under his direction several mines at Villanueva de los Castillejos were started in 1858 to work the pyrolusite-psilomelane ores that cropped out at the surface. Soon afterwards Baron de Bache began to work mines in the same district and in the vicinity of Elosno. In 1878, the application of manganese in the manufacture of steel on a large scale created a lively demand for the ores, which led to the opening of several mines that had been neglected.

Turkey.—About 5,000 tons of manganese are produced annually. The mines at Kassandra, in the Province of Salonica, furnish slightly over one-fifth of this amount, chiefly in the form of pyrolusite, which is shipped to European seaports. An equal quantity of higher grade ore is derived from the workings in the Phlinika district in Asia Minor. The ore here assays 52% manganese. A smaller amount comes from the Zen-ghan mines with average assays showing 83% manganese dioxide. About 1,000 tons are shipped to France every year from the Province of Trebizond. Some deposits of manganese occur in the Province of Aidin, in western Asia Minor.

WORLD'S PRODUCTION OF MANGANESE ORE. (a).
(In metric tons.)

Year.	Austria Hung'y	Belgium	Bosnia(b)	Brazil. (d)	Canada. (d)	Chile. (d)	Colombia.	Cuba.	France	Germany.	Greece.	India.	Italy
1900....	14,550	10,820	7,939	108,244	34	25,715	8,748	21,973	28,992	59,204	8,050	129,865	6,014
1901....	12,077	8,510	6,346	100,414	447	18,480	695	25,586	22,304	56,691	14,166	122,831	2,181
1902....	12,883	14,440	5,760	157,295	175	12,990	Nil.	40,048	12,536	49,812	14,962	160,311	2,477
1903....	11,489	6,100	4,537	161,926	135	17,110	(c)	21,070	11,583	47,994	275,232	174,563	1,930
1904....	10,189f	(c)	(c)	208,260	123	(c)	(c)	33,152	(c)	52,886	239,635	140,953	(c)

Yr.	Japan.	New Zealand.	Portugal.	Queensland.	Russia.	South Australia. (d)	Spain.	Sweden.	Turkey	United Kingdom.	United States. (e)
1900	15,228	166	1,971	77	802,234	Nil.	112,897	2,651	d 38,100	1,384	221,714
1901	16,298	208	904	221	522,395	134	60,325	2,271	(c)	1,673	649,016
1902	10,866	Nil.	Nil.	4,674	536,518	18	46,069	2,850	(c)	1,299	989,519
1903	5,616	71	30	1,341	d458,894	10	26,194	2,244	39,500	831	671,151
1904	(c)	......	.....	843	(c)	(c)	(c)	2,297	(c)	8,880	461,854

(a) From official statistics. (b) Includes Herzegovina. (c) Statistics not available. (d) Export returns. (e) Includes output of manganiferous iron ore. (f) Austria only.

The Uses of Manganese.

About 90% of the world's output of manganese is smelted into an alloy with iron, in proportions ranging from 2% up to 90% Mn. Those containing the lesser proportions of manganese are called spiegeleisen, while the richer ones, ranging normally around 80% Mn, are termed ferromanganese. These alloys are used exclusively by the steel makers for two purposes: (*a*) In the manufacture of bessemer and open-hearth steel, the addition of manganiferous cast iron before pouring the ingots prevents oxidation of iron, increases the power of carbon to combine with iron at high temperature while restraining its separation as graphite at low temperature, hinders the formation of blow-holes, removes oxide and silicate of iron, removes some sulphur and counteracts the evil effects of the remainder, as well as of phosphorus, copper, oxide and silicates, thus avoiding 'hot-shortness' and making a more malleable and forgeable steel.[3] While the presence of 1 or 2% of manganese in the finished steel may tend to brittleness, its bad effect has generally been overestimated. (*b*) In the manufacture of special manganese steels, notable for their hardness and tensile strength.

In the chemical trade, manganese oxide is an active oxidizing agent. It is used in the preparation of bromine, chlorine, manganates and permanganates. In the glass industry it is used to decolorize glass, containing iron, by oxidizing it from the ferrous to the ferric state. Pyrolusite is the ore of manganese possessing oxidizing power to the highest degree. Manganese salts are employed also in the dyeing and ceramic arts. Ore intended for other uses than the making of iron alloys has to be of exceptional purity. In the chlorination process of gold extraction, manganese ore carrying 70 to 80% dioxide is used as an oxidizer, and is mined for this purpose in California, Colorado and Queensland.

Manganese Steel.—A recent British patent for the making of manganese steel covers the use of a ferromanganese carrying 70 to 90% Mn, and less than 3% C. While melted, it is to be poured into the molten decarbonized iron instead of being added in the usual way. This is said to give a low-carbon manganese steel of remarkable toughness.

In the ordinary methods, granulated ferro-manganese is added to the steel fusion. Up to 2.5%, the presence of manganese in steel has small influence.[4] Additions of manganese above this confer hardness at the expense of strength and ductility, reaching a maximum at between 4 and 6%. Further additions of manganese increase strength and toughness, while hardness diminishes slightly, the maximum of both strength and toughness being reached at about 14% Mn, hardness still being sufficient to resist machining. At 15% Mn, ductility decreases rapidly, tensile strength being maintained up to 20% Mn, when it, too, disappears. The effect of these extreme proportions of manganese is masked by the high accompanying contents of carbon, unavoidably introduced by the ordinary methods of manufacture. The best manganese steel, containing 14% Mn and not over 1% C, is fluid, solidifies quickly and with strong contraction, forms pipes but not blow-holes, does

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[3] Henry M. Howe, 'The Metallurgy of Steel,' p. 42.
[4] *Ibid*, p. 361.

not segregate, is forgeable, but does not weld. Although ordinarily brittle and not very strong, a quick quenching from whiteness gives it extraordinary strength and toughness and rigidity under impact. Such steel is admirably adapted for, and is now used extensively in, the wearing parts of mining, milling and dredging machinery.

Other Alloys of Manganese.—Manganese may be made by the aluminothermic method so as to be absolutely free from carbon and practically free from iron. This pure manganese resists atmospheric influences indefinitely, while that reduced by carbon in the ordinary way degenerates rapidly upon exposure. The fusing point of pure manganese has been determined at 1,245° C. Manganese alloys in all proportions with copper, nickel, zinc, tin, aluminum, chromium, titanium and boron. As a constituent of brass and bronze, manganese adds strength, density and often elasticity. Manganese, however, should not be added to bronze containing more than 3% of tin.

Manganese copper alloys, containing 2 to 12% Mn, are made in large amounts; those containing 5 or 6% Mn have the same color as copper and are extremely fire resistant, being used in the fire-boxes of locomotives. These alloys are best made from pure manganese, since even a small quantity of iron, introduced in even the best ferromanganese, destroys the elasticity and the fire-resistant properties. To make a copper-manganese alloy the copper is first melted in a graphite crucible, manganese is then added at intervals in small pieces; 20% of manganese requires the alloy to be heated for an hour; greater proportions require more time. For a 100-lb. yield of 30% alloy, 75 lb. of copper and 32 lb. of manganese should be used. It is best cooled by pouring into water, when its granular shape will adapt it for incorporation into subsequent alloys.

For nickel castings, manganese acts as a deoxidizer and produces a casting of greater density. About 2% is advised. Manganese is better than magnesium for this purpose, since an excess is not detrimental. In the mints, 2% of manganese is added to the nickel-copper alloy intended for coinage. With aluminum, 3% of copper-manganese, free from iron, makes a stronger, denser and more workable alloy than does nickel, and at less expense.

An alloy of 30% chromium and 70% manganese. 'chromium-manganin,' is used for the making of copper containing chromium. 'Manganese-titanium,' containing from 30 to 35% Ti, and 'manganese-boron,' containing 20% Bo, are also used for alloying with copper.

Determination of Manganese.—Messrs. Olsen, Clowes and Weidmann propose a new method.[5] For 150 mgm. of manganese, 10 c.c. of a 5-N solution of ammonium chloride or 2.75 gm. of the dry salt, and five times the theoretical amount of ammonium sulphide are used. The concentrated solution of the manganese salt (10 c.c.) is poured into the boiling solution of the ammonium salts (90 c.c.), and the heating continued until the pink sulphide

[5] *Journal* of the American Chemical Society, 1904, XXVI, p. 1,622.

which is first precipitated is completely transformed into the green modification. The ammonium sulphide must be prepared immediately before use, be free from the yellow sulphide, and must be used in sufficient excess. The transformation of the pink precipitate into the green sulphide is generally complete in half an hour; if necessary, 10 or 15 c.c. more of the ammonium sulphide solution are added after this time. The green sulphide is filtered off, washed with distilled water containing ammonium sulphide and chloride, dried and ignited in a current of dry hydrogen free from arsenic hydride.

MICA.

The greater part of the mica produced in the United States comes from North Carolina and New Hampshire. The product of the Western States is low-grade 'A' mica, lacking the easy and perfect cleavage that gives to the mineral its chief value. All domestic mica is harder, and therefore less suitable for armature insulators, than the Canadian and Indian product. The mica industry has been marred by a great number of extravagant, over-confident enterprises, owing to a lack of appreciation of the facts that only the clear sheet mica, cut into pieces as large as 8 by 10 in., commands the high prices quoted in the prospectuses, and that to mine material for the sole purpose of grinding it, is entirely unprofitable, since the scrap from the sheet-mica producers will abundantly supply the demands of an already overcrowded ground-mica market. Probably not over 10 or 15 per cent of the crude mica mined in the United States can be cut into sheets; in California and New Mexico the proportion falls to 2 or 3 per cent, while the North Carolina product shows the largest proportion of the first-class mica. The mica component of the pegmatite dikes, the only association in which the mineral is found in commercial quantities, is generally under 10 per cent of the whole, so that, in the most favorable locality, the sheet mica constitutes less than 2 per cent of the whole amount of rock that must be moved for its recovery.

Uses.—The electrical industry consumes the most mica, the mineral having a high non-conductivity. It is used as an insulator between the segments of armatures and for many other circuit-insulating purposes. For armature construction, the white mica from India is preferred, as its softness causes it to wear down flush with the copper segments, while its purity and uniformity of quality make it better to be relied upon. The amber mica of Canada is also used extensively for this same purpose, being softer even than the India product, but inferior to it, by reason, not of its slight iron content (Ontario mica ranges around 0.5% iron oxides), but of the greater difficulty in the inspection for grosser impurities along the cleavages, and of its lesser resistance to heat. The General Electric Company obtains its supply from its own mine near Sydenham, Ontario, presumably the largest producer of high-grade mica in the world. For the cutting of armature insulators, the largest and most expensive sheet mica is not required. 'Micanite' and other patented composites are built up to the required size by cementing together smaller pieces with various adhesive substances, and are then as satisfactory as intact sheets, and more economical. The demand for large-sized clear sheets, for use in stoves, has almost disappeared, as stove-door frames are now designed to permit the use of smaller pieces of mica. This is partly compensated by the increasing use of mica lamp chimneys, and other novelties requiring large sheets. Scrap mica, formerly thrown away, is now ground to various degrees of fineness. The coarsest is made into boiler and steam-pipe lagging, for which purpose it is superior even to asbestos. Thus, calling the loss by condensation in a bare steam pipe 100, the loss in the same pipe covered with a mica jacket would be only 12, a saving of 88 per cent. Somewhat finer mica is made into roofing and fire-proofing material. Mica, in fine powder, is the basis of lubricants for heavy and slow-moving bearings, and the very finest is used for decorative work, wall papers and paints.

The leading users of mica, whose offices are in New York, are Eugene Munsell & Company (the originators and patentees of 'Micanite'); Sills-Eddy Company, Standard Oil Company, Mica Roofing Company.

Production and Imports.—The production of mica in the United States is constantly growing; it cannot, however, supply the domestic consumption, which depends for nearly two-thirds of its needs upon mica imported from India and Canada, in the face of a heavy duty of 20 per cent *ad valorem,* in addition to 6c. per lb. on unmanufactured and 12c. per lb. on cut and trimmed.

PRODUCTION AND IMPORTS OF MICA IN THE UNITED STATES. (a)

Year.	Production.				Imports.			
	Sheet.		Scrap.		Unmanufactured.		Cut or Trimmed.	
	Lb.	Value.	Sh. Tons.	Value.	Lb.	Value.	Lb.	Value.
1900....	456,283	$92,758	5,497	$55,202	1,892,000	$290,872	64,391	$28,688
1901....	360,060	98,859	2,171	19,719	1,598,722	299,065	78,843	35,989
1902....	373,266	83.843	1,400	35,006	2,149,557	419,362	102,299	46,970
1903....	619,600	118,088	1,659	25,040	1,355,375	288,783	67,680	29,186
1904....	668,358	109,462	1,096	10,854	1,085,343	241,051	61,986	22,663

(a) From "The Mineral Resources of the United States." Exports were valued at $760 in 1903 and $1,770 in 1904.

Of the 1904 imports, 795,843 lb., valued at $198,482, came from Canada, constituting the Dominion's entire output. The remainder came from India.

Canada and India.—These countries, with the United States, provide over nine-tenths of the world's production. The Canadian deposits of phlogophite, the magnesia or amber mica, are in Ontario and Quebec, and their output in 1904 was valued at $152,170. The Indian localities are in the Nellore district of Madras and on the borders of the Hazaribagh and Monghyr districts of Bengal. The localities in Bombay and Burmah have nearly ceased production. The mica is of the muscovite, or potash, variety. The value of exports offers the best indication as to the production, as only small quantities of the poorer grades are utilized in India. Exports have averaged around 1,000 short tons annually, of a value of

$9,845 per ton. Over three-quarters of the export goes to England, part of it for transshipment to the United States. That which is sent direct to this country brings the higher price, as only the best grades can stand the tariff. The mica industry employed 8,776 men in 1903, being second only to gold mining in this respect; 27 licenses, covering 3,223 square miles, had been granted for mica mining up to the end of 1903. It is only since 1902 that Canada has become a strong competitor of India in the world's production.

MOLYBDENUM.

The search for molybdenum is being stimulated by a growing demand for the metal among the makers of special steels, notably the drawers of steel wire, the manufacturers of machine tools and the founders of armor plate. Only two ores of molybdenum have been found in commercial quantities in the United States: Molybdenite, the sulphide, MoS_2, and wulfenite, the molybdate of lead, $PbMoO_4$.

The production of molybdenum ores in the United States in 1904 was only 14.5 short tons, valued at $2,175, as compared with 795 tons ($60,865) mined and concentrated in 1903. Only molybdenite is produced regularly, the wulfenite being obtained as a residue from the treatment of gold and copper ores along the Rio San Pedro, Pinal county, Arizona.

Mineralogical Character.—Molybdenite, molybdenum disulphide, MoS_2 (S, 40%; Mo, 60%), is a soft, bluish-gray mineral having a metallic luster and a greasy feeling. It may occur as tabular, hexagonal crystals or in finely granular masses, but it appears most commonly as foliated masses or as separate scales. Such scales are flexible, but they are not elastic, differing in the latter respect from mica. Molybdenite, although just twice as heavy as graphite, is often confused with it; the two minerals, however, may be easily distinguished by any one of several tests. A streak of molybdenite on glazed porcelain has a distinctly greenish tinge, while a graphite streak is clear black. A little piece of molybdenite strongly heated by a blowpipe gives a greenish-yellow color to the flame, while graphite shows no color and is slowly consumed; both minerals are infusible. Heated in an open tube, molybdenite gives off sulphurous fumes and a sublimate of pale yellow oxide. Heated on charcoal, molybdenite emits a strong sulphurous odor and deposits a coating which is yellow while hot and white when cold; the white coating, if touched intermittently with the yellow flame, becomes deep blue. Graphite is insoluble in acids, while molybdenite decomposes in strong nitric acid, leaving a white or grayish residue of molybdic oxide; and also gives a blue solution with sulphuric acid.

Beads of borax or of sodium ammonium phosphate show characteristic molybdenum reactions with molybdenite, while graphite, unless impure, does not react in them. If a flake of graphite is placed in contact with a fragment of zinc, both being submerged in a solution of copper sulphate, it will be quickly copper-plated, by electrolytic action; a scale of molybdenite, similarly treated, will be plated much more slowly.

Petrological Associations.—Molybdenite occurs almost invariably associated with igneous rocks or their metamorphic derivatives, although it has been found in different varieties of schist in Europe, in limestone in Europe and the United States, and in a conglomerate in Switzerland. Commercial deposits have been found only in pegmatite and quartz veins, usually in conjunction with granites. Impregnations of the sulphide are sometimes found in granite.

Molybdenum Mining in the United States.

Arizona.—Wulfenite, the molybdate of lead, is found in the copper mines of Pinal county, at Mammoth and at Troy. The Mammoth has been a famous gold mine, and the tailing accumulated during previous years is now being picked over in a small way, and for three years has afforded the entire output of wulfenite marketed in this country. The Troy-Manhattan Copper Co. has discovered sufficient quantities of wulfenite in its copper mines at Troy to warrant the erection of a 40-ton mill for concentrating the molybdenum ore, and it is now installing a plant for treating the concentrate. The wulfenite is found in quartz veins, and constitutes 1½ to 3% of the mine product.

Maine.—At Cooper, Washington county, the American Molybdenum Co. has developed deposits of molybdenite and has erected a concentrating mill.[1] The mineral occurs in short, hexagonal crystals, as a constituent of pegmatite dikes which cut an acidic granite. It constitutes also, to a lesser extent, a component of the granite, in which it is more abundant near contacts of the pegmatite dikes. The conditions of mining are favorable, and, with good management, the deposit should afford a steady supply.

Montana.—A molybdenite deposit at 10,000 ft. elevation and 10 miles from railroad has been developed at a point 30 miles northwest of Dillon. The ore is found in two quartz veins averaging 10 in. thick, which outcrop for 300 ft. The granite between them is also seamed with narrow streaks of the sulphide, and with quartz veins carrying lesser proportions. Molybdenite has also been slightly developed in Carpenter's gulch, two miles east of Ophir.

Washington.—In Chelan county molybdenite has been developed at a point 30 miles from the head of Lake Chelan; the ore occurs in a 2-ft. quartz vein which outcrops horizontally 900 ft. up the side of a granite precipice. The molybdenite forms seams, up to several inches thick, ramifying through the quartz, and ranges from particles up to irregular masses, often occurring as well developed crystals. It has not been found in the biotite granite, which constitutes the country rock.

Market and Prices.—The United States consumes all of its own production of molybdenum ore and imports additional supplies from Scandinavia. Molybdenum ore, to be marketable among manufacturers of metallic molybdenum, ferro-molybdenum and nickel-molybdenum alloys, which are used in the preparation of special steels, should contain at least 45% molybdenum,

[1] George Otis Smith, 'A Molybdenite Deposit in Eastern Maine,' U. S. Geol. Survey, Bull. No. 260.

and be free from copper. At times it would be difficult to sell even a 50 or 55% ore, and orders have been solicited by sellers at as low as 20 to 25c. per unit ($180@$237.50 per long ton f. o. b. New York) for mineral averaging 95% molybdenum sulphide. Consumers have sometimes purchased the ore at an f. o. b. mine price, the conditions of the contract being based on the quality of the ore, quantity available, and distance from economical transportation.

Several manufacturers in the United States employ electricity to produce metallic molybdenum, 98 to 99% in purity; ferro-molybdenum, 50 to 55%; and nickel-molybdenum, 75% Mo, and 25% nickel. The annual output is about 35,000 lb. molybdenum metal, worth $2.75 per lb., at New York; and 16,000 lb. ferro-molybdenum, quoted at $1 up, according to quality.

Molybdenum Mining in Foreign Countries.

Australia.—Molybdenum is found throughout Australia and Tasmania, generally associated with tin-bearing granites. In the New England district of New South Wales, 30 to 40 tons are obtained yearly. Queensland produced 21 tons of molybdenite in 1904, obtained at the tungsten mines of Herberton and Hodgkinson districts. At North Yelta, South Australia, the Paramatta Copper Mine, Ltd., recovers a small amount of 95% molybdenite ore from its copper lode, through which it is distributed in small but uniform amounts.

Canada.—Molybdenite is reported in almost every Province. Only in Ontario, however, has it been mined commercially. There it occurs with iron sulphides in a granite country rock, near Sheffield, Addington county. The rock, carrying about 4% molybdenite, is quarried; in 1903, from about 600 tons of rock raised, 85 tons of molybdenum ore was recovered and shipped to the United States and elsewhere.

Norway.—Molybdenite is mined in the district of Fjotland. In 1903, the output was 30 metric tons ($21,600), and in 1902, 20 tons.

Metallurgy of Molybdenum.

Concentration of Molybdenite.—Experiments by J. W. Wells, of the Kingston School of Mines, appear to have met with success. The method depends upon the fact that molybdenite, when passed through rolls, does not become pulverized, but separates into flakes while the accompanying minerals are crushed to powder. It is stated that a sample of ore containing mica and quartz, after passing through rolls and being screened, furnished 1.4% of flakes, consisting principally of mica and molbydenite. After a second screening through a finer mesh, a further 1.54% of material of similar composition was obtained. The two concentrates in each case contained about 55% of molybdenite and 45% of mica. To separate these minerals, several methods were tried, but the best results were obtained with a Wetherill magnetic separator, which removed practically all the mica, and gave an ore containing 90 to 91% of molybdenite.

Reduction of Metallic Molybdenum.—Electrically.—Molybdenite is heated in a carbon tube with an arc of 350 amperes and 60 volts; sulphur dioxide is evolved; when the current is increased to 900 amperes and 50 volts, complete fusion is obtained in a short time and the sulphur is entirely expelled. The metal prepared in this way contains sometimes as much as 7% of carbon, about one-sixth of which is in the form of graphite. This carbon may be removed by heating with molybdic oxide.

By the Aluminothermic Method.—Like chromium, molybdenum is now produced in a fused state by the aluminothermic reaction. It is a metal of gray color, like steel, and has a dense structure. It contains as chief impurity about 1 or 2% of iron besides very small quantities of silicon, its purity being 98 to 99%. Molybdenum is applied for making tool-steel, and is often used as a substitute for tungsten. Molybdenum has the property of rendering the tool-steel especially hard. The percentage in which molybdenum is used for such purposes is much smaller than that of tungsten. It is also much easier to harden molybdenum steel than tungsten steel. In most cases, besides the addition of molybdenum, a high percentage of chromium, free from carbon, is also added.

The disadvantage of ordinary commercial molybdenum in powdered form is that this powdered metal is always somewhat oxidized, and that these oxides impair considerably the quality of molybdenum steel, and in many cases spoil it. The fused molybdenum, made by the aluminothermic reaction, is absolutely free from oxide, so that the disadvantages just mentioned are absent.

Since molybdenum is used mostly in conjunction with chromium, an alloy of chromium and molybdenum has been prepared by the aluminothermic process, and the use of this alloy may often be preferable. This alloy contains equal quantities of molybdenum and chromium. Like all other metals and alloys made by the aluminothermic process, molbydenum is free from carbon. The latest alloy of this nature is one of 75% molybdenum, with 25% nickel.

Determination of Molybdenum.—Gravimetric Method of H. Borntraeger. —About 1 gm. of the powdered ore is digested in an Erlenmeyer flask with 25 c.c. of concentrated nitric acid for two hours in order to convert the molybdenum into molybdic acid. The latter is dissolved in ammonia and filtered off; the residue is treated a second time with nitric acid and ammonia; the combined filtrate is then acidified with nitric acid and evaporated to dryness. The molybdic acid is separated from the dry ammonium nitrate by digesting and washing with 50% alcohol, which dissolves only the ammonium nitrate. The molybdic acid is then collected on a weighed filter or dissolved in normal ammonia and the excess of ammonia titrated with standard acid.

Volumetric Method.—About 1 gm. of the finely powdered mineral is fused with sufficient sodium peroxide in a nickel crucible. The mass is then allowed to cool, after which the melt is dissolved in H_2SO_4. The solution is then neutralized with NH_4OH and the precipitated ferric oxide filtered off and washed. The filtrate is now acidulated with H_2SO_4 and passed through a column of metallic zinc (Jones reductor) and titrated with potassium permanganate.

Electrolytic Method of L. H. Pollock and Edgar F. Smith.—The finely divided ore is fused with Na_2CO_3 and $NaNO_3$; the melt after cooling is digested in water, filtered and washed. The filtrate is acidified with $HO_2H_3O_2$ and the molybdenum is precipitated electrolytically as a black adherent coating of hydrated molybdenum sesquioxide, which is dissolved in HNO_3 and weighed as molybdic oxide.

Reduction of Molybdenum Compounds by Magnesium in Sulphuric Acid Solutions.[2]—While the possibility of determining molybdenum by reducing the trioxide with zinc in sulphuric acid solution and titration with permanganate is disputed, it can be done quite well by substituting magnesium for zinc. The substance is gently heated for 30 to 45 minutes in a flask provided with a Bunsen valve, with magnesium and a sufficient quantity of sulphuric acid (1:5), poured into a capacious porcelain basin, diluted with about 300 c.c. of water at 30 to 40° C., containing a little sulphuric acid and titrated with N/20 permanganate.

[2] B. Glasmann; *Berichte*, XXXVIII, p. 604.

MONAZITE.

The production of monazite in the United States in 1904 was 745,999 lb., valued at $85,038. The output was 119,001 lb. less than in the previous year; but its value exceeded that of 1903 by $19,838, due largely to the purer product that was placed on the market, which also accounts for the decrease in quantity.

PRODUCTION OF MONAZITE IN THE UNITED STATES.

Year.	Quantity.	Value.
	Pounds.	
1900	908,000	$48,805
1901	748,736	59,262
1902	802,000	64,160
1903	862,000	64,630
1904 (a)	745,999	85,038

(a) Includes small amounts of zircon, gadolinite and columbite.

The larger part of the American production of monazite is obtained from North Carolina, with smaller quantities from South Carolina. It has also been noticed in the sands of one river of South Carolina, which flows from the South mountains. It is found in connection with zircon, white and green sands, magnetite and titanic iron grains on the south side of the South mountains; and with the same accessories besides gold on the north side of the same range. It occurs both in placer deposits and in veins, the latter being the rarer, only one mine, near Shelby, N. C., being worked on vein matter.

The monazite sand, obtained by concentration in sluice-boxes, is dried by spreading on an oiled cloth and exposing in the sunshine, or by heating in a crude sheet-iron stove. Further concentration is effected by the Wetherill electro-magnetic separator. The machine designed for this purpose has four magnetic fields of varying intensities. The first magnet withdraws all the magnetic iron, the larger pieces of garnet, and generally all the ilmenite. The second magnet attracts the finer garnets and the last trace of ilmenite. The third extracts the coarser monazite, and the fourth the remaining monazite, leaving a tailing of quartz, zircon and rutile. The monazite concentrate carries 95 to 99% of the mineral.

The operators of concentrating plants are the Incandescent Light & Chemical Co., at Carpenters Knob, N. C.; the Carolina Monazite Co., with a mill at Shelby, N. C., and another at Gaffney, S. C.; and the German Monazite Co., operating at Oakspring, N. C. The Carolina company is controlled by English owners, who also have a mill at Hildebran, N. C. These companies obtain their washed material from independent workers, some of whom collect as much as a ton of concentrate in a year, and from their own operations on land leased from its owners. The average price paid for washed concentrates is 5c. per lb., the buying companies showing no willingness to bid against each other.

Brazil.—The exports of monazite from Brazil are rapidly increasing. In 1904, 4,860 metric tons, valued at $522,360, as compared with 3,299 metric tons, valued at $355,867, in 1903, and 811 tons of the value of $81,115 in 1902, were produced. Most of the Brazilian monazite is obtained from the province of Bahia, where it occurs in beach sands along the ocean. The village of Prado, not far from the island of Alcobaca, is the center of the mining industry. New discoveries have been reported at Sapucaia, Rio de Janeiro, and along the Parahyba river. The Brazilian mineral is said to be finer grained than the American, and it is also of more uniform grade, containing on the average 4.5 to 5.2% thoria.

Russia.—Monazite is found in some of the placers on the Sanarka river in the Ural district, and in Siberia, in the placers on the banks of the Lena and Vitim rivers.

Uses.—Monazite is an anhydrous phosphate of the rare earths of the cerium group—cerium, lanthanum and didymium—but it usually contains also a variable amount of thorium, and it is this latter element that gives the mineral its commercial value. Monazite concentrate contains from 3 to 9% of the oxide thoria. This is separated by carefully guarded processes, and, in solution, is used to saturate the cotton mantles of the Welsbach and other incandescent gas burners. The cerium, separated in the reduction of thoria, finds a limited application, as oxalate, in pharmacy.

Separation of Thorium from Cerium, Lanthanum and Didymium.—A. C. Neish[1] has developed a method based on the fact that metanitrobenzoic acid precipitates thorium from a neutral solution of the nitrate as $Th(C_6H_4NO_2CO_2)_4$. Thus, on treating 25 c.c. of a solution containing an amount of thorium equivalent to 0.1128 gm. of thorium oxide, with about 150 c.c. of a 0.35 to 0.4% solution of the acid at 80° C., and keeping the beaker at 60° to 80° C. for 15 minutes, a bulky precipitate is deposited which, after being washed with a 5% solution of the precipitating acid and ignited in a platinum crucible, leaves the quantitative amount of thorium oxide. For the ignition the filter paper should be placed while still moist in the uncovered crucible, and heated first in the Bunsen flame, and then for 15 minutes in the blast flame. For the complete separation of thorium from cerium, etc., re-precipitation is necessary. For this purpose the precipitate is dissolved off the paper by means of hot dilute nitric acid (1:5), the paper well washed with hot water, and the solution diluted to about 150 c.c. and treated with 25 c.c. of the *m*-nitrobenzoic acid solution. Sufficient methyl orange to give a decided red tint to the liquid is now added, and

[1] *Journal* of the American Chemical Society, 1904, XXVI, p. 780.

dilute ammonia solution (1:10) run in until the color changes to pink, the liquid being thoroughly stirred after each addition. Care must be taken not to continue the neutralization until the liquid becomes yellow, or the other earths will be re-precipitated. To insure complete precipitation of the thorium compound an additional 50 c.c. of the reagent are now added, the beaker heated on the water-bath as before, the precipitate collected, washed, dissolved in dilute nitric acid, and once more precipitated, before final ignition. *m*-Nitrobenzoic acid gives no precipitate with glucinum, gadolinium, yttrium, titanium, and samarium; zirconium gives a white opalescence and precipitate which increases on heating, while erbium gives a white curdy precipitate. Mercurous and mercuric nitrate give heavy curd-like precipitates which dissolve on heating.

Analysis of Monazite Sand.[2]—Two grams of the sand in a fine state of division are mixed with 10 to 15 c.c. of concentrated sulphuric acid in a porcelain crucible, which is gradually heated on a plate until the excess of acid is evaporated. More acid is then added, the contents stirred, and digestion continued for three hours, after which time the phosphates are converted into sulphates. The crucible is now cooled in ice water and the mass introduced drop by drop into 600 c.c. of water also cooled to 0° C., the crucible itself being finally placed in the beaker and left over night. The solution is heated to boiling, and treated with a boiling solution of oxalic acid (saturated in the cold), which is added in large excess with constant stirring. The white crystalline precipitate that separates on cooling, consisting of thorium, cerium, lanthanum, and didymium oxalates, is collected and washed with a dilute solution of oxalic acid, after it has stood for several hours. The filter paper containing the precipitate is returned to the same beaker and boiled with 10 to 15 gm. of potassium hydroxide and 25 to 50 c.c. of water, and the resulting hydroxides filtered off from the liquid which has previously been diluted to about 300 c.c. The precipitate is washed free from alkali and dissolved in hot dilute nitric acid (1:5), the solution evaporated to dryness on the water-bath, and the residue moistened with water and evaporated until free from all traces of free nitric acid. The nitrates are dissolved in 500 to 600 c.c. of water, 150 to 250 c.c. of the solution of *m*-nitrobenzoic acid slowly introduced with constant stirring, and the liquid heated at 60° to 80° C., and filtered from the precipitate, which is dissolved in dilute nitric acid, re-precipitated, and ignited as described above. A pure white thorium oxide is more readily obtained by neutralizing of the thorium *m*-nitrobenzoate with potassium hydroxide instead of with ammonia, a slight excess of the reagent converting the flocculent *m*-nitrobenzoate first precipitated into the more compact hydroxide.

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[2] *Loc. cit.*

NICKEL AND COBALT.

There was no production of metallic nickel or cobalt oxide from domestic ores in 1904. A small amount of matte containing these metals was made at Mine La Motte, but it awaits refining. The nickel industry of the country is in the hands of the International Nickel Co., which declines to report the amount of nickel recovered from its imported ores. The company obtains its supplies of ore from Canada and New Caledonia.

There was a decided falling off in the quantity of nickel ore and matte imported into the United States in 1904, but owing to the higher grade of the material the decrease in value was not so pronounced. Nickel ore and matte imported in 1904 amounted to only 8,548 long tons, valued at $915,-470, as compared with 15,936 tons, valued at $1,285,935, in 1903—a decrease of 7,388 tons in quantity, and of $370,465 in value.

It should be noted, however, that most of the nickeliferous matte imported from Canada is entered under the designation of copper matte. As neither copper nor nickel matte pays customs duties, a stricter classification is not insisted upon.

Market and Prices.—Neither the demand nor quotations showed any fluctuations throughout the year. Prices were maintained steadily at 47@50c. per pound for large orders, down to one ton. For smaller quantities, the prices ranged around 60c. per pound.

UNITED STATES IMPORTS AND EXPORTS OF NICKEL AND COBALT.

Year.	Nickel.				Cobalt.	
	Imports. (a)		Exports. (b)		Imports.	
	Long Tons.	Value.	Pounds.	Value.	Pounds.	Value.
1900	25,670	$1,183,884	5,869,906	$1,382,727	54,073	$88,651
1901	52,111	1,637,166	5,869,655	1,521,271	71,969	134,208
1902	14,817	1,156,372	3,228,607	925,579	79,984	151,115
1903	15,936	1,285,935	2,414,499	703,550	73,350	145,264
1904	8,548	915,470	7,519,206	2,130,933	42,352	86,925

(a) Ore and matte. (b) Comprises domestic nickel, nickel oxide and matte.

Mine La Motte, in Missouri, has for a long period produced nickel and cobalt matte to the value of $5,000 to $15,000 annually, as a by-product in the smelting of 2,000 to 2,500 tons of pig lead per year. Of the contents of this matte, about one-third by weight is cobalt. In 1904, the production was probably below the average, since much less work than usual was done.

In 1903, Idaho and Oregon gave an output of 135 tons of nickel and cobalt ores, but in 1904 no ore was produced in either State. In Virginia and North Carolina a considerable tonnage of low-grade ore was recovered in the development of deposits at Hemlock, Floyd county, Va., and near Webster, Jackson county, N. C., but none of this ore was sent to the smelters.

An interesting occurrence of nickel has been noted in the Grand Encampment district, Wyoming. A pyrrhotite deposit, occurring at the contact of norite with an earlier eruptive rock, carries an appreciable quantity of nickel. The geological conditions of the formation resemble in many respects those of the Sudbury nickel field in Canada. The discovery of nickel-bearing veins in Washington and Colorado was reported during 1904.

Nickel and Cobalt Mining in Foreign Countries.

Argentina.—A cobalt deposit recently discovered at Valla Hermoso, Vinchina, Provincia de la Rioja, Argentina,[1] was worked in a small way. The ore occurs on the western slope of the Cerro de Famatina, a spur of the Andes, in a talcose schist, usually near its contact with an acid, igneous rock. A number of veins appear at the surface, but only one has been exploited. This has been opened at three points by two adits and a cross-cut from the side of the hill to the vein. The orebody varies in width from 90 cm. to 1.3 m., with an average of about 1.1 m. The ore consists of cobaltite and arsenopyrite in a gangue of quartz. At present this ore is hand-cobbed into first- and second-class ores. Assays of the first- and second-class ores sorted in this way are as follows:

	First-class Ore.	Second-class Ore.
Cobalt....................per cent..	6.0 to 7.0	3.0 to 4.5
Nickel.................... " ..	0.5 to 2.5	0.1 to .8
Gold.........grams per metric ton..	25.0 to 30.0	10.0 to 20.0
Silver........ " ..	150.0 to 300.0	90.0 to 180.0

About 300 tons of ore have been produced, of which 150 tons have been hand-cobbed, and of these only a few tons were first class. It is reported that the ore is readily concentrated, so that the entire output of the mine can be brought up to a first-class ore. This would permit the utilization of all the low-grade ore, which is now being thrown on the dump.

The distance of this property from Nonozasta, which is the nearest railway station on the F. C. A. Del Norte line, is 120 miles. All the ore that has been concentrated has been shipped to England. The second-class ore would bring from £12 to £17 in England, after paying transport charges of £8 to £9 per ton, besides other costs.

Australia.—Nickel occurs in Queensland, New South Wales, and Tasmania, but the ores of only the last named State are worked. Nickel deposits of commercial importance are known in several districts of the west

[1] The Engineering and Mining Journal, August 4, 1904.

coast of Tasmania, and rich ore is occasionally shipped from Trial Harbor and Heemskirk mines. The nickel is generally associated with serpentine, but in a few instances it is found with copper pyrite.

Cobalt is mined in a small way at Port Macquarie, on the north coast of New South Wales. The annual production is about 150 tons. This output could be largely increased if the deposits, which are extensive, were worked in a systematic manner, and the ore treated by an efficient concentration process. At the present time both the mining and the metallurgical treatment are crudely conducted.

Canada.—Apart from the increased production, the most noteworthy feature of the nickel industry in Canada in 1904 was the attention directed to the newly discovered deposits near Haileybury, along the new Temiskaming & Northern Ontario Railroad. They are situated about 90 miles northeast of Sudbury, and the ore is of different character from that obtained on the Sudbury field. The rock associated with the Sudbury deposits, which are not veins, but deposits of irregular shape, is norite, a variety of gabbro. The Haileybury deposits appear to be defined veins traversing what is locally known as Huronian slate and breccia-agglomerate. The ore consists of niccolite, the arsenide of nickel, and smaltite, the diarsenide of nickel, together with much native silver.

On weathered surfaces the vein matter is coated with pink-colored cobalt bloom. In some of the ore the minerals annabergite, dycrasite, chloanthite, and heterogenite are visible. The ore assays 16 to 20% cobalt; 4 to 7% nickel; 7% iron; 60 to 70% arsenic and sulphur. Some of the ore carries $5,000 worth of silver per ton. These deposits appear to have considerable extent, and promise to become of great commercial importance.

The mines in the Sudbury district are now disputing with those in New Caledonia for the leading position as a source of nickel. It is evident, however, that within the next few years Canada will easily outstrip the French colony in nickel production, on account of the better mining and smelting facilities in the Dominion.

PRODUCTION, EXPORTS AND IMPORTS OF NICKEL IN CANADA. (a)

Year.	Production.		Exports.		Imports
	Pounds. (b)	Value. (c)	Pounds. (d)	Value. (e)	
1900	7,080,227	$3,327,707	13,493,239	$1,040,498	$6,988
1901	9,189,047	4,594,523	9,537,558	958,365	12,029
1902	10,693,410	5,025,903	3,883,264	834,513	15,448
1903	12,505,510	5,002,204	9,032,554	878,159	26,177
1904	10,547,883	4,219,153	14,229,973	1,237,307	16,330

(*a*) Statistics for production and imports cover calendar years, and are taken from the Annual Reports of the Geological Survey of Canada. Figures for exports cover the fiscal years ending June 30, 1900-04, and are taken from the Statistical Year Book. (*b*) Pounds of metallic nickel contained in copper and nickel matte exported. (*c*) On the basis of refined nickel at New York, from THE ENGINEERING AND MINING JOURNAL average annual quotations. (*d*) Pounds of nickel ore, matte or speiss. (*e*) Spot value, to the producer, of the exported material; hence the apparent discrepancy in value when it is known that practically the entire production is exported.

Of the Canadian nickel exports in 1904, Great Britain took 2,307,538 lb., valued at $292,036, while the United States took 11,922,355 lb., valued at $945,256. Imports come from the United States and comprise mainly nickel anodes, dutiable at 10% *ad valorem,* with less amounts of duty-free nickel bullion. The condition of the industry during the last five years is indicated by the following table:

Schedule.	1900.	1901.	1902.	1903.	1904.
Ore raised............Short tons	216,695	326,945	269,538	152,940	203,388
Ore smelted...........Short tons.	211,969	270,380	233,388	220,937	118,470
Per cent nickel..................	1.67	....	2.55	3.16	5.10
Per cent copper..................	1.59	....	1.78	1.81	2.41
Ordinary matte ......Short tons.	23,336	29,588	24,691	30,416	} 8,924
Bessemerized matte...Short tons.	112	15,546	13,332	14,419	
Nickel content........Short tons.	3,540	4,441	5,945	6,998	5,274
Copper content........Short tons.	3,364	4,197	4,066	4,005	2,445
Value of nickel (a)	$756,626	$1,859,970	$2,210,961	$2,499,068	} $82,193,198
Value of copper..................	319,681	589,080	616,763	583,646	
Wages paid.......................	728,946	1,045,889	835,050	746,147	(b)
Men employed.....................	1,144	2,284	1,445	1,277	(b)

NOTE.—The quantities reported in 1901, 1902 and 1903 under "bessemerized matte" include both bessemerized matte and high-grade matte, the former being the product of the Mond Nickel Company's works and the latter of the Ontario Smelting Works, which retreat the low-grade matte produced by the Canadian Copper Company. (a) Value based on nickel in matte and not on refined nickel. (b) Not available.

Chile.—Cobalt mines are operated in the Provinces of Atacama, Coquimbo, and Aconcagua. The production in 1903 was 284 metric tons of 7.15% ore. The largest producer is the Rosa Amelia mine, situated in the department of Freirina, Atacamba; this mine, in 1903, gave 133 tons of ore carrying 0.09% cobalt. In the Goyenechea mine, in the department of Chañaral, an argentiferous cobalt ore is mined carrying 8% cobalt.

New Caledonia.--The International Nickel Co. and Société le Nickel are the chief operators of nickel mines in New Caledonia. During the past year their properties were actively developed and good returns were obtained.

The exports of ores from the Colony for the full year are reported by the *Bulletin du Commerce,* of Noumea, as follows, in metric tons:

	1903.	1904.	Increase.
Nickel Ore..................	77,360	98,655	21,295
Cobalt Ore..	8,292	8,964	672

The export of cobalt ore was larger than in any previous year. The largest exports of nickel ore were reported in 1901, when the total was 133,676 tons, or 35,021 tons more than last year.

For a complete review of the mining industry of New Caledonia, reference should be made to "Richesses' Minéralés de la Nouvelle-Caledónie" in *Annales des Mines,* Tome IV (1903), p. 301, to Tome V (1904), p. 691.

Transvaal.—Cobalt is found in lodes traversing a dense quartzite belonging to the upper Pretoria beds, in the Balmoral district in the Transvaal. The quartzite is an altered igneous rock of granitic character. The veins occur within a short distance of the edge of a granite outcrop, suggesting contact metamorphism. They strike in a direction more or less normal to the contact and vary in thickness from a few inches up to 2 ft. The gangue consists of a dull gray or greenish quartz, pink feldspar, and a ferro-magnesian mineral, which are also the essential constituents of the granite. The cobalt occurs as smaltite, and is disseminated in small bunches and stringers through the gangue. The lodes are believed to be true pegmatite veins resulting from the intrusion of the granite and accompanying pneumatolytic action. No nickel is present in any of the veins.

Other sources of supply are found on the islands Ostero and Foeoe, off the west coast of Norway. The ore at the latter place carries 2.25% nickel and 2.2% copper, without any concentration, and is conveniently situated for shipment. Other mines have been opened at Evje, Ringerike and Askim, in southern Norway, the latter mine affording a hand-cobbed product carrying 2.42% nickel and cobalt. Near Carlsruhe, Saxony, a dyke carrying an 8-ft. seam of nickeliferous pyrrhotite ore has recently come into prominence. The ore carries 4 to 5% nickel, a little cobalt, and 2% copper.

Uses of Nickel and Cobalt.

Nickel is chiefly employed in the manufacture of special nickel- and nickel-chromium steels, and the use of these steels in shipbuilding, armor plate, artillery, eye-bars and other purposes in the arts is constantly increasing. There is probably no armor or protective-deck plate made that does not contain from 3 to 5% of nickel. The high specific gravity of a nickel-tungsten alloy (14.5), combined with its great strength, make it very valuable for the manufacture of projectiles.

The properties which make nickel-steel, or nickel-chromium steel, valuable in the arts are hardness, great tensile strength, great ductility, and a very high limit of elasticity. A singular feature of the nickel-steel used in the Krupp armor plate is that when it is pierced by a projectile it does not crack and warp. Krupp steel contains 3.5% of nickel, 1.5% of chromium, and 0.25% of carbon.

Nickel-steel is particularly adapted for heavy forgings, electrical machinery, cables and wires. The British and American naval engineers are using nickel-steel to a very large extent in marine engines. The high permeability of nickel-steel at high inductions, its high tensile strength and elastic limit, make it valuable in the electrical industries. In rock-drills, and other machines subjected to repeated and violent shocks, nickel-steel containing 3% nickel and 0.40% carbon is used. A possible application may be found for nickel-steel in making cutlery, to which its comparative freedom from corrosion, and its ability to take and keep a sharp edge, adapt it.

Cobalt has been found to exercise an influence on steel similar to that of nickel; its limited supply, however, removes it from competition with nickel in this application. Cobalt oxide is used in the glass and ceramic arts to give the well known blue color. As a blue pigment, cobalt is used either as 'smalt,' or as 'cobalt blue'; the latter is now replacing the older method of blue coloring by reason of its superiority. Smalt is a glass, colored blue by admixture of cobalt, and is made by fusing together roasted cobalt ore, silica and potash, then powdering and washing the fusion. Smalt is a particularly permanent color. Cobalt blue is a mixture of the oxides of cobalt and aluminum. The best process of manufacture[2] is to precipitate cobalt phosphate by adding sodium phosphate to a solution of cobalt nitrate, washing the precipitate. One part of this is mixed with eight parts of freshly precipitated alumina (by addition of sodium hydroxide to a solution of alum or aluminum sulphate) and the mixture heated at bright red heat in a crucible for 45 minutes. The mixture will then have developed a fine blue color; it is then ground with water and dried.

Progress in the Metallurgy of Nickel and Cobalt.

Physical Properties.—H. Copaux prepared nickel and cobalt containing not more than 0.05% of non-metallic impurities and determined the physical constants, with the following results,[3] as compared with previously accepted figures:

	Nickel.		Cobalt.	
	Observed.	Former.	Observed.	Former.
Specific gravity at 15° C.	8.8	8.3–9.2	8.8	7.96–9.5
Hardness	3.5	....	5.5	....
Melting point	1470° C.	1480° C.	1530° C.	1600–1800° C.
Specific heat (20–100° C.)	0.108	0.108	0.104	0.103
Electrical resistance at 0° C.	6.4	6.9	5.5	....
Coefficient of expansion (0° –20° C.)	0.0061	0.0061	0.0055	....
Breaking stress	42	90–55	50	115

The unit of specific gravity is water at 4° C. = 1; of hardness, Moh's scale; of specific heat, water at 15° C. = 1; of electrical resistance, microhms-centimeters; of breaking stress, kilograms per square millimeter.

Nickel Hydroxide in the Manufacture of Caustic Soda.—Hans A. Frasch[4] found that nickel and cobalt could be readily separated from copper by ammoniating a solution of these metals and precipitating the nickel and cobalt in the form of nickel- and cobalt-ammonium chloride, by the addition of sodium chloride to the ammoniated solution; the copper remained in solution. By this method the nickel contents of solutions containing 125 gm. nickel were reduced to 0.05 gm. per liter. It was then found that

[2] 'Painters' Colors, Oils and Varnishes,' George H. Hurst, third edition, p. 225.
[3] *Comptes rendus,* CXL, p. 657.
[4] For full description see 'A New Caustic Soda Process," by Hans A. Frasch, *Journal* Society of Chemical Industry, Jan. 16, 1905.

nickel hydroxide in the presence of ammonia will react upon sodium or potassium chloride, resulting in nickel-ammonium chloride and caustic alkali; thus, if ammoniated salt brine is treated with nickel hydroxide the reaction forms nickel-ammonium chloride and caustic soda solution. The former being insoluble in the caustic liquor is separated by filtration, washed with ammoniated salt brine and subjected to distillation, whereby the ammonia and nickel hydroxide are recovered and returned to the process, while the caustic soda solution is concentrated in the ordinary manner. The amount of nickel hydroxide required is about 80% of the amount of salt to be converted.

About 73% of sodium chloride contained in the brine will be converted. The reaction requires about an hour. If the process, and particularly the recovery of the nickel oxide, is properly conducted, complete conversion of the salt in theoretical quantities may be obtained. It is claimed that the equipment of plant, as well as cost of manufacture by this method, are less than are involved in the manufacture of soda ash by the ammonia process, while it possesses the further advantage that consumers may easily produce their own caustic solutions direct from salt.

Electrometallurgy of Nickel.[5]—G. H. Brin reduces nickel oxide, or an ore of the oxide, in an electric furnace in presence of silica and carbon, to obtain either a nickel silicide, or a double silicate of iron and nickel. These are refined in a suitable furnace, mixed with calculated proportions of nickel oxide or iron oxide, or a mixture of the two, according to whether it is desired to obtain pure nickel or ferro-nickel. Sulphur may be eliminated in the process by addition of a small proportion of manganese silicide.

M. Malzac has patented[6] a process in which silicated nickel ores, and especially such as those of New Caledonia or of Silesia, are digested with sulphuric acid (or other strong acid) and the mass is lixiviated, in some cases with addition of ammonia to the washing water. The filtered solution is heated with lime, the ammonia expelled is recovered, and the product, freed from the precipitated calcium sulphate, etc., by filtration, is electrolyzed, preferably with addition of ammonia to facilitate the cohesion of the metals deposited.

E. Günther[7] has been successful in the direct electrolytic treatment of a nickel matte low in copper. The solution of the material at the anode was satisfactory. Using slightly acid nickel sulphate as electrolyte, at first 92% of the current efficiency was attained, which, only much later, fell to 80%. At the cathode, nickel of 99.27% purity was deposited in an excellent form.

Electrolytic Refining of Copper-Nickel.[8]—A. G. Betts, Troy, N. Y., has invented a method of separating nickel from copper, and the recovery of both, by a series of electrolyses under different conditions. A solution of

[5] *Journal* of the Society of Chemical Industry, Nov. 30, 1904.
[6] English Patent No. 1,556, Jan. 21, 1904.
[7] *Metallurgie,* 1904, I, p. 77. *Zeitschrift für Electrochemie,* 1904, X, p. 836.
[8] United States Patent, No. 789,523, May 9, 1905.

copper and nickel sulphates is electrolyzed, using an alloy of copper and nickel as the anode; copper is deposited and nickel sulphate remains in solution. The latter is then electrolyzed, using an anode of spongy lead, nickel being deposited on a suitable cathode; the lead sulphate formed is then reduced to spongy lead by making it the cathode in an electrolytic cell, sulphuric acid being simultaneously formed. The acid is then electrolyzed, using an anode of copper and a cathode of lead peroxide; copper sulphate is re-formed and is returned to the bath in which copper is deposited.

Electrolytic Deposition of Nickel Sheets.—D. H. Browne has investigated the conditions under which tough, firmly adherent and thick deposits of nickel may be obtained. He emphasizes the advantages of renewing the solution in the neighborhood of the cathode, as also of using the more soluble chloride and sulphate of nickel, rather than the double sulphates. With a copper or tinned-iron cathode thickly coated with graphite, a solution of nickel sulphate and an efficient circulation, a deposit, started at anything between 50 and 300 amperes per square meter, can be carried through, and will produce a smooth, easily separated sheet that will lie flat. Such deposits are, however, glass hard and very springy, and unless annealed cannot be bent. The best conditions for depositing flexible sheets of nickel from chloride solutions are said to be: (1) neutrality of solutions; (2) heating the bath, which increases the flexibility; (3) solution of about 70 gm. $NiCl_2$, 180 gm. NaCl per liter; (4) current from 100 to 200 amperes per square meter; (5) efficient circulation. Curved cathodes, of a curvature varying with the current density employed, are recommended for obtaining flat plates without tendency to curl.

Preparation of Nickel-Steel from Magnetic Sand.—According to Sjöstedt,[9] the magnetic sand obtained at Sudbury contains 2 to 3% of nickel and 1 to 2% of copper. After mechanically separating the portion rich in copper, the average composition of the sand is found to be: Nickel, 3%; copper, 0.5%; sulphur, 28%; iron, 50%; and phosphorus, 0.01%. This is roasted and then smelted with coke and lime in an electric furnace of the usual type; the product contains about 8% of nickel, 53% of iron, and 3% of sulphur. By this means it is stated that 27 kg. of nickel-steel can be produced in one hour, by employing 108 kilowatts, the cost being computed to be $25.11 per ton.

Electrolysis of Cobalt.[10]—F. M. Perkin and W. C. Prebble offer a suggestion bearing on the electrolytic determination of cobalt. The method yields firm, bright deposits, and gives analytically correct results: One gm. of cobalt ammonium sulphate is dissolved in 50 c.c. of water and 5 c.c. of a 5% solution of phosphoric acid is added. After a further addition of 25 c.c. of a 10% solution of di-sodium phosphate, the liquid is made up to

[9] 'Nickel Steel from Magnetic Sand,' by E. A. Sjöstedt, L'Electricien, 1904, p. 27c
[10] Faraday Society.

130 c.c. and electrolyzed. A brown deposit of cobalt oxide forms on the anode after half an hour, and this is dissolved away by adding about 0.5 gm. of hydroxylamine sulphate or chloride. When the bulk of the cobalt has been deposited, it is advantageous to add a few drops of dilute ammonia to neutralize the excess of electrolytically liberated acid. At a temperature of 55 to 60° C., electrolysis is complete, and after 3½ hours, the current density being kept low for the first hour (0.4 ampere per sq. dcm.), and then raised to 1 or 1.8 amperes. Whereas this phosphoric acid bath was found to be the only one suitable for cobalt, nickel, which deposits well from several other baths, with this one gave unsatisfactory results.

PETROLEUM.

The production of petroleum in the United States in 1904 was 115,243,572 bbl., as compared with the 98,835,967 bbl. in 1903; a gain of 17,407,605 bbl., or 17.6%. California increased its lead, which it obtained first in 1903, over all other States, by a gain of more than 4,000,000 bbl. Indiana made a substantial gain of 1,600,000 bbl., but all the other Eastern States show a marked declining tendency, although they must for many years afford the chief supply of high-grade refining oils.

The States of the Middle West and the South, in which the petroleum industry is of comparatively recent origin, show the greatest activity. Texas is already second only to California in size of output, and the Kansas-Indian Territory field is making rapid strides. Louisiana in 1904 more than tripled its 1903 output. This tendency indicates a reversal of the previous relative importance of the heavy asphaltic and the lighter oils with paraffine base. In 1900, the Appalachian and Lima fields afforded 92% of the total output of the country; this preponderance has been progressively disappearing, until, in 1904, these fields gave only 31% of the total production. The following table gives the output of crude petroleum in barrels of 42 gallons:

PRODUCTION OF CRUDE PETROLEUM IN THE UNITED STATES (a).
(Barrels of 42 gallons).

	1900.	1901.	1902.	1903.	1904.
Appalachian Field (b)	35,540,965	33,618,180	32,018,787	29,897,815	31,408,567
California	4,250,000	8,786,330	14,356,910	24,340,839	28,423,860
Colorado	525,000	460,520	396,901	483,925	501,763
Indiana	4,329,950	5,757,086	7,535,561	9,177,122	10,744,849
Indian and Oklahoma Territory	....	....	37,100	138,911	1,366,748
Kansas	65,000	179,150	322,023	1,018,199	4,250,779
Louisiana	....	....	548,617	917,771	2,941,419
Ohio (Lima field)	16,407,704	16,176,293	15,877,730	14,893,853	13,350,060
Texas	800,000	4,393,660	18,083,658	17,955,572	22,241,413
Wyoming	7,200	5,400	6,253	8,960	11,542
Others	30,000	2,585	957	3,000	2,572
Total	61,955,819	69,379,204	89,184,497	98,835,967	115,243,572

(a) Statistics of the Geological Survey, except for California and Indiana. (*b*) New York, Pennsylvania, West Virginia, Southeast Ohio, Kentucky and Tennessee.

Alaska.—Petroleum is being developed at Controller Bay, Cook Inlet, and at Cold Bay, widely separated points along the south coast of Alaska.[1] At Controller Bay, 15 wells had been, or were being, drilled in September, 1904, one of which supplies oil for drilling work at other points. No other well has struck oil, although none has passed below 1,100 ft. At Cook Inlet, four wells have been drilled. One of them found gas and oil at 770 ft., and a small output was recorded. At Cold Bay, several derricks have been erected

[1] 'The Petroleum Fields of the Pacific Coast of Alaska,' George C. Martin, U. S. Geol. Survey, Bulletin No. 250.

and several wells have reached 1,500 ft. The petroleum of Controller Bay, to which that of Cold Bay is similar, appears to have a paraffine base, to be rich in volatile products, and to be nearly free of sulphur.

EXPORTS OF MINERAL OILS FROM THE UNITED STATES. (In gallons.)
(1 = 1,000 in quantities and values) (a).

Year.	Crude Petroleum.		Naphthas.		Illuminating.		Lubricating and Paraffine.		Residuum. (b)		Totals.	
1900....	133,161	$7.341	18,570	$1,681	739,163	$54,693	71,211	$9,933	19,750	$845	986,855	$74,493
1901....	127,008	6,038	21,685	1,742	827,479	53,491	75,306	10,260	27,596	1,255	1,079,059	72,786
1902....	145,234	6,331	19,683	1,393	778,801	49,079	82,200	10,872	38,316	922	1,064,234	68,597
1903....	126,512	6,782	12,973	1,519	691,837	51,356	95,622	12,690	9,753	282	936,697	72,629
1904....	111,176	6,351	24,989	2,322	761,358	58,384	89,688	12,393	34,904	1,174	1,022,115	80,624

(a) In addition to the above, the following quantities of paraffine and paraffine wax were exported: 1900, 157,108 lb. ($8.186); 1901, 151,695 lb. ($7,960); 1902, 175,268 lb. ($8,398): 1903, 204,120 lb. ($9.596); 1904, 174,582 lb. ($8,273). (b) Reported in barrels of 42 gallons.

California.—For two years now California has maintained its lead over all other States in petroleum output, having surpassed Ohio for the first time in 1903. Production in 1904, as reported by the California Petroleum Miners' Association, was 28,423,860 bbl. A review from the Secretary of the California Petroleum Miners' Association will be found on a following page.

Colorado.—The Florence field produced 501,763 bbl., valued at $1.152, in 1904, as against 483,925 bbl. (89.2c.) in 1903, and 396,901 bbl. ($1.22) in 1902. Towards the end of the year, the unexpected growth of production to 3,000 bbl. per day, refining and storage capacity being limited, made necessary the shutting off of about 100 wells, and the few independent owners were the first to suffer. The United Oil Co., at Florence, immediately started to enlarge its plant. About 500 wells have been drilled, but only about three wells in eight are now profitable. The high grade of the oil and the long life of the wells (they average 5 years, some have lasted for 10 to 20 years, and one has yielded more than 1,000,000 bbl.) have been the profitable factors. Oil is contained in the Pierre (Cretaceous) beds, though the most productive horizons can not be defined.

Indiana. (By W. P. Blatchley.)—The condition of the oil industry in Indiana has become an index to the financial and commercial progress of the State. A report for the year 1904 reflects an exceedingly bright outlook, but yet the oil industry needs more than ever an independent market and less domination by the Standard Oil Co. Independent refineries have been suggested, but no relief has been secured along this line as yet.

During the year a large area of producing territory was added to the Indiana oilfield. This addition was not made by any notable strike, but by gradual development along the margins of tested productive territory; and, under the stimulus of high prices, by more careful testing of interior areas that had previously been condemned; the field, which covered 1,350 square miles January 1, 1904, has been increased at least one-third. About 300 new oil companies were formed and incorporated during the year, and 55 foreign companies were admitted to do business in the State under the corporation law. There were 4,049 producing wells drilled during the year (4,239 in 1903) and 577 dry holes.

The production of the Indiana wells in 1904 was the largest year's output in the history of the oil industry in the State. Less than 700,000 bbl. were produced in January and February, but from then on the production increased rapidly, owing to the numerous gushers found in the deep-sand pools. From 683,334 bbl. in January, the output increased to 1,065,620 bbl. in December; total production for the year, 10,744,849 bbl.; valuation, $11,305,688. The average price paid was $1.08¼. Land owners received about $6,000,000 for their royalties, and the rest was received by the well owners. There were at the close of the year 30,540 producing wells in Indiana, a limited number of which produce gas. This record is unequaled by any other high-grade oilfield in the United States. Fabulous prices are being paid for territory, and companies' holdings change hands occasionally at figures that are surprisingly large. Some companies pay as much as 50% monthly dividends, others 300% yearly. The oil industry is destined to bring more wealth to Indiana than did natural gas during the seventeen years of its production.

Kansas and Indian Territory. (By Erasmus Haworth.)—During 1904 oil development in Kansas and the Indian Territory was unusually vigorous. At the beginning of the year less than 1,600 wells were producing oil within the entire area; at the close there were fully 4,000. The total production of oil during the year was 5,617,527 bbl., of which Kansas gave 4,250,779 bbl. and Indian Territory and Oklahoma the remainder. In 1903, the gross output was 1,071,125 bbl. (Kansas, 932,214), and in 1902, 368,849 bbl. (Kansas, 331,749). During 1904, the daily average for the whole field rose from 9,107 bbl. in January to 24,353 bbl. in December, averaging 15,287 bbl. per day for the year. The average price per barrel was 97c. in 1904, $1.04 in 1903, and 88⅖c. in 1902.

The most productive areas in Kansas are found principally in Allen, Neosho, Wilson, Montgomery and Chautauqua counties. Early in the year there was great activity in the Bolton field near Independence, in Montgomery county; also rapid development in all of the other counties named, particularly Chautauqua. By the end of the year, activity had moderated to a considerable extent in all parts of Kansas except Chautauqua county.

The new outlying fields that were developed during the year within the State were one in the vicinity of Erie in Neosho county, and one in the vicinity of Paola in Miami county, which together gave an output of 14,500 bbl. Some oil developments began about Erie in 1903, but during 1904 a good supply of oil was obtained from many different wells. This has scarcely been marketed at all, on account of a lack of facilities for transportation. Activity about Paola began in earnest in midsummer, 1904, and continued to the end of the year. Here a shallow oil sand is found at a depth of about 350 ft., which seems to be as productive as the average oil sand of Humboldt and Chanute. The Standard Oil Co. has promised Paola a pipe-line.

Oil development at Coffeyville began during 1903 and continued throughout 1904. A fair amount of good oil was found in shallow sands from 350 to 500 ft. deep. This territory seems to be very spotted, so much so that during the latter part of the year prospecting was not crowded. Oil was found also about Tyro, nine miles east of Caney, near the southern boundary of the State. That field, likewise, is spotted, some wells flowing as much as 250 bbl. per day, while others near by may be dry. A fair pool was opened up during the year in the vicinity of Wayside, on the Santa Fé railway, about six miles southwest of Bolton, or 12 miles from Independence.

In Chautauqua county there seem to be three well-defined pools; the Spurlock-Blundell pool near the southern line of the county, south and a little west of Peru; the Hoffman pool, from three to five miles south of Sedan, and the pool immediately under the little town of Peru. The Spurlock-Blundell area had the greater development early in the year, but later the Hoffman field became the most active. It bids fair to develop into the best oilfield yet opened up in the State. More than a hundred wells were put down on town lots in Peru. They started with a capacity of from 20 to 30 bbl. per day, but are now almost exhausted. In the vicinity of Humboldt and Chanute, oil is obtained at from 700 to 900 ft.; in the Bolton-Wayside area from 800 to 1,000 ft.; at Coffeyville oil thus far found is shallow, from 350 to 500 ft.; at Tyro it is from 1,050 to 1,200 ft.; at Caney near 1,400 ft.; in the Spurlock-Blundell pool, oil is usually found at 1,100 to 1,150 ft., and in the Hoffman pool at about 1,200 to 1,300 ft. depth. The oil-bearing rock is the Cherokee shale, the lowermost member of the Pennsylvania series, resting unconformably upon the Boone formation, which, in adjacent parts of Missouri and Arkansas, is noted for its zinc and lead ores. No gas or oil has been found in Kansas in or below the Boone horizon.

Throughout more than half the year development in the Indian Territory was confined principally to the lands belonging to the Osage Indians, on account of difficulties in the way of obtaining leases elsewhere. The Indian Territory Illuminating Oil Co. has a blanket lease on the entire Osage lands and sub-leases to actual operators. Development was confined principally to the extreme eastern portion of the Osage lands until near the close of the year. In September a good oil well was brought in at Cleveland, in Oklahoma Territory, just across the Arkansas river from the Osage lands. This resulted in a great rush to all adjacent lands, both in Cleveland on the south and in the Osage nation on the north, and at present many drills are in operation on both sides of the river. It is reported that leases there are higher than anywhere else, excepting immediately adjacent to Bartlesville. Development was also carried on throughout the year in the vicinity of Muskogee, Chelsea, Tulsa, Red Fork and Bartlesville.

Later in the year the Secretary of the Interior began to confirm leases within the Cherokee territory, and drilling began immediately with great activity, so that at present derricks are being erected and drills are in operation in many places. A few small areas were leased previously, notably, Section 12, including nearly all the town-site of Bartlesville, which was leased to the Cudahy Co.; and an area of 12 sections near Chelsea leased to the Cherokee Oil & Gas Co. A part of the town-site of Bartlesville was deeded outright, so that the owners can lease or drill at their pleasure. Since Cherokee leases have been confirmed, drilling has become very active in the vicinity of the little town of Alluwe, about 30 miles south of Coffeyville, and also at the villages of Dewey and Lenapah, the former being four miles north of Bartlesville and the latter ten miles south of Coffeyville. At the close of November, Chelsea had about 96 producing wells, Red Fork 50, Cleveland 10, Muskogee 35 or more, Bartlesville nearly 200, and other points within the Osage territory 75 or 80 more.

At Chelsea and Alluwe the wells are from 300 to 600 ft. in depth; at Red Fork and Tulsa, from 700 to 1,000 ft.; at Muskogee, 1,000 to 1,200 ft.; at Bartlesville, about 1,100 to 1,400, and at Cleveland, 1,600 to 1,700 ft., the deepest of any in the entire Kansas-Indian Territory field.

Some recent analyses of Kansas oils are given in the following table. The method consisted of distilling the volatile products in fractions, each approximating one-tenth of the original volume, while noting the limiting temperatures in Centigrade and the specific gravity of each fraction, in Baumé degrees:

DISTILLATION OF KANSAS PETROLEUMS.

	Humboldt.		Neodesha.		Neodesha, 2.		Topeka.	
	Temp. Deg. C.	Sp. gr. Deg.B.	Temp. Deg. C.	Sp. gr. Deg.B.	Temp. Deg. C.	Sp. gr. Deg.B.	Temp. Deg. C.	Sp. gr. Deg G.
Crude, at 60° F.	....	27.3	....	32.8	....	31.5	....	27.7
First tenth	95–160	40.1	95–201	52.1	95–200	....	70–185	49.2
Second tenth	160–190	40.1	201–298	38.8	200–285	....	185–254	40–2
Third tenth	190–250	32.5	298–320	33.9	285–320	....	254–290	34.0
Fourth tenth	250–265	32.5	320–337	30.4	320–330	....	290–297	32.2
Fifth tenth	265–270	31.5	337–350	29.5	330–345	....	297–310	30.1
Sixth tenth	270–278	31.5	350–	29.0	345–360	....	310–328	28.8
Seventh tenth	278–305	30.5	....	27.9	....	....	328–330	28.0
Eighth tenth	305–340	30.5	....	27.8	....	....	330–330	27.9
Ninth tenth	340–360	....	....	27.0	....	....	330–360	27.9
Tenth tenth	....	....	....	26.9	....	....	360–	27.6
Coke, per cent by weight	3.20	....	0.98	....	0.77	....	2.10	....

(a) *Proceedings* of the Western Gas Association, Chicago, May 17, 1905; in the *Progressive Age*, Aug. 1, 1905, p. 396.

The Standard Oil Co., under the title Forest Oil Co., but later changed to Prairie Oil & Gas Co., entered the field in 1895; in 1897 it built a 500-bbl. refinery at Neodesha. Within the last two years it has built a refinery at Kansas City, Mo., with a pipe system branching into Kansas and Indian Territory, and reaching every producer of reasonable magnitude. The prices paid at the wells, for oil to be transported by the pipe-line, ranged from 31c. for the heavy oils (22°-28° B.) to 72c. for the lighter (32° B.) oils. This stimulated a production greater than the refiners could handle, so that, with the successive reductions in prices, many producers failed to pay dividends. Resentment against the trust finally became so acute that, in the winter of 1904, the legislature was led to appropriate $410,000 to build an independent State refinery at Peru, seeking to avoid the Constitutional prohibition of State participation in 'works of internal improvement' by making the refinery an adjunct of the State penitentiary. The Supreme Court has since ruled the act unconstitutional. The Federal Commissioner of the Bureau of Corporations, however, is investigating the whole matter.

Louisiana.—The Jennings and Welsh fields, in Calcasieu parish, made a heavy output in 1904—6,611,419 bbl., at an average value of 36⅓c. per bbl., as against only 917,771 bbl. (45⅓c) in 1903 and 548,617 bbl. (34⅖c.) in 1902. Jennings oil is lower in sulphur than Beaumont oil, but is not so adaptable to the distillation of commercial oils as to use, in its crude state, for gas making, in which employment it makes a more stable gas than the Texas oils. The oil-bearing stratum consists of unconsolidated, coarse-grained sand, and lies at an average depth of 2,000 ft. Since the latest gushers have come in, the earlier wells have declined, and many have ceased entirely, while salt water has appeared in others. In the fall of 1904, of the 90 wells down, six were flowing and 30 pumping, giving an output of 15,000 bbl. per day; with the bringing in of the Seagrove and the Wilkins No. 2, a 15,000-bbl. gusher, in December, the output rose to 50,000 bbl. per day. This, however, was a maximum point, the output declining early in 1905. Up to the end of the year, the Southern Pacific's tank cars offered the only means of export, but early in 1905 pipe lines were begun to the Atchafoya river, a distance of 45 miles, and to the Mississippi. Promising developments have occurred at Shreveport, where a good pumping field is anticipated, and at Caddo Island, whose oil resembles that of Corsicana, Texas.

ANALYSIS OF JENNINGS OIL.

Color, reddish brown; specific gravity, 0.9172=22.6 deg. B.; water, 5 per cent by volume; sulphur, 0.36 per cent by weight.

Temp. of dis.; Deg. F.	Per cent by volume	Per cent by weight.	Specific gravity.		Description of Fraction.
			Direct.	Baume	
210–302	2.2	2.04	0.8517	24.5	Light canary.
302–350	0.5	0.46	0.8568	33.4	Colorless.
350–400	0.7	0.65	0 8618	32.4	"
400–450	9.7	9.23	0.8726	30.4	Light canary.
450–500	14.1	13.60	0.8846	28.3	"
500–550	13.9	13.53	0.8928	26.8	"
550–572	5.8	5.73	0.9061	24.5	Canary.
572–600	5.1	5.06	0.9102	23.8	"
600–650	23.6	22.91	0.8903	27.2	"
650–700	17.1	16.93	0.9802	24.1	Terra cotta.
700–760	4.2	4.59	1.0041	0.6	Dark bronze green.
Coke.		2.38			Coke.
Total	96.9	97.11			

Texas.—Oil wells are being operated in eight counties of Texas, while indications of oil have been noted in 36 counties. The Nacogdoches field was the earliest and is still active, though making no progress. Its crude is not rich in illuminating oils, but it remains fluid below zero F. The Corsicana field, opened in 1894, produces two kinds of oil—a light one suitable for distillation of illuminating oil and gasolene, and a heavy oil, only half the market value of the former. The oil sand, ranging from 10 to 40 ft. thick, lies uniformly at a depth of 1,000 ft. Two extensive refining plants have been operated for several years in the vicinity of this field. The Beaumont field, whose famous Spindle Top gushers, early in 1901, were spouting 500,000 bbl. per day, declined rapidly, until at the end of 1904 it was giving less than 3,500 bbl. per day, and the size of its 1904 output was surpassed by two more recent fields. Its first production came from a depth of over 1,100 ft., but now many well casings are being withdrawn to the shallower sands that were passed by in the search for gushers, and new wells will be put down to them. The Southern Pacific passes through the Beaumont field and offers a good market for oil. The Sour Lake field was opened in 1885, but was not developed until after the Spindle Top excitement.

The Saratoga and Batson fields are the heaviest producers of the State,

ANALYSES OF TEXAS OILS. (a)

Nacogdoches.		From near Waco.		Sour Lake.		
Fractions Deg. F.	Per cent by weight.	Fractions, Deg. F.	Per cent. by weight.	Fractions, Deg. F.	Per cent by volume.	Specific gr. Deg. B.
Below 300	0.04	Below 250	1.14	212–266	0.07	....
300–345	0.37	250–400	1.25	266–320	0.03	....
345–390	1.38	400–600	11.67	320–392	1.57	74.7
390–435	2.09	500–520	28.36	392–572	19.47	37.6
435–480	3.14	Total below 520	42.42	572–641	5.15	49.0
480–525	6.25	Sp. gr. at 60°.	35.6°B.	Residue.	71.11	13.1
525–615	7.07	....	....	....	....	....
615–680	5.63	....	....	....	....	....
Residue.	74.03	....	....	....	....	....

Fractions Deg. Fahrenheit.	Corsicana.			Beaumont, No. 1.			Beaumont, No. 2.		
	% by Wght.	% by Vol.	Sp. gr. Deg. B.	% by Wght.	% by Vol.	Sp. gr. Deg. B.	% by Wght.	% by Vol.	Sp. gr. Deg. B.
Crude at 60.	......	......	39.25	......	......	22.2	......	......	......
130–200	2.24	2.80	80.0	......	......	......	......	......	......
200–250	4.31	5.10	69.5	2.92	2.4	50.4	......	0.6	......
250–300	6.69	7.60	61.75	1.01	1.3	45.7	1.79	0.9	37.0
300–350	7.44	8.20	56.00	2.08	2.3	37.9	......	0.5	......
350–400	8.75	9.40	51.25	3.15	2.4	34.0	2.37	2.6	34.1
400–450	7.07	7.40	46.75	6.39	6.8	31.8	5.30	5.7	31.1
450–500	8.09	8.30	43.0	14.45	15.1	29.0	7.45	7.9	29.0
500–550	6.43	6.45	39.5	17.10	17.5	25.7	12.32	12.9	27.1
550–600	7.85	7.75	36.5	22.87	23.2	24.4	19.55	20.2	24.9
600–650	15.43	14.95	33.5	16.84	17.3	26.3	32.44	33.4	24.4
650–665	18.07	17.25	31.0	......	......	......	......	......	......
650–700	1.41	1.30	26.0	2.87	2.8	18.4	8.79	8.8	21.0
700–730	(b) 1.63	1.40	14.5	......	......	......	4.06	4.0	17.8
700–810	......	......	......	3.41	2.9	2.7	......	......	......
Coke.	2.63	......	......	3.24	......	......	4.02	......	......

(a) *Progressive Age,* Aug. 1, 1905, p. 401. (b) Over 650.

affording three-quarters of the output of South Texas. They are in the vicinity of Sour Lake, and were developed at the same time. Fires at Batson did damage in the fall of 1904. The Humble field is the newest of the big producers, its first gusher having been brought in on Jan. 7, 1905, at the rate of 8,500 bbl. per day. The oil is dark, gravity 22° B., and has a paraffin base. Inrushes of salt water and underground disturbances have delayed development. A pipe line was projected, and material obtained, but construction had not begun at the end of the year.

Analyses of Texas oils are given on page 350. The method here used was to fractionate between definite temperature limits, noting the proportional weight and volume of each fraction and its specific gravity.

The status of the fields on Feb. 1, 1905, and their annual production for the last five years, are shown thus:

TEXAS OILFIELDS. (a)

Field.	On Feb. 1, 1905.			Annual Production.				
	Weekly production.	No. wells.	Bbl. per well.	1900.	1901.	1902.	1903.	1904.
Batson	11,000	256	43	.....	....	....	4,518	10,204,300
Corsicana	......	......	......	829,560	763,424	571,059	401,817	503,647
Humble	9,310	4	2,327	.....	....	....	....	....
Saratoga	20,135	38	530	.....	....	....	75,000	704,350
Sour Lake	11,450	103	111	.....	....	....	8,848,159	5,707,500
Spindle Top	5,730	100	57	.....	3,593,113	17,420,949	8,600,905	2,828,150
Total	57,625	501	115	829,560	4,356,537	17,992,008	17,930,399	19,947,947

(a) *Progressive Age,* Aug. 1, 1905, p. 400.

These principal fields account for over nine-tenths of the State's output, small fields at Port Arthur, Sutherland Springs, and in Matagorda county supplying the rest. The total output of the State in 1904 was 22,241,413 bbl., of an average value of \$0.367 per bbl.; in 1903 it was 17,955,572 bbl. (\$0.419), and in 1902, 18,083,658 bbl., valued at \$0.221 per bbl.

It is estimated that \$36,147,000 was invested in the oil industry of Texas during the four years ending December, 1904, in drilling and equipping wells, constructing pipe lines and tankage, building refineries and purchasing cars and vessels for transporting the product. Eight companies control the pipe lines, aggregating 513.5 miles, of which mileage 32% is owned by two public-service companies, and the remainder by six private enterprises. The J. M. Guffey Petroleum Co.'s quotation of pipe-line tolls, Feb. 14, 1905, was 27c. per bbl. from Humble to the docks at Port Arthur, *via* Spindle Top, 89.3 miles, or a charge of ⅓c. per bbl. per mile. The customary storage charge in the southwest Texas field is 33⅓c. per 1,000 bbl. per day, or 1c. per bbl. per month. At Port Arthur, a dockage charge is levied at the rate of 1c. per bbl. for the first 5,000 bbl. and ½c. per bbl. for amounts in excess of this at one loading.

A recent eight-hour test of Beaumont oil was made at the Dallas Electric Co.'s plant, using one burner under a 370-h. p. boiler, with 10 ft. of heating surface, and feed water at 90° F., showing the following results: 6,447.5 lb. oil (7.43 lb. per gal.) evaporated 75,985 lb. water, under steam pressure of 110 lb., or 11.78 lb. water per pound of oil. With a factor of evaporation 1.169, this was equivalent to 13.77 lb. water from and at 212° per pound of oil. At 59c. per bbl., the oil used in this test cost $12.19. A precisely similar test, under identical conditions, on Huntington, Ark., coal, showed an evaporation of 7.59 lb. water per pound of coal, or 8.87 lb. from and at 212°. The total evaporation—75,973 lb.—cost $15.75, with coal at $3.15 per ton delivered. Another parallel test between coal and Beaumont oil (16° B.) on a Southern Pacific company's locomotive over a 224-mile stretch, at 130-lb. steam pressure, showed 74.14 miles run per ton of oil (3.1 bbl.), as against 55.72 miles per ton of coal; with oil at 30c. per bbl., coal should not cost but 93c. per ton, or with coal at $3, oil would be as cheap a fuel at 97c. per bbl.

West Virginia.—The production of this State is slowly declining, although it still surpasses the combined output of Pennsylvania and New York. In the production of 'white sand oil,' the finest petroleum in the world, it will undoubtedly retain its lead, since it has a larger area of such oil territory than any other State. It is noticeable that, as production declines, the price per barrel advances, the same being true of Pennsylvania.

Wyoming.—Of the 21 known fields in the State, Salt Creek is the largest producer, giving a steady output of 5,000 to 6,000 bbl. per year, of excellent lubricating stock worth $7 per bbl. The fields at Bonanza, Cottonwood and Cody, in Big Horn county, are receiving marked attention, due to the extension of the Burlington railroad to Cody. The Bonanza field affords an oil altogether different from the usual heavy lubricating oil of the State. Its specific gravity is only 0.884 (36° B); its flashing point is 55° F., and on distillation it yields over 20% gasolene and 40% kerosene. The wells at Salt Creek and Sander, and the refinery at Casper, have been bought by the Belgo-American Drilling Trust. The main drawback to the industry is the insufficiency of transport.

PRODUCTION OF CRUDE PETROLEUM IN FOREIGN COUNTRIES. (a).
(In metric tons.)

Yr.	Austria.	Hungary.	Canada. (e)	Germany.	India.	Italy.	Japan. (d)	Rumania.	Russia.
1900	347,213	2,199	101,743	50,375	151,523	1,683	124,613	250,000	10,524,919
1901	404,662	3,296	89,126	214,095	201,105	2,246	(b) 159,730	320,000	(c) 10,879,736
1902	520,847	4,347	75,985	49,725	227,340	2,633	142,518	310,000	(c) 10,327,044
1903	672,508	3,010	69,686	60,743	352,848	2,486	172,923	384,303	9,772,009
1904	827,117	......	77,129	89,606	....	......	......	......	10,059,221

(a) From the official reports of the respective countries. This table is not complete since it does not include the production of Sumatra, Borneo, Java, South Africa, Peru and some other countries. (b) In 1901 Japan also produced 11,214 tons of refined. (c) Output of Baku fields. (d) Reported in units of capacity but reduced to metric tons on the uniform basis of 0.90 as an approximate specific gravity. (e) Reported in barrels of 35 imperial gallons (1 bbl. weighs 143.2 kg. on an approximate sp. gr. of 0.90.)

An estimate of the world's production of crude oil, in round numbers, is given by *The Petroleum Review,* thus:

PETROLEUM OUTPUT OF THE WORLD.

	1902.	1903.	1904.
	Tons.	Tons.	Tons.
United States	10,980,000	12,557,000	15,000,000
Russia	10,950,000	10,320,000	10,600,000
Sumatra, Java and Borneo	732,000	830,000	1,000,000
Galicia	576,000	713,800	827,100
Rumania	310,000	384,300	496,800
India	209,000	325,400	404,000
Other Countries	270,000	250,000	250,000
Total	24,027,000	25,380,000	28,577,900

It will be noted that the United States maintains its lead as the greatest producing country in the world, and that in 1904 it supplied considerably over 52% of the world's total production.

Borneo.—The extensive petroleum resources of Borneo are being developed by the Shell Transport & Trading Co. The fields are at Balik Pappan and Sanga-Sanga, 50 miles apart; the refinery is at the former. Heavy, light, and paraffin oils are all found, at different horizons, on the island. During 1904, 30 wells afforded heavy oil and 21 gave light oil; other wells are approaching productivity. Production has been:

	Light Oils.	Heavy Oils	Total.
	Tons.	Tons.	Tons.
1901	66,069	57,523	123,592
1902	21,745	88,905	110,650
1903	25,553	122,349	147,902
1904	165,915	121,902	287,819

Thus, during the past year each well has produced 8,000 tons of light oils and 4,000 tons of the heavy crude. Some wells have been producing for many years, and one of these has, during the past year, yielded no less than 105,800 tons.

Japan.[1]—American methods have aided materially in developing the oil industry in Japan. The first modern boring machinery was introduced in the Amaze field in 1871. Seventeen years later, in 1888, the Japan Petroleum Co., capitalized at 150,000 yen (since increased to 1,200,000 yen, or $597,600), was formed, to operate in the oilfields of Echigo on the American system. In the last financial year this company paid a dividend of 45%. The great success of this company initiated a boom, and in the two years from 1890 to 1892 more than 200 oil companies, mostly speculative, were organized in Higashi Yama. In 1893, the Hoden Oil Co., capitalized at

[1] The Engineering and Mining Journal, July 21, 1904, p. 96.

25,000 yen, was organized. In nine years the capitalization of this company was increased to 1,500,000 yen ($747,000), and in March, 1902, it acquired control of 14 oil companies, three refineries, three pipe-line companies, and 10,000 acres of proved oil land in the Echigo field. The company is operating 244 wells, has 32 miles of pipe line, 84 tank cars, gives employment to 1,184 men, and produces daily over 50,000 gal. refined oil. Another large consolidation is the International Oil Co., organized in 1900, with property in Kasuga Shinden, in the suburbs of the city of Naoyetsu, the terminal of the Hoku-Yetsu and Slim-Yetsu railways. The International's present share capital is 10,000,000 yen ($4,980,000). The daily capacity is 120,000 gal. refined oil.

Mexico.—The State of Chihuahua has offered a bonus of $10,000 and exemption from taxation for 10 years for the first discovery of oil in commercial quantities. Mexico places an import duty of $4.68 per barrel for crude and $16.20 per barrel for refined oil for the purpose of stimulating the local industry.

Rumania.—The production of petroleum did not begin in Rumania until 1860. It amounted to 384,000 tons in 1903 and exceeded 410,000 tons in 1904; this puts Rumania fifth among the producers of petroleum. Exports in 1904 were: Crude, 25,675 metric tons; illuminating, 74,445 tons; lubricating, 6,668 tons; residuum, 13,575 tons; benzine, 39,131 tons; total, 159,524 tons, an increase of about 34,200 tons. Crude and residual decreased, while refined and benzine increased strongly. France and England are the leading markets.

Developments are confined to the vicinity of Compina-Boustenaci-Poiana, in which are 66 operators.[2] At first they got their petroleum by ditches and shallow excavations, then by shafts, but now by boring wells. In this district are more than 1,000 shafts, of depths varying from 4 to 250 meters, and 300 bores, the deepest of which goes to 600 meters. The crude petroleum sells for 15 to 20 francs per ton (43 to 57c. per bbl.).

Internal domestic consumption reached 132,000 tons in 1903—a small amount, for this figure does not represent more than 5 kg. per capita. Industrial consumption of residues is principally that by railroads, which have used this fuel since 1887; in 1903, out of 512 locomotives, 373 were burning petroleum residues. In order to facilitate exportation, a pipe line from Compina to the port of Constantza, a distance of 330 kilometers, has been projected; but the project is vigorously opposed.

Russia.—Development in the Baku district progressed actively during 1904, although destructive fires, labor disturbances and demoralization of the export trade prevented its due manifestation. The total output of the district in 1904 was 10,059,221 metric tons (614,115,445 poods),[3] as com-

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[2] M. Aron, *Memoirs* de la Société des Ingenieurs Civils de France, August, 1905, p. 298.

[3] 1 pood = 36.112 lb.; 1 metric ton = 61.05 poods. Assuming an average specific gravity of 0.90 for petroleum, a barrel of 42 United States gallons weighs 0.14309 metric ton, or 8.7356 poods. (A practically equivalent barrel of 35 Imperial gallons weighs 0.14320 metric tons or 8.7422 poods.)

pared with 9,772,009 metric tons in 1903. The different fields contributed to this output as follows:

PRODUCTION OF THE BAKU OILFIELDS IN 1904. (a)

Field.	Spouters.		Pumping.		Total.	
	Poods.	Barrels.	Poods.	Barrels.	Barrels.	Metric tons.
Balakhony	....	....	82,037,410	9,390,730	9,390,730	1,343,774
Bebe-Aibat	22,355,200	2,558,596	158,786,182	18,176,074	20,734,670	2,967,099
Binigadi	....	....	304,486	34,854	34,854	4,987
Ramany	8,499,900	972,974	133,809,495	15,313,586	16,286,560	2,191,803
Saboontchi	5,370,000	614,697	211,452,673	24,204,747	24,819,444	3,551,559
Total, 1904	36,225,100	4,146,267	577,890,345	67,119,991	71,266,258	10,059,322
Total, 1903	53,515,000	6,125,798	543,066,155	62,164,166	68,289,964	9,771,681

(a) From the *Neftianoe Dielo*, by the *Petroleum Review*.

From this it appears that, while the gushing wells are diminishing their volume, the pumping wells, the mainstay of the industry, are becoming more productive. The Saboontchi field, although it retains its leading position, shows a diminution, when compared with 1903, of 13,600,000 poods, sustained by the pumping wells. Balakhany also decreased by 6,600,000 poods. The other fields all showed enlarged outputs, Ramany by 14,000,000, Bebe-Aibat by 22,700,000, and Binigadi by 46,000 poods. The loss of production by the December strike was not less than 110,000 bbl. per day for the month.

The number of wells which produced oil during the whole or part of 1904 was 2,066, against 1,877 in 1903, while the number of spouters in 1904 was 26, against 33 in the previous year. The number of wells that commenced drilling in 1904 was: Balakhany, 65; Saboontchi, 116; Ramany, 62; Bebe-Aibat, 59; a total of 302, against 233 wells started in 1903. The number of wells completed during 1904 was: Balakhany, 53; Saboontchi, 106; Ramany, 54; and Bebe-Aibat, 45; or a total of 258, as against 193 wells for 1903. The condition of the district at the end of 1904 is indicated by the following:

December 31.	1903.	1904.
Producing wells	1,420	1,555
Trial pumping	27	31
Drilling	358	279
Deepening	96	66
Cleaning out and under repair	257	327
Standing idle	1,276	1,443
Total	3,434	3,701

The total number of firms operating in the oilfields during 1904 was 143, but out of these, nine of the largest firms, with a production of more than 20,000,000 poods each, together contributed no less than 54.5% of the total production. It is noticeable that the whole output of the spouting wells is controlled by the firms whose output is largest.

The pipe line from Baku to Batum is still incomplete. Much progress, however, is being made, and it is the general opinion that the whole length will be completed during 1905. At the end of 1904 the line was working only from Baku to Aibat and from Michaelovo to Batum, so that oil had to be pumped at Aibat into railway tank cars and conveyed to Michaelovo, where it again entered the pipe. Even this has greatly facilitated transport of standard kerosene, for the sending of the tank cars to the many refineries at Baku by the railway has now ceased.

A British consular report states that shipments of all petroleum products from Batum only have been:

To	1903.	1904.
	Barrels.	Barrels.
Foreign countries	9,415,256	9,261,718
Russia	502,750	427,690

Shipments from Novorossisk, the other Black Sea port, in 1904, comprised 21,879,992 poods of refined, and 1,782,320 poods of residuum and crude.[4]

In the early part of 1904, prices of kerosene were fairly high, but later the demand decreased and a considerable fall in prices followed. Meanwhile Baku continued forwarding kerosene to Batum, so that toward the autumn the tank storage accommodation at that port became scarce, and at the end of the year stocks of oil were so large that all available reservoirs were filled. Tankage at Batum is estimated at 15,500,000 poods, and the stocks amounted to nearly 15,000,000 poods.

In the spring of 1905, the stocks of refined oil at Batum were nearly twice as large as at the same time in 1904, and owing to the fact that these stocks are available only for export, and that recent labor and political disturbances have made the shipment of all goods almost impossible, they act as a depressing influence upon the export market, since buyers for export think there is a limit to the storage and the credit of the refiners, and that when that limit is reached the refiners will have to sell their stocks at a heavy discount. This is one reason for the declining price of Russian refined for export. Another is the declining price of American refined.

At present there seems to be no demand for refined oil for export and very little for the home trade. The export demand is influenced undoubtedly by the foregoing conditions, and general trade is exceedingly dull because of strikes and other disturbances at Baku and in all parts of Russia.

[4] Reported by Jane & Macandrew, London.

The Petroleum Industry of California in 1904.

BY C. T. DEANE.

California in 1904 produced more oil than any other State in the Union and more than any foreign country except Russia. The number of barrels (42 gal.) consumed in 1904 was 28,425,860—an increase of 5,000,000 barrels over 1903. All the railroads of the State, steam, electric and cable, use oil for power exclusively. There is hardly a manufacturing plant in California that has not discarded coal, finding it more economical to use the new fuel. All the mining and milling companies in California and Arizona have substituted oil for other fuels. Four barrels of oil are equal to one ton of the very best Welsh coal; three-and-a-half barrels equal one cord of the best hickory wood. About six-and-a-half barrels of 15° gravity oil weigh one ton. All the illuminating gas throughout California is made from oil, being cheaper, better and less dangerous than coal gas. During the past year a number of ocean steamships have been altered from coal- to oil-burners, notably the great vessels of the American Hawaiian Steamship Company, which run between the Hawaiian Islands and San Francisco and then to New York. These vessels carry about 10,000 barrels of oil for the through trip, making no stop for over 12,000 miles after leaving San Francisco. It has been demonstrated that vessels using oil increase their speed about one knot, due, no doubt, to the fact that the steam pressure can be kept continuously the same, as it cannot when furnace doors are being frequently opened for the introduction of coal.

California crude oil, having an asphaltum base, has been largely used during the past year in road making. All the counties, through their boards of supervisors, are using every exertion to oil not only the country roads but also the streets in the smaller cities and towns. These roads, after having been put in condition at a cost of about $200 per mile, require sprinkling but once a year. The Southern Pacific and the Santa Fé Railroad companies oil their tracks, so that traveling in California is devoid of cinders and dust; we understand that some of the Eastern roads are using Texas oil, which also has an asphaltum base, for the same purpose. The Government at the present time is making inquiries as to the cost of oil in barrels for use in road making in Panama and the Philippine Islands. Crude oil treatment is particularly useful in the tropics, where the heavy rainfall makes traveling over the country roads almost impossible. Oiled roads, if properly constructed as to foundation and drainage, shed all water, retaining a smooth, elastic and dry surface.

The possibility of the exhaustion of the California oilfields, which a few years ago was discussed frequently, has been removed. As new discoveries enlarge the territory, it becomes plain that oil fuel has come to stay, and that it is to be the steam producer of the twentieth century. The Baku district in Russia, with not over 5,000 acres of proved territory, has produced for the past ten years between 50,000,000 and 75,000,000 barrels a year. The Kern river district alone, which has 4,000 acres of proved oil-lands, has been producing during the last three years about 15,000,000 barrels a year; the most conservative estimate of this pool gives it one thousand million barrels.

There are in California twelve oil districts, the limits of which, with the exception of Kern river, have not yet been defined. During 1904 the southern portion of the Coalinga district has developed a large and very rich territory, and has doubled its output during the year, its production in 1904 being 4,544,160 barrels. Another district which has come into prominence during the past year is Santa Maria, in the southern part of San Luis Obispo county. There are now two pipe lines running from this district to the ocean at Port Harford, the distance being 15 miles.

PRODUCTION OF CRUDE OIL IN CALIFORNIA FOR 1904.

(Reported by the California Petroleum Miners' Association.)

District.	Barrels.
Fullerton	876,000
Puente	204,000
Whittier	780,000
Los Angeles	1,080,000
Newhall and Ventura	540,000
Summerland	80,000
Santa Maria	750,000
Kern River	17,500,000
Sunset and Midway	376,000
McKittrick	1,650,000
Coalinga	4,544,160
Sargents	42,700
Half Moon Bay	1,000
	28,423,860

Considerable attention has been given during the year to the pipe-line. After the completion of the Standard line from Bakersfield to the bay of San Francisco at Point Richmond, with a branch to Coalinga, the producers in that district conceived the idea of building a line to Monterey, a distance of 87 miles; that line is now in operation, carrying to tidewater about 10,000 barrels a day. At the present writing a third line is projected from Coalinga to Alviso, at the extreme southern end of San Francisco bay, passing through the Fresno-San Benito territory, which all experts believe will eventually be an oil producer.

Now that the local needs are fairly well provided for, the oil men of California are turning their attention to the exportation of their commodity. There should be a large consumption of fuel-oil at Panama and all along the Southern Pacific coast.

During the latter part of 1904 the Standard Oil Company offered a reduced price for oil at the well of 12.5c. per barrel, but the independent companies refused to sell at that price, formed a combination of their own, and immediately made a contract with the Associated Oil Company for one year at 18.5c. Many think that they could have done better if they had held out for a few weeks longer. I believe that at the termination of the present contract, the large companies—the Standard and the Associated—will have to pay a much higher price.

The consumer in San Francisco is paying from 65 to 70c. for oil, which is equal to $2.80 for coal. Coal fit for steam purposes cannot be bought in this market for less than $7 per ton, and is being used only for domestic purposes and by ocean-going steamers, a large number of which are still using the old fuel. All river, bay and coast steamers are using oil exclusively. In a few years there will not be a single coal-burner leaving this port.

PHOSPHATE ROCK.

The output of phosphate rock in 1904 amounted to 1,874,428 long tons, valued at $6,873,625, as compared with 1,581,576 tons ($5,319,294) in 1903. Of this amount, 1,319,403 tons was marketed, domestic consumers taking 466,520 tons, while foreign demand called for 852,883 tons. Foreign consumers in 1904 thus utilized nearly two-thirds of the production in the United States, the largest proportion of the output yet accorded to them:

PRODUCTION AND SHIPMENTS OF AMERICAN PHOSPHATE.
(In long tons.)

Phosphates.	1903.				1904.			
	Production.		Shipments.		Production.		Shipments.	
	Quantity.	Value.	Domes.	Foreign	Quantity.	Value.	Domes.	Foreign
Florida, hard rock. . . .	412,876	$1,988,243	2,352	456,520	531,087	$2,672,184	6,800	487,244
Florida, land pebble. . .	390,882	885,425	157,015	151,761	460,834	1,102,993	133,549	218,745
Florida, river pebble. .	56,578	113,156	66,655	Nil.	81,030	199,127	79,195	Nil.
Total, Florida.	860,335	$2,986,824	226,022	617,281	1,072,951	$3,974,304	219,544	705,989
North Carolina.	45	500	45	500	Nil.	. . . . . .	Nil.	. . .
S. Caro., land rock. . . .	233,540	721,303			258,806	830,117		
S. Caro., river rock. . . .	25,000	62,500	271 685	33,170	12,000	31,200	241,026	29,780
Total, S. Carolina. . .	258,540	$ 783,803	271,685	33,170	270,806	$ 861,317	241,026	29,780
Tennessee.	460,530	1,543,567	2,650	109,265	530,571	2,037,804	5,850	117,114
Other States.	2,125	4,600	2,125	. . .	100	200	100	. . . . .
Total, United States	1,581,576	$5,319,294	502,527	760,216	1,874,428	$6,873,625	466 520	852,883

Market and Prices.—The expectation that German superphosphate manufacturers will agree to rehabilitate their market has given American exporters reason to hope for higher prices on phosphate. During 1904 the most notable advances in prices were: $9.84 to $12.09 for Florida high-grade rock; $6.39 to $8.40 for land pebble; $9.54 to $11.40 for Tennessee rock; $5.61 to $6.88 for South Carolina rock. In competition with the American phosphates were exports of 775,000 tons from Africa, paying an ocean freight of $1.4[illegible] to $2.22, and selling in Europe at $6 to $7.60 for Algerian, and $5.75 to $6.60 for Tunis rock. There were also sent to Europe in 1904 some 125,000 tons high-grade phosphate from Christmas and Ocean islands, paying a freight of about $6.48, and marketed at $11.75 to $14.45 per ton, delivered. Europe thus imported from the regions named a total of 1,780,000 tons, valued at approximately $10,375,683, of which $5,105,650 represented cost of freight.

Exports and Imports.—About half the total exportation of this country is comprised by the hard phosphate rock of Florida, and of this, Germany takes nearly half. Most of the Tennessee output is exported, through Florida and Virginia ports, going principally to southern and central

Europe. Of South Carolina's output, on the contrary, about nine-tenths is consumed at home. The ocean freight on European exports ranged from $2.64 to $3.72, or between one-third and one-half of the cost of the phosphate delivered at the seaboard.

Imports comprise guano from Peru, crude phosphate from the West Indies and superphosphates from Belgium. Imports have been in the amounts indicated by the following:

IMPORTS OF FERTILIZERS INTO THE UNITED STATES.
(In long tons.)

	1901.		1902.		1903.		1904.	
	Quan.	Value.	Quan.	Value.	Quan.	Value.	Quan.	Value.
Guano	4,949	$71,140	8,407	$164,783	21,007	$251,966	35,876	$478,388
Crude phosphates	175,765	872,503	137,386	646,264	132,965	679,112	130,214	745,744
All other fertilizers	.....	1,506,965	.....	1,725,333	.....	2,353,496	.....	2,856,141
Of which— Kieserite and Kainite.	240,937	1,360,619	225,413	1,016,032	158,313	773,758	218,957	1,050,082

The domestic trade, which takes little over half the production, showed some improvement in 1904, and prices ranged from $6.50 to $7.50 per ton for high-grade rock, f. o. b. Florida ports; $3.75 to $4 for Florida land pebble; $4 to $4.25 for Tennessee export rock, f. o. b. Mount Pleasant, and $2.95 to $4 for the various domestic grades; $2.75 to $3.50 for South Carolina rock, f. o. b. Ashley River.

Undoubtedly the most gratifying feature of the phosphate industry today is the gradual elimination of speculative buying, and the introduction of economic management, which promises better profits for the future.

Production by States.

Arkansas.—A phosphate deposit is worked at Batesville. The rock mined assays from 50 to 80% phosphate of lime. The small annual production is consumed locally, but it is proposed to erect large works for the manufacture of superphosphate for the Eastern market. There was no output in 1904.

California.—Some interest has recently been aroused by the discovery of apatite, analyzing as high as 44% phosphoric acid, in the Grapevine mining district, east of Banner, bordering the desert, in San Diego county. Transportation is the problem that will decide the development of the 2,000 acres located.

Florida.—The industry in Florida is gradually coming under control of a few large miners, and the affiliation of the Dunnellon and Buttgenbach concerns has greatly lessened competition in the export trade. The Dunnellon company will soon erect the first superphosphate plant, to utilize the large stocks of 70 to 77% rock in Florida; its initial capacity will be 30,000 tons acid phosphate per annum, to be enlarged gradually to four units.

The total product mined in 1904 is estimated at 1,088,087 long tons, of which hard rock constituted 49.4%; land pebble, 43%; river pebble, 7.6%. As compared with the output of these varieties in 1903, hard rock shows an increase of 29%; land pebble, an increase of 18%, and river pebble, one of over 43%. Shipments of phosphate offer the most reliable indication as to mining conditions.

Extensive preparations are under way to enlage the facilities for handling Florida hard rock for export at Port Inglis, and when the necessary improvements have been finished on the Withlacoochee river, shipments will be made on a much larger scale than hitherto. In 1904 Port Inglis handled approximately 123,000 tons; Savannah, which usually ships about one-third of the total exports of Florida hard rock, in 1904 exported 152,456 tons.

SHIPMENTS OF FLORIDA PHOSPHATES.
(In long tons.)

Hard Rock Phosphate.			Land Pebble Phosphate.		
Destination.	1903.	1904.	Destination.	1903.	1904.
Austria	9,000	2,200	Great Britain	29,226	27,945
Belgium	35,400	32,703			
Denmark	11,870	8,450	Baltic ports	40,550	76,740
France	5,865	20,085			
Germany	246,824	205,703	Continental ports	41,655	63,610
Great Britain	43,271	60,795			
Holland	73,280	100,603	Mediterranean ports	34,630	50,450
Italy	18,542	8,040			
Norway and Sweden	15,862	28,215	Other foreign ports	5,700	.....
Spain	5,606	5,584			
Other foreign countries	.....	14,866	Total Exports	151,761	118,745
			Domestic shipments	157,015	133,549
Total Exports	465,520	487,244	Total land pebble	308,776	352,294
Domestic shipments	2,352	6,800			
			Domestic river pebble	66,655	79,195
Total hard rock	467,872	494,044	Total phosphate	843,303	925,533

South Carolina.—The phosphate industry in South Carolina is recovering from its decline. The river deposits are not yielding well; but the marsh lands on Morgan, Coosaw and Buzzard islands are becoming large producers. The phosphate industry is now largely in the hands of Tennessee capitalists. Very little stock was on hand at the end of 1904.

Tennessee.—Tennessee phosphates are generally divided into three classes:

1. Blue rock, found in Hickman, Lewis and the western portion of Maury counties.

2. White rock (rose-colored) in Perry and Decatur counties.

3. Brown rock, which occurs in Maury, Giles, Williamson, Davidson and Sumner counties, and possibly (in small deposits) in a few of the other counties of the Middle Tennessee basin. There is also a considerable deposit of brown rock in Hickman county, along the valleys of Duck river and its tributaries.[1]

[1] 'Tennessee Phosphate,' by H. D. Rhuhm, *American Fertilizer*, December, 1904.

The blue rock varies from a dark to a grayish blue, and is very dense and heavy. The deposits lie on a level, outcropping above the limestone on the hillsides, and are supposed to extend through the hill. The bottom of the deposit, lying on a shale bed, above the limestone, is practically solid, and above this is a softer and lower-grade mass, interspersed with kidney formations of hard rock. The seams vary from a few inches to 30 in. or more, and are generally covered with a solid slate roof. This rock grades from 60 to 70% bone phosphate of lime, with less than 2.5% iron and alumina.

The so-called white rock is rose-colored, with white streaks through it. This is also a dense rock, but hardly as heavy as the blue rock. The deposit, like the blue rock, is supposed to run through the hills, and on Tom's creek, where a prospect tunnel has been driven, beginning in a boulder outcrop, a seam about 18 in. thick was struck, which gradually thickened, the tunnel ending at 300 ft. in a 14-ft. face of solid rock. This rock grades as high as 82 and 83% bone phosphate of lime, and is very low in iron and alumina.

The brown rock varies from a dark brown to a light gray, and is much lighter and more porous than the other two varieties. It lies in a blanket formation over the limestone, and is the top rock. It is of a laminated structure, with interstices filled with dirt, which to some extent clings to the rock when mined. The deposit averages about 3 to 4 ft. thick, and the overburden about 6 to 10 ft. The brown rock in the Mount Pleasant field analyzes from 75 to 80% bone phosphate of lime, and 3 to 7% iron and alumina, the latter depending largely on its preparation for market. The other deposits—in Sumner, Williamson, Davidson and Giles counties—vary in bone phosphate of lime from 55 to 75%.

The method of mining in the blue rock is tunnel work through entries from the outcrop. The most complete plant now working in this rock is that of the Meridian Fertilizer Co. on the Centerville branch of the Nashville, Chattanooga & St. Louis railroad, a short distance south of Twomy. The plant is equipped with air pumps and exhaust fans, the drills being operated by compressed air. The rock in the mines is 'shot' and loaded into tram cars, hauled to and dumped by trips into the crusher, from which it passes through a cylindrical dryer and is discharged into the cars or elevated to storage bins. The seam of solid rock in this mine averages about 30 in., and maintains practically a uniform thickness the whole length of the main tunnel, which has been driven 500 or 600 ft. The slate covering forms a good, substantial roof, and no timbering is required. Washing is unnecessary.

Brown rock represents the simplest mining proposition, it being won entirely by open-cut work. The overburden is first removed from a section (usually with plows and wheel scrapers), and then the rock, which is in layers, is easily loosened with picks, pieces too large to handle being broken and thrown out on the bank with 10-tined forks, the dirt and small stuff passing through the forks being thrown back with shovels. The rock, when mined, if intended for the domestic market, is spread out on the ground and allowed to 'sun dry,' and is then hauled to the cars and loaded. If mined in wet weather, or if the rock is very dirty, it is burned. The higher grade, intended for export, requires more preparation. After being mined it is hauled to the loading place, and there built up in kilns, underlaid with cordwood, the larger pieces of rock forming the walls. When ready to prepare for market these kilns are fired and the rock burned, thus ridding it of moisture and caking the adhering dirt, so that in breaking it will scale off. After the wood has burned out, and the rock cooled sufficiently, it is broken up with hammers, screened and loaded into the cars. During fair weather this work can be carried on in the open air, but, to be able to ship at all seasons, kiln sheds are built, under which the burning takes place; also storage sheds to house the finished product.

The waste small rock in the spoil bank is saved by four of the larger companies that have constructed washers The saving by this method is at least 25%, and these washers also yield a much cleaner and higher-grade product. After washing, the rock is burned, and then, instead of breaking by hand, it is put through crushers and screened.

Mining in Foreign Countries.

Prospecting for phosphate deposits is carried on actively all over the world and reports of rich discoveries are often made; but investigation generally tends to modify them, and few succeed in passing the test of commercial exploitation. At present the African and the Pacific island deposits are being most actively exploited, and in the immediate future their production will require greater consideration in the European markets. Already the shipments from Christmas and Ocean islands are factors in the Australian and Asiatic markets, and their influence on prices is rapidly extending in Europe.

Canada.—Phosphate mining in Canada is chiefly confined to the apatite deposits in Wright and Labelle counties, near Ottawa. The mineral is of good grade and is largely used in the manufacture of phosphorus. The production in 1904 amounted to 917 tons, valued at $4,590, as compared with 1,329 tons, valued at $8,214, in 1903.

Phosphate-yielding mineral land to the extent of 2,000 acres in Burgess township, in eastern Ontario, has been secured by a German-American company, which is capitalized at $75,000. Fifty men are employed, and the phosphate is being shipped to Germany.

A small amount of phosphate is obtained as an accessory product of some of the mica mines in Quebec. Most of it is supplied by the Blackburn mine, and a small amount comes from some workings on the Lièvre. The Chemical & Fertilizer Co. manufactures superphosphate at Buckingham with second-grade material, while the higher grade is used by the Electric Reduction Co. of the same place for the manufacture of phosphorus.

Chile.—Numerous valuable deposits of guano occur along the Chilean coast between Tocopilla and Ariga and on the numerous little islands between Pisagua and Coquimbo. Exportation to foreign countries is prohibited, and the Government proposes to devote the phosphate fertilizer deposits to the benefit of national agriculture. Production amounts to about 11,000 metric tons per annum. The larger portion is obtained at Punta Pichalo, near Pisagua, while about 1,500 tons are brought from the coastal islands. The guano contains from 12 to 17% of phosphoric acid. The agricultural districts around Concepcion consume most of the locally produced guano, which is shipped from the phosphate beds direct to the port of Talcahuano.

India.—India is poor in phosphate deposits. The only one of importance occurs in the Cretaceous beds of the Perambalar taluk, Trichinopoly district, Madras Presidency.[2] It is estimated that to a depth of 200 ft. the beds contain phosphate amounting to about 8,000,000 tons. The nodules are irregularly distributed through clay, varying between 27 and 47 lb. per 100 cu. ft. The nodules contain from 56 to 59% of phosphate and about 16% of carbonate of lime. Alumina and oxide of iron vary between 4 and 8%.

Attempts to dispose of this phosphate in a finely powdered condition for use as fertilizers on coffee plantations failed, and commercial conditions for the manufacture of superphosphates are unfavorable.

Small quantities of apatite are turned out in the Hazaribagh and Nellore mica mines. Apatite occurs also near Mussoorie, in East Berar, and in the Eocene shales above the coal near Dandot colliery in the Punjab Salt Range.

New Zealand.—Approximately 4,400 tons of 60 to 80% phosphate rock were mined on the Milburn and Clarendon deposits in the Tokomariro district, Otago, New Zealand, in 1904. Its value for the preparation of fertilizer is apparently well established in local markets and the demand for it is steadily increasing.

South Australia.—Phosphate deposits have been discovered in the vicinity of Angaston, at Koonunga. The formation is connected with a crystalline limestone of Cambrian age. The rock occurs in boulders, masses and nodules embedded in clay and earthy matter, approximately amounting to about 10% of the whole mass. A special feature is the frequent occurrence of radiated concentric crystalline phosphate in addition to the massive cellular and chalk-like rock usually found. A 400-ton lot marketed in Adelaide assayed 67 to 70% tricalcic phosphate and sold at 5d. per unit, equivalent to about $6.85 per ton.

The Broken Hill Proprietary Co. has purchased several phosphate deposits in South Australia and is erecting works at Port Pirie, where superphosphate will be manufactured with sulphuric acid obtained from a subsidiary plant connected with the Carmichael-Bradford process of lead smelting.

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[2] 'Review of Mineral Production of India,' T. H. Holland, *Records*, Geological Survey of India, Vol. XXXII, Part I, p. 113.

Tunis.—Valuable phosphate deposits occur in the district of Uarfa-Tarf, 50 km. west of Gafsa. The formation is 5 m. thick and assays 63% tribasic phosphate of lime, 14 to 20% carbonate of lime, and 1.5% iron and alumina. Attention was attracted to this Tunisian deposit by the public sale on Dec. 21, 1904, of the Aïne-Moulâres deposit to a syndicate at 1.52fr. (29.3c.) per ton royalty on an annual output of 250,000 tons for a term of 50 years. This price compares with 1.77fr. (34.2c.) per ton paid by the present owners of the Kalaat-Es-Eenam property. It is said that the Aïn-Moulâres deposit contains fully 12,000,000 tons of phosphate, that will carry from 63 to 67% bone phosphate. The contention is made that the price to be paid is considerably less than had been offered the Government of Tunis, and some trouble is expected to occur, as the Compagnie des Phosphates et du Chemin de Fer de Gafsa had signified its intention to work the new deposit by right of prior option. The Gafsa company has discovered a new phosphate bed on its Diebel-Redeyef property. To develop this deposit a 20-mile spur on the Gafsa railway to Sfax is necessary. Shipments from Sfax in recent years have grown remarkably, and by far exceed those from the Algerian mines. The assay value and export cost of the Sfax-Gafsa company's deposits are as follows:

Redief.—The deposits are said to be rich, the 'extracts' containing 63 to 64% of tribasic phosphates. The cost of export (including royalty and export duty) is 94c. per ton.

Aïn-Moulâres.—The 'extracts' are reported to contain 65 to 70% of tribasic phosphate; total cost of export is estimated at $2.12, the railway rates to Soussa (the port of outlet) being heavy.

Metlaoui.—The extracts from this deposit contain 60% of tribasic phosphate; the cost of export is about 86c. per ton. About 400,000 tons of phosphate were extracted from this deposit in 1904, and shipped to Europe, chiefly to the United Kingdom, France and Italy.

PRODUCTION OF PHOSPHATE ROCK IN THE WORLD.

(In metric tons.)

	1899.	1900.	1901.	1902.	1903.
Algeria	324,983	319,422	265,000	305,174	320,843
Aruba (Dutch W. Ind.)	(c)	(c)	(c)	10,530	15,511
Belgium	(a) 190,090	(a) 215,670	222,520	(b) 135,850	(b) 184,120
Canada	2,722	1,284	937	776	1,205
Christmas Island	(c)	(c)	(c)	61,178	70,096
France	645,868	587,919	535,676	543,900	475,783
French Guiana	(c)	(c)	(c)	4,230	(c
Norway	1,500	300	738	2,295	1,795
Redonda (Br. W. Indies)	1,507	2,230	Nil.	132	1,102
Russia	16,863	25,663	21,276	13,709	(c)
Spain	3,150	4,170	4,220	1,150	1,124
Sweden	(c)	(c)	(c)	3,895	3,219
Tunis	....	....	....	264,930	352,088
United Kingdom	1,469	630	71	87	71
United States	1,539,953	1,515,075	1,507,548	1,514,159	1,606,881

(a) Cubic meters. (b) Metric tons of phosphate of lime; in addition there were 315,200 cubic meters of phosphatic chalk in 1902 and 350,250 cubic meters in 1903. (c) Statistics not available.

PLATINUM.

The domestic production of platinum is exceedingly small, and is derived as a by-product in the refining of gold, copper and nickel ores. In 1904 the output of platinum did not show an increase, although the demand for it continues strong. As in previous years, fully nine-tenths of the production of this valuable metal was supplied by Russia. A small quantity is obtained in the Rambler mine of Wyoming, and along the coast of Oregon and California. Most of the California metal is obtained at the San Francisco Mint, in parting and refining gold which comes from certain localities in Trinity, Shasta and Plumas counties, in that State. Some platinum and palladium is also recovered at the Orford Copper Company's works, at Constable Hook, N. J., in refining nickel matte from the Sudbury district in Ontario. The quantity of the domestic supply, however, is not sufficient to affect the market seriously, and the principal part of the metal used in the United States is imported from Russia. Most of it comes here in crude form, and is refined at works in the vicinity of New York. These imports in 1904 were 7,111 lb. ($1,812,632), as compared with 7,852 lb. ($1,921,772) in 1903 and 7,231 lb. ($1,950,362) in 1902.

Prices of platinum in the United States were very strong throughout the year, as supplies were not abundant, and the consumption in the electrical and chemical industries is generally increasing. The quotation for ingot metal in New York advanced from $18.50 per oz. to $19.50 at the close of the year.

PRODUCTION OF PLATINUM IN THE UNITED STATES. (a)
(In troy ounces.)

Year.	Quantity.	Value.
1900	400	$2,500
1901	1,408	27,526
1902	94	1,814
1903	110	2,080
1904	(b)200	2,600

(a) Statistics of the United States Geological Survey. (b) Not including $6,000 worth of platinum said to have been contained in slime from the copper ore of the Rambler mine.

British Columbia.—The production of platinum in British Columbia in 1904 was confined to Granite creek, in the Similkameen. The creek yielded 35 oz. of crude platinum, valued at $12 per ounce, which was recovered from sluice-boxes in washing for placer gold. Platinum occurs in considerable quantity at several points on the Quesnel river, Cariboo district. The Consolidated Cariboo company is now saving the heavy concentrates from the sluice-boxes. A sample of concentrates taken from the sluice-boxes after clean up in September, 1904, assayed as follows:

	Oz. per ton.	Gross value per short ton.
Gold	95	$1,900
Silver	180	90
Platinum	64	832
Palladium	64.4	1,769
Osmiridium	42	1,386
Copper	10.5%	16
Total value		$5,994

The gold and silver values, doubtless, are included in particles of pyrite and argentiferous galena, and partly in small particles of gold covered by manganese and other metallic oxides. The platinum, palladium and osmiridium occur in minute metallic grains, and enclosed in small fragments and nuggets of magnetite and chromite, which form a large part of the bulk of the concentrate found after cleaning up the placer gold.

These metals are also found in the Thibert creek hydraulic workings, and definite steps will be taken to save them.

Colombia.—This Republic is believed to contain deposits which can be worked at a profit on a commercial scale. These deposits were the source from which platinum was first introduced into Europe towards the middle of the eighteenth century. The placers are found along the head waters of Atrato and San Juan rivers on the western Cordillera slope. The region is not particularly accessible, and in the state of the country in recent times mining has been largely at a standstill.

New South Wales.—Deposits of platinum are found over an area of about two miles in length and one in width at Fifield, New South Wales. The field is worked in a desultory manner, as there is a scarcity of water in the district and the platinum sand can only be worked part of the year. The production in 1904 amounted to 535 crude oz., as compared with 530 oz. in 1903. The value of the crude metal is $10 per ounce.

Russia.—The source of a considerable part of the world's supply of platinum is the district of Nijni Taagil. It is situated on the west slope of the Ural on the Kama, a feeder of the Volga river, in the north part of the Province of Azan. An olivine rock decomposing into massive serpentine, and surrounded by pyroxenite, constitutes the chief massive. On the west are chlorite and talc schists. On the east is a diorite, called by some Russian authorities uralite-gabbro or epi-diorite. There is no doubt that the platinum occurs in massive olivine rock. The richest platinum placers which are in olivine rocks show no gold nor quartz; but as the washing departs from the rock gold and quartz both appear; this was also shown by G. Rose. The platinum was found microscopically in the olivine rock by Lacroix. No chromite was found in the washing, but a little of this appears in the microscopic examination of thin sections of the fresh rock. Chromite may be concentrated with the platinum. It is not yet shown that the milling of the massive rock for platinum would be profitable. The view that the olivine-gabbro is the mother rock is substantiated by the ready decomposability that its ingredients would show to the wearing of streams, while the diorite would resist this grinding action. Olivine or serpentine rock seems invariably to accompany valuable platinum placers. It may be said that platinum occurs in Russia in basic peridotites, while rocks rich only in feldspar give but little or none of the metal. On the eastern slope of the Ural deposits of more than 2,000 sq. m. in extent are being developed in the districts of Goroblagodatsk and Bisersk. These districts are about 130 miles north of Nijni Taagil. Platinum also occurs extensively in the gold-bearing gravels of Siberia, and probably some is recovered in connection with the gold workings.

Platinum production in Russia in 1904 was 306 poods (161,139 troy oz.), contributed by the following districts:

PLATINUM PRODUCTION OF RUSSIA IN 1904. (a)

District.	Kilograms.	Troy Ounces.
Tcherdinsk	153.6	4,938
Perm	1,107.1	35,593
South Verkhotoorsk	3,538.5	113,763
North Verkhotoorsk	207.3	6,666
South Ekatherinburg	5.6	179
Total, 1904	5,012.1	161,139
Total, 1903	6,003	193,000
Total, 1902	6,133	197,173

(a) Privately communicated by W. A. Abegg, Inspector of Mines, Warsaw.

An event of some interest in 1903 was the introduction of dredges in the valley of the river Iss, where the most productive placers are found. In 1904 the production was curtailed on account of the war with Japan and the drafting of many of the Ural workers into the army. A short time ago it was reported that an American firm had taken an option on the output of the Taghisk placers, in the Urals, for a term of 10 years, at an average price of 10,000 rubles per pood, which is equivalent to $9.78 per oz. for the crude metal.

Technical.

Separation of Platinum from Gold.—Platinum is best separated from gold, silver and other metals by the electrolytic method.[1] A solution of gold chloride containing free hydrochloric acid or a suitable chloride is used as electrolyte. If the temperature is kept up to the normal point (67° C.) and sufficient free acid is present, no chlorine appears at the anode, but the gold goes regularly into solution. Moreover, when these conditions are ful-

[1] E. Wohlwill, *Electrochemical Industry*, 1904, II, p. 221.

filled, a sufficiently high current density can be used to make the operation of refining as rapid as the old chemical process, which it has entirely displaced in Germany and in the United States Mint at Philadelphia. Any platinum present in the impure gold anodes passes into solution, but is not deposited at the cathode, and consequently accumulates in the electrolyte; it is removed by precipitation with ammonium chloride from time to time. Platinum is shown by electrolytic experiments to be much more widely distributed than is generally supposed, and occurs in small but appreciable quantities in nearly all silver. Palladium can be separated in a similar manner, and in view of its occurrence in the Sudbury nickel ores and the black sands from the British Columbia and other placers, attention is drawn to this point.

Origin of Platinum.—The origin of platinum is still a mooted question. The di-arsenide, sperrylite, was discovered as recently as 1889 in heavy concentrate of gold ore from Sudbury, Ontario, and has also been identified at the Rambler mine in Wyoming. Kemp[2] recognizes the vein-concentration type of platinum deposit and also the form of dissemination in massive rock, usually basic eruptive. Whether the latter clearly comprises a case of magmatic deposit is not yet established. The mode of transportation of platinum is not at all clear, but C. W. Dickson mentions a case of migration of platinum in solution; it is that of a limestone bed or lens in an ancient gneiss in Sumatra. The alteration of limestone to garnet and wollastonite was followed by hot mineralizing solutions carrying gold, copper and platinum.

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[2] For the most complete statement as to the occurrence of platinum see 'The Geological Relations and Distribution of Platinum and Associated Metals,' U. S. Geol. Survey, *Bulletin* No. 193.

QUICKSILVER.

The production of quicksilver in the United States during 1904 amounted to 2,643,304 lb. (1,192 metric tons), valued at $1,489,716. The decrease was due principally to less activity in California; Texas increased its output slightly, and a small amount was contributed by the Sacramento mine at Mercur, Utah. The Black Butte district of Oregon made no production during the year.

A point of importance to the trade was the concerted action taken by the California producers and dealers in reducing the weight of the standard 'flask' from 76.5 lb. to 75 lb., the change having gone into effect on June 1, 1904. The heavy flask, based on the old Spanish pound, had been the standard for many years at Almaden, and had been generally adopted throughout the world, but during 1903 the Rothschilds, controlling the industry in Spain and Austria, inaugurated a new 75-lb. standard, based on the English pound, and the belated step of the California producers followed as an act of self-protection. The Texas producers have not yet made the change.

PRODUCTION AND EXPORTS OF QUICKSILVER IN THE UNITED STATES.

Year.	Production.				Exports.			Imports.	
	Calif. Flasks.	Texas. Flasks.	Total. Met. Tons.	Value.	Flasks.	Met. Tons.	Value.	Pounds.	Value.
1900......	26,317	1,700	966	$1,288,851	10,172	353	$425,812	2,616	$1,051
1901......	26,720	2,935	1,023	1,382,305	11,219	389	475,609	1,441	789
1902......	29,552	5,252	1,208	1,515,714	13,247	459	575,099	Nil.	....
1903......	32,094	5,029	1,288	1,564,734	17,575	610	719,119	Nil.	....
1904......	29,217	5,336	1,192	1,489,716	21,064	731	841,108	212	160

QUICKSILVER PRODUCTION OF THE WORLD.
(Metric tons.)

Year.	Austria.	Hungary.	Italy.	Japan.	Mexico.	Russia.	Spain.	United States.	Total.
1900..........	510	32	260	0.3	124	304	1,095	983	3,311
1901..........	525	33	278	0.8	128	368	754	1,031	3,120
1902..........	511	45	259	1.4	191	416	1,425	1,208	4,056
1903..........	523	44	314	0.2	188	362	914	1,288	3,633
1904..........	536	(a)	355	(a)	(e)190	393	1,020	1,517	4,011

The figures for Austria, Italy and Spain for 1903 have been furnished by V. Spirek. (a) Not yet reported. (e) Estimated.

Market.—Quicksilver suffered but few fluctuations in price during 1904.

A declining tendency was noticeable, being accelerated by the substitution of the 76.5-lb. by the 75-lb. flask. The monthly quotations at New York and at San Francisco, for both domestic and export shipments, are indicated by the following:

QUOTATIONS FOR QUICKSILVER IN LARGE LOTS DURING 1904.

Month.	New York.	San Francisco.		Month.	New York.	San Francisco.	
		Domes.	Foreign.			Domes.	Foreign.
January	$45.75	$44.50	$41.50	August	$43.50	$43.50	$41 75
February	45.50	44.50	41.50	September	41.40	42.45	40.85
March	45.40	44.50	41.50	October	40.00	41.75	41.75
April	45.00	44.50	41.50	November	40.00	41.75	41.75
May	44.94	44.19	41.81	December	40.00	42.25	41.00
June	44.75	43.30	42.70				
July	43.81	43.50	41.94	Year	$43.34	$43.39	$41.63

London quotations showed a declining tendency also, having dropped from £8 5s. to £7 15s. in the course of the year.

California.—The output of this State, 2,235,100 lb. (equivalent to 29,217 large flasks or 29,801 small ones), valued at $1,270,940, showed a decrease of 2,877 flasks from the output of the previous year; the highest record ever attained was 36,104 flasks in 1895. This decrease in production occurred in spite of additions to the number of producers, several developing mines having made their first outputs in 1904. The expansion of the industry, however, is not likely to continue, since the low range of prices during 1904 indicates a condition of over-production. Considerable quantities of California quicksilver, not absorbed by domestic requirements, are exported to Asia, in the face of Spanish and Austrian competition, at prices ranging about $1.50 per flask less than those obtained on domestic sales. Home consumption also is stationary, if indeed it is not slightly diminishing owing to the tendency to replace amalgamation processes in gold-milling by the cyanide process, thus reducing the main demand for quicksilver. The whole California supply is disposed of through a joint selling agency, so that, when export sales are heavy, the actual average price obtained for the product of the entire district falls below current market quotations. If the present decline continues, many mines, beginning with those whose output is of low-grade ore, will have to suspend operations.

The report of the Quicksilver Mining Co., for the year ending April 30, 1904, shows that 4,340 flasks of mercury were produced, of an average value of $40.495, or $175,747 in all. The cost of production per flask comprised the items: Pay-roll, $33.745; supplies, $7.99; miscellaneous and taxes, $0.957; total, $42.692. Deducting miscellaneous receipts gave a net average cost of $38.157 per flask, over which the average price realized showed a profit of $2.338 per flask.

There were mined 40,398 tons of rock, of which 11,051 tons came from prospecting and deadwork, and 22,347 tons from vein and stopes, yielding together 5,082 tons 'granza,' and 33,980 tons 'tierras,' or a total of 39,062 tons ore.

The average yield of all the ore reduced during the year showed a slight improvement, owing to the better grade of ore obtained the first half of this year, 0.448%, against 0.418% for 1902-3. The cost of obtaining ore from the old dumps was reduced, but the cost of daily labor, transportation and some other items increased. The expenditure for prospecting and deadwork amounted to $22,144, which was somewhat less than in the previous year.

An average of 151,636 men were employed for a total of 47,390.25 days, at an average daily wage of $2.199, which makes the total expenditure for labor $104,240.

The various Victoria workings, together with El Colegio and Santa Rita West, yielded the greater part of the ore supply derived from the mine during the year.

Small ore shipments were made from the Little Grover, San Francisco and Main Tunnel workings, in addition to the few tons obtained from the Clements and Los Angeles tunnels. A considerable quantity of 'tierras' was recovered from the old workings encountered in El Colegio, and development was active in the old ground situated between the 900 and 1,000 levels in Victoria. The San Francisco and Little Grover, which contributed several thousand tons of metal and 'tierras' last year, became exhausted, and were closed down in July, 1903. The Santa Rita West workings deteriorated considerably during the year. In preceding years this portion of the mine furnished a large part of the total output; but the main pillars lying in the general run of the ore have finally become exhausted, and the work done for the present consists in blasting out the low-grade mineral still showing. The proximity of the old workings makes the prospect of a permanent improvement uncertain.

The work in El Colegio has been extended to within 40 ft. of the 300 level, in direct line with the main tunnel. During the early part of the year the working yielded some good ore, but the nearer approach to the 300 level shows a decrease in the quality. Nearly the entire output is derived from old workings, and some good break rock and 'tierras' have been obtained from this source. The method of square-setting has been used throughout, which necessitates the use of a considerable amount of timber and labor in filling in the worked-out squares with waste, in order properly to support the loose ground.

The metal coming from the Victoria during the last six months has been of a lower grade than usual. This is due chiefly to the deterioration in the workings above the 800 level. The ore obtained from these ('vug' and 'intermediate') has heretofore been of fair quality, the metal usually making along the hanging in seams several inches wide. The greater portion of this territory is nearly worked through to the Santa Rita West ground, where no ore of importance is showing. The 950 and 1,000 levels, opened up this year, furnished a considerable quantity of low-grade ore and 'tierras' to the total output.

In his inspection of the California quicksilver deposits, William Forstner has recorded[1] valuable data bearing on the theory of ore deposition as applied to quicksilver. He notes that individual deposits differ strongly from each other and that no general theory can be laid down.

Texas.—This State recorded an output of 408,204 lb. (5,336 flasks), valued at $218,776, showing a slight advance over the figures of the two preceding years, 5,029 flasks in 1903 and 5,252 flasks in 1902. The industry began here in 1899, reaching its present productiveness in four years, since which time it has remained nearly stationary. The productive area lies just north of the Rio Grande, in the angle limited by the sharp bend of the river to the northward; Terlingua is the center of activity, and Marfa, on the Southern Pacific, 104 miles to the north, is the nearest railroad point. The geology and other features of the district have been described by engineers[2] and by the University of Texas Mineral Survey.[3] A statement of the present condition of the industry, made by the Director of the University Mineral Survey, will be found on a following page.

Quicksilver Mining in Foreign Countries.

Algeria.—The first quicksilver mine in Algeria commenced production in 1903. It is at Taghit, and the deposits are reported to be extensive. The works, which were built in 1903, are equipped with two furnaces, one being a Spirek shaft furnace, with a capacity for treating six tons of ore daily, and the other a Cermak-Spirek roasting and calcining furnace, also of six tons capacity. The first year 20 metric tons of quicksilver were produced and exported. The figures for 1904 are not yet attainable, but it is understood that there was considerable increase. The ore carries zinc, which is also recovered after driving off the quicksilver.

Australia.—Quicksilver occurs at Yulgibar, on the Clarence river, and in the Mudgee district, New South Wales, and at Kilkivan, and other localities in Queensland, but no deposits were worked in 1904.

In some of the West Australian mines, particularly those on the Kalgoorlie field, telluride of mercury is found in association with telluride of gold. A silver-white specimen of telluride from No. 5 level in the Oroya mine assayed: Gold, 40%; silver, 3.0%; a tarnished specimen yielded gold, 7.2%; silver, 0.2%; and a black telluride specimen showed 0.5% gold and 0.2% silver. The mercury appears to be in the minerals coloradoite and calaverite.

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[1] The Engineering and Mining Journal, LXXVIII, 1904, pp. 385 and 426.
[2] *Ibid,* LXXVII, April 28, 1904, p. 685.
[3] *Ibid,* LXXVII, January 28, 1904, p. 160; LXXVIII, August 11, 1904, p. 212.

Austria.—The Idria mines, which are owned and operated by the Government, in 1904 produced 536 metric tons of quicksilver, recovered from 88,278 tons of ore, as compared with 520 in the previous year, from the treatment of 83,321 tons of ore. The ore occurs in a quartz, calcite and dolomite gangue in a series of veins connected with a fault dislocating a large area of Paleozoic, Mesozoic, and Cenozoic rocks. The quicksilver deposits are actually in Triassic strata. The metal is chiefly found in the form of cinnabar, but other quicksilver minerals, as well as native mercury. are occasionally found.

Italy.—Quicksilver mining in Italy is confined to the Monte Amiate district, in Tuscany. The output in 1904 amounted to 355 metric tons, as compared with 314 tons in 1903. In 1904, imports of 24 metric tons of mercury and exports of 266 tons were recorded.

Mexico.—Quicksilver deposits have been discovered in many parts of Mexico in veinlets and irregular deposits in limestone and serpentine. Among these the Huitzuco, in the State of Guerrero, is successfully worked and is notable for containing the rare mineral livingstonite, the sulphantimonide of mercury (mercury, 14%; antimony, 53.2%; iron, 3.5%; sulphur, 29.08%).[5] The workings follow an old hot-spring conduit or geyser pipe. The ore-shoot has been mined to a depth of 500 ft. The orebody averages 3 ft. wide and 10 to 20 ft. in length.

Other important deposits are worked at Guadalcazar, in San Luis Potosi, Ranas, in Queretaro, and Batuc, in Sonora.

Peru.—Quicksilver deposits have been worked at Huancavelica, since 1566, and it is estimated they have yielded over 55,800 metric tons of mercury. The ore is cinnabar, and it occurs in veins and stockwerkes intersecting a series of sedimentary rocks, chiefly limestone and quartzite, and in disseminated masses along the contact of igneous intrusions. The deposits stretch from Chunamachay to San Antonio, a distance of several kilometers. The ore averages from 2 to 3% quicksilver per ton.

Russia.—A quicksilver deposit is worked in the Ekaterinoslav district, in Russia. The annual production is about 350 to 400 metric tons. The output in 1904 amounted to 331.8 metric tons.

Spain.—There are about 25 quicksilver mines working in Spain, in the provinces of Almeria, Granada and Oviedo. The historic mines at Almaden continue the largest producers. The Almaden mines yielded 1,020 metric tons of quicksilver in 1904, as against 914 tons in 1903—an increase of 106 tons.

Venezuela.—According to Cortese,[6] cinnabar occurs in Venezuela in a white sandstone in the Chaguarama valley. It is in a district that has experienced much volcanic activity, and where many boracic and sulphurous acid geysers are still discharging hot mineral solutions.

[5] See 'The Quicksilver Deposits of Huitzuco,' by Frank D. Pagliucci, The Engineering and Mining Journal, March 2, 1905.
[6] See The Engineering and Mining Journal, November 10, 1904.

Condition of the Quicksilver Industry in Brewster County, Texas.[7]

BY WILLIAM B. PHLLIPS.

Two companies now produce quicksilver in the Terlingua district, Brewster county, and a third is building a new furnace. The Marfa & Mariposa Mining Co. has two 10-ton Scott furnaces in operation at Terlingua. Much of its cinnabar is now obtained from deep workings, although up to the beginning of the present year by far the larger quantity of quicksilver was obtained from shallow pits and open-cuts in the Edwards limestone. The company, after four years of profitable operations, has undertaken deeper work, and the results have been satisfactory. The ore continues in depth, in quality such as to keep the two furnaces steadily at work. A wire-rope tramway connecting the more important shafts with the furnaces has enabled the company to cheapen its transportation costs, and at the same time to widen the workable area. In addition to the cinnabar, which continues to be the chief ore, important finds of terlinguaite (an oxychloride of mercury) are made from time to time. The workings, which aim to prove the ground in California hill, near the contact of the limestone with a butte of andesite, are not yet sufficiently advanced to show actual conditions, but judging from other localities where workable cinnabar is found in intimate association with igneous rocks, one may anticipate the discovery of good ore at this place. Reference to this will be made when I speak of the workings of the Big Bend Cinnabar Mining Co. and the Dallas Mining Co., at Study Butte, 12 miles to the east.

H. W. Turner, of San Francisco, an experienced mining engineer, has taken charge of the Mariposa property, succeeding W. L. Study, who goes as manager for the Big Bend company. The Marfa & Mariposa company has been more successful than any other enterprise in the field. It had ample capital, good property, and conservative and skillful management, and although its natural resources may not have been better than those of any other company, its success has been the salvation of the district. Other companies organize, acquire good property, build furnaces, operate them for a while, and then withdraw, but the Mariposa goes quietly on turning out quicksilver month after month. It is today the only continuously profitable quicksilver mine conducted on a considerable scale in the Texas field. The Terlingua Mining Co. and the Colquitt-Tigner Mining Co. erected good furnaces, but they are now cold. Their ore was as rich as any ever found in the district. The 50-ton furnace of the former and the 10-ton furnace of the latter company were well built, and each one turned out a fair yield; but something went wrong, and operations were suspended.

Six and a half miles east of Terlingua is the property of the Chisos Mining Co., Sec. 295, Block G 4, Henry J. Lewis, manager. Mr. Lewis is operating four 600-lb. iron retorts, and has done very well this year, using

[7] The Engineering and Mining Journal, October 6, 1904. p. 553.

selected ore. At this camp the ore is held in Austin chalk and Eagle Ford shales, the two formations shading into each other with no sharp line of demarkation. A drift is now being run on the contact between the shales and an outcrop of igneous rock. Here, in close association with the cinnabar-bearing chalk and shales, is found a small area of Cretaceous coal measures, a formation more largely developed towards the east at Terlingua creek and Rough run. This property adjoins Sec. 70, Block G 12, where the McKinney Brothers built some retorts last year and operated them for a while. Good ore was found here, as also on the Dawson claims, north of McKinney, but nothing is being done now. The ore from Secs. 70 and 295 contains bituminous matter; both oil and ammoniacal compounds distil over with the quicksilver. The Marfa & Mariposa Mining Co., with two 10-ton Scott furnaces, and the Chisos Mining Co., with four 600-lb. iron retorts, are the only producers of quicksilver in the district today.

The Big Bend Cinnabar Mining Co., H. M. Nesmith, manager, and the Dallas Mining Co., W. L. Study, manager, are in Sec. 216, Block G 4, at Study Butte, 12.5 miles east of Terlingua and six miles east of the Chisos Mining Co. The Big Bend company has recently let a contract for the erection of a 50-ton Scott furnace. As to the occurrence of the ore, these camps are the most interesting in the entire field. The cinnabar is held not only in the clays and shales, but also and particularly in a purely igneous rock closely resembling rhyolite, but needing further study. This rock outcrops on the top of the butte and dips towards the north and east under the shale. The thickness of the lava sheet (it may originally have been a laccolite) is about 200 ft., and it carries cinnabar in thin stringers, as small and rich veins and as impregnations with flattened pyrite crystals. Much of the rock, while not showing visible cinnabar, 'horns' well, a point that it is provident to remember when prospecting.

Neither of the companies had penetrated the lava sheet by the middle of August, the Dallas company having encountered more water, at a depth of 140 ft., than could be handled without a steam pump. The main shaft of the Big Bend company is down 140 ft. on the hill above the shaft of the Dallas Mining Co., but the difference in elevation being nearly 100 ft. only a trickle of water is coming in. The cinnabar in the igneous rock is not confined to any one horizon, or level, but is found all the way down the shaft, not in large amounts, it is true, but the material is workable and will all be sent to the furnace. Now and then the stringers thicken and high-grade ore is obtained. Occasionally one may see evidences of decomposition in the gangue, where it is penetrated by the stringers of ore, but this is by no means the rule. For the most part the material is perfectly sound. The fracture planes of the rock often show a coating of cinnabar and pyrite, the latter in tabular form. At Study Butte the cinnabar occurs in three distinct classes of material—in the unaltered igneous rock, in the decomposed igneous rock, and in the clays and shales of the Upper Cretaceous.

It is the purpose of the Big Bend company to sink the main shaft to a depth of 500 ft. through the lava and into the underlying shales. The Dallas Mining Co. will also sink to this depth, and one may look forward to some important contributions to the geology of the district, as this has affected the deposition of the ore.

These two companies are about to come to an agreement for the installation of a pumping plant on Terlingua creek, 1½ miles distant, to supply the boilers and camps with water. They are more favorably situated with respect to water than any of the other companies, having an abundant supply within 1½ miles, the elevation to be overcome being about 300 ft. to the top of the Butte, or 250 ft. to the boilers at the Big Bend shaft.

The Dallas Mining Co. is also opening some promising prospects in Block G 3, southeast of the Chisos mountains, at the Lindsey finds. The Comstock Mining Co. is prospecting in Sec. 34, Block G 12, near the Colquitt-Tigner property, and Mr. McFarlane is working at the old Contrabandista, northwest of Sajitas, and about 10 miles west, a little south from Terlingua. Messrs. Lewees & Goade have secured some of the claims formerly held by the Terlingua Mining Co., in Sec. 40, Block G 12, and are taking out some excellent ore. Active prospecting is in progress on Big Christmas mountain, but nothing is now being done to develop the discoveries made at the Croton spring, 12 miles southeast of Christmas mountain. In Block G 2, east of the Chisos mountains and south of the Black Knob, fair washings of cinnabar have been found, and it is also reported from localities east of Tornillo creek and from the vicinity of McKinney Springs, Sec. 54, Block 20. Taking the district as a whole, the tendency of the new finds is decidedly towards the east, and further discoveries may be expected east and southeast of the Chisos mountains.

The scarcity of fuel is a serious drawback. Up to this time the ordinary timber of the region, such as mesquite, cottonwood, cat-claw, etc., has been used, but such growths are seldom dense, large or abundant, and they have been drawn upon so persistently that the end is plainly in view. There is plenty of good timber on the upper reaches of the Chisos mountains, and on some of the foothills oak, cedar, juniper and piñon, on lands belonging partly to the public school funds and partly to the railroads. To use this, however, requires a long haul, from 20 to 40 miles, and the price has risen to $6 a cord, delivered, some offers even at this price having been refused by the wood-haulers.

It was to study the availability of the coal along Rough run and Terlingua creek that a party was sent out this summer by the University Mineral Survey. Observations confirmed the absence of any large coal area, but indicated that, while the seams can not be expected to yield more than 15 or 20 in. of good fuel, this will be sufficient for present needs. If, however, any great enlargement of the quicksilver industry in Brewster county is to be looked for, a source of coal must be found. The supply of wood, never very abundant, is steadily diminishing and is obtained at constantly increasing difficulty and expense. In order to draw on the supply in the Chisos mountains long roads will have to be built and maintained.

The quicksilver industry of Texas may be said to be in a healthy condition in spite of the suspension of operations by two plants, the Terlingua Mining Co. and the Colquitt-Tigner Mining Co. The Big Bend company and the Dallas company are pushing their work with intelligence and skill. New finds are made on the older properties as well as in new localities, money is being freely invested, and a better class of miners will certainly be drawn thither to replace the Mexicans. The latter now perform all the ordinary and some of the skilled labor, at wages ranging from 90c. to $1.25 per day. The Mexican laborer, as a rule, is willing and faithful, but seems to be lacking in discretion, needing close supervision over all that he does. His industriousness under the most disagreeable weather conditions is commendable, and to his credit it must be said that he has discovered all the cinnabar exposures in the region.

SALT.

The production of salt of all kinds in the United States in 1904 was 22,030,002 bbl. (of 280 lb.), valued at $6,021,222, as compared with 18,968,089 bbl., valued at $5,286,988, in 1903. Nearly every producing State contributed to this increase, especially Michigan, Kansas and Louisiana; Ohio alone made a less output than in 1903.

PRODUCTION OF SALT IN THE UNITED STATES. (In barrels of 280 lb.) (a)

Yr.	California.	Illinois.	Kansas.	Louisiana.	Michigan (c)	Nevada.	New York. (c)	Ohio, W.Virginia and Pa.	Utah.	Other States.	Total Barrels.
1900	455,271	55,000	2,350,000	386,744	6,845,685	5,786	8,123,550	1,688,286	267,857	560,550	20,738,729
1901	601,659	99,700	2,087,791	451,430	7,729,641	13,781	7,286,320	1,385,257	334,484	569,092	20,566,661
1902	682,660	90,009	2,158,486	399,163	8,131,781	14,829	8,523,389	2,318,579	417,501	1,112,824	23,849,221
1903	629,701	(d)	1,555,934	568,936	4,297,542	(d)	8,170,648	3,043,135	212,955	489,238	18,968,089
1904	821,557	(d)	2,161,819	1,095,850	5,425,904	(d)	8,600,656	3,030,829	253,829	639,558	22,030,002

(a) Statistics of the United States Geological Survey. (c) Includes brine used in manufacture of alkali. (d) Included in 'Other States.'

The output in 1904 was constituted by the following grades, in barrels of 280 lb.: Table and dairy, 2,508,408; common fine, 6,819,109; common coarse, 2,604,981; packers, 96,130; solar, 1,189,393; rock, 4,369,141; milling, 349,421; other grades (brine used by the makers of soda and other sodium salts), 4,093,419. As compared with the previous year, packers and solar salts showed the only decreases; the finer grades increased slightly, while coarse, rock and milling salts showed distinct increases. The heavier output of rock salt was attributable to the expansion of the salt industry in Louisiana, where rock salt is cheaply mined in the 'mounds' which are numerous in the southern part of the State.

Imports and Exports.—The salt imported and entered for consumption during 1904 was 330,932,467 lb.[1] ($516,807), as against 324,229,131 lb. ($496,054) in the previous year. The imports in 1904 included 69,657,850 lb. ($209,509) in bags, barrels, or other packages; 142,556,161 lb. ($184,461) in bulk; and 118,718,456 lb. ($122,837) for curing fish. Salt in bags, barrels, or other packages is subjected to a duty of 12c. per 100 lb. (33.6c. per barrel), and salt in bulk is taxed at the rate of 8c. per 100 lb., or 22.4c. per barrel. The duty on imported salt in bond, used in curing fish taken by vessels licensed to engage in the fisheries and in curing fish on the navigable waters of the United States, or on salt used in curing meats for export, may be remitted.

Exports of domestic salt amounted to 27,928,088 lb. ($113,625) in 1904, as against 25,499,630 lb. ($95,570) in 1903; and re-exports of foreign to 2,089,234 lb. ($2,814) in 1904, as against 7,804,215 lb. ($26,636) in 1903.

Referring to the fiscal year ending June 30, in 1904, Italy for the first time led both the United Kingdom and the West Indies in the amount of salt

[1] Figures of the Bureau of Statistics. Obtained by adding to (or subtracting from) the annual imports the decrease (or increase) in the amount of salt remaining in bonded warehouses between the beginning and end of the year.

contributed to United States consumption, while the West Indies has now for two years led the United Kingdom. Imports from the latter country, however, consist of finer material, its value being more than three times that of the total West Indian imports. Exports to Japan have recently fallen off about one-third, while shipments to Mexico and Canada have doubled.

Consumption.—From the following table, showing the consumption of salt in the United States, it will be seen that the proportion supplied by imports has steadily declined, the total domestic consumption at the same time steadily advancing:

CONSUMPTION OF SALT IN THE UNITED STATES.
(In barrels.)

	1900.	1901.	1902.	1903.	1904.
Domestic production (a)	20,869,342	20,566,661	23,849,231	18,968,089	22,030,002
Imports	1,427,921	1,440,950	1,319,744	1,171,288	1,186,712
Total supply	22,297,263	22,007,611	25,168,975	20,139,377	23,216,714
Exports	53,650	67,376	36,388	91,070	99,743
Domestic consumption	22,243,613	21,940,235	25,132 587	20,048,307	23,116,971
Percentage of imports to total consumption	6.4	6.6	5.3	5.8	5.1

(a) Statistics of the Geological Survey.

World's Production.—The following tables are, of course, not complete, since salt, being a universal necessity, is produced in nearly every quarter of the globe:

SALT PRODUCTION OF THE CHIEF COUNTRIES OF THE WORLD.
In metric tons and dollars.)

Yr.	Algeria.		Austria. (a)		Canada.		France.		Germany.	
1900	18,325	$76,288	330,277	$9,957,173	56,296	$279,458	1,088,634	$2,415,973	1,514,027	$4,627,500
1901	18,518	79,976	333,238	9,888,231	53,927	262,328	910,000	2,012,800	1,563,811	5,064,750
1902	27,263	112,792	310,807	9,330,813	57,203	296,845	863,927	2.493,001	1,583,458	4,830,077
1903	26,329	96,553	359,014	9,614,510	56,671	297,517	967,531	2. 44,086	1,693,935	4,810,000
1904	(c)	.....	(c)	....	62,411	318,628	(c)	....	1,700,932	4,923,250

Year.	Greece.		Hungary. (a)		India. (d)		Italy.	
1900	22,411	$336,165	189,363	$5,456,600	1,021,426	$1,146,363	367,255	$602,440
1901	23,079	351,700	211,321	6,553,449	1,120,187	1,405,682	435,187	668 982
1902	25,200	362,750	211,679	6,600,748	1,056,899	542,106	458,497	686,525
1903	(c)	....	212,586	6,566,238	836,394	1,477,027	488 506	717,466
1904	(c)	....	(c)	....	(c)	....	(c)	....

Yr.	Japan.		Russia.		Spain.		United Kingdom.		United States.	
1900	669,694	(b)	1,768,005	3,124,000	450,041	834,535	1,873,601	3,059,600	2,651,278	6,944,603
1901	659,118	4,808,185	1,705,922	3,547,627	345,063	599,934	1,812,180	2,864,950	2,612,204	6,617,449
1902	620,820	4,360,637	1,847,019	3,846,086	426,434	682,664	1,924,273	2,886,665	2,409,174	5,286,988
1903	657,489	4,634,606	(c)	....	427,394	670,247	1,917,184	2,973,783	2,408,646	5,286,988
1904	(c)	....	(c)	....	(c)	....	1,921,899	2,906,343	2,797,461	6,021,222

(*a*) The high valuation in Austria and Hungary is due to government monopoly and high taxation. (*b*) Not reported in official statistics. (*c*) Statistics not yet published. (*d*) Does not include salt made in certain native States and untaxed.

Output of additional countries during 1903, in metric tons: Australia, 40,642; Bahamas, 1,400; Cape Colony, 15,113; Ceylon, 2,739; Cyprus, 2,478; Turks and Caicos Islands, 55,626; Tunis, 18,846; Peru, 17,637; Switzerland (1902), 50,990; Venezuela (1902), 10,153 tons.

SULPHUR AND PYRITE.

The sulphur production of the United States has suddenly acquired startling proportions with the growth of the industry in Louisiana. The Union Sulphur Co., owning the Frasch patents, controls the Louisiana output, and has not yet made any statement as to its work in 1904; we estimate that it must have been around 190,000 tons. Nevada and Utah reported a production of 3,492 tons, about the same as for recent years.

The production of pyrite, not including the Western pyritic ores mined for their precious metal contents, was 173,221 long tons, valued at $669,124, as compared with 199,387 tons, valued at $787,579, the output of the previous year. The shortage was quite evenly distributed among the productive areas, a few of the Virginia mines being the only ones to show increased outputs. Although the total for that State was less in 1904 than in the preceding year, Virginia contributed nearly three-quarters of the whole production, followed by Massachusetts, California, Ohio and New York, in the order named.

CONSUMPTION OF SULPHUR IN THE UNITED STATES.
(In long tons.)

Source.	1900.	1901.	1902.	1903.	1904.
Sulphur—Domestic production	4,630	6,866	7,443	35,098	193,492
Imports	166,457	175,310	176,951	190,931	130,421
Total	171,087	182,176	184,394	226,029	323,913
Exports	540	207	1,253	967	2,493
Consumption	170,547	181,969	183,141	225,062	321,420
(a) Sulphur contents at 98 per cent.	167,136	178,330	179,478	220,560	314,992
Pyrite—Domestic production	201,317	234,825	228,198	199,387	173,221
Imports	329,449	403,706	440,363	427,319	413,585
Total	530,766	638,531	668,561	626,706	586,806
Exports	......	......	3,060	1,330	......
Consumption	530,766	638,531	665,501	625,376	586,806
Sulphur in domestic at 44 per cent.	88,579	103,323	104,071	87,730	76,217
Sulphur in foreign at 47 per cent.	154,841	189,742	205,532	200,215	194,385
Total sulphur content	243,420	189,742	309,603	287,945	270,602
Grand total sulphur consumption	410,556	471,395	489,081	508,505	585,594

(a) Includes crude and refined sulphur.

SULPHUR.

Louisiana.—Sulphur occurs accessibly situated in Calcasieu parish, 230 miles west of New Orleans, 12 miles from Lake Charles, and 16 miles from Sabine Pass. The first explorations were for petroleum, but when sulphur was discovered, a shaft was sunk on the Kind-Chaudron system and several other processes were tried. Shaft sinking proved costly, and the great difficulties encountered in the soft quicksand and gravel necessitated the abandonment of the work. The unique method, however, suggested and patented by Herman Frasch in 1891, which consists in melting the sulphur in the ground and raising it to the surface while melted, has made it possible for American sulphur to compete successfully with Sicilian. In fact, Mr. Frasch states that the cost of production is sufficiently low to permit exporting to Sicily and selling there at the Sicilian's cost.

The Frasch process consists in drilling a well precisely as for petroleum. This is cased with a 10-in. iron pipe which enters 10 ft. into the rock overlying the sulphur bed, and is sealed at its lower end with melted sulphur. Inside the 10-inch pipe is placed one of 6 in. diameter; inside the latter one of 3 in., and finally inside the 3-in. pipe one of 1 in. diameter. All except the casing pipe are recovered when the well is abandoned. The well itself is carried down to the bottom of the sulphur bed, and the inner pipes are dropped nearly to the bottom of the hole. Water heated to 330° F. is forced down the 3-in. pipe under a pressure corresponding to that temperature, and in coming in contact with the sulphur-bearing rock, melts the sulphur, which collects at the bottom of the well as a thin liquid of about 2 sp. gr. Compressed air is forced down the 1-in. pipe, and the bubbles of air mixing with the liquid sulphur reduce its specific gravity and it rises with great rapidity through the outside pipes. When the cavity becomes so large that the influx of cold water, of which large volumes, charged with hydrogen sulphide, are contained in the rock, is larger than the supply of hot water, the outflow of the well begins to diminish. After great quantities of hot water have been introduced, the rock becomes locally heated, so that the inflow of ground water has less retarding effect, and the total output of a well may reach 23,000 tons. At present there is sufficient heating capacity at Sulphur Mine to operate two wells with a daily output of 500 to 700 tons of sulphur. The maximum daily production of one well has been 550 tons, and the record for two wells is 850 tons per day. The average monthly production is between 15,000 and 16,500 long tons of sulphur, which is stored in large reservoirs, mostly 72 ft. square by 14 ft. deep.

Nevada.—The Rabbit Hole Sulphur mines have recently been described by George I. Adams.[1] They are situated in northwestern Nevada, at the western base of the Kamma mountains and 35 miles from Humboldt House, a station on the Southern Pacific at the border of the Black Rock desert, from which they may be reached by wagon road. The rocks in which the sulphur deposits occur are Miocene tuffs and fragmental volcanic eruptions cemented by quartz and chalcedony, and apparently have been leached by hot waters. It is thought that the sulphur at these mines was derived from great depth and deposited by solfataric action.

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[1] *Bulletin* 225 of the United States Geological Survey.

The sulphur is obtained from open pits, adits and underground chambers, where it is found as masses of crystals depending from the walls of irregular cavities and incrusting free surfaces. It has the beautiful yellow color of crystallized sulphur, with here and there a reddish tinge due to the presence of a small amount of cinnabar. The most important mass of sulphur is, however, of a different type, and has the appearance of having originated as a flow of molten sulphur which welled up and filled open channels in the rocks. It contains occasional fragments of rock, but is remarkably pure. Its color is a dark resinous yellow. The mines have been worked since 1900 by the Nevada Sulphur Company, of San Francisco. The equipment consists of two retorts, each of 2.5 tons capacity. The crude sulphur is melted in these retorts by steam injected at a pressure beginning at 70 and then lowered to 50 lb. per sq. in. The melted sulphur trickles down through a grate into the kettle-shaped bottom of the retort, from which, while liquid, it is run into molds making 250-lb. cakes. When cold, these are broken and crushed to pea size, and marketed in 100-lb. sacks.

The Humboldt Sulphur Company, at Humboldt, has suspended operations and its property is on the market. In Utah, the Utah Sulphur Company maintains about the same production that it has reported for the last three years.

Foreign Countries.—Sicily.—The production of sulphur in Sicily, as will be seen from the following table of exports, has ranged within narrow limits for several years, but has shown a constantly growing tendency. Exports during 1904 totaled 475,745 long tons, while stocks on hand at the several seaports increased from 361,220 tons at the beginning to 396,541 tons at the end of the year, indicating thereby a production of 511,066 long, or 519,243 metric tons, during 1904.

The industry in Sicily suffered from heavy rains during the fusion sea-

TOTAL EXPORTS OF SULPHUR FROM SICILY. 1900-1904.
(In long tons.) (a)

Country.	1900.	1901.	1902.	1903.	1904.
Austria	21,594	18,842	19,086	17,926	23,374
Belgium	9,721	7,471	12,323	15,233	13,627
France	103,647	74,394	67,249	74,372	103,040
Germany	28,702	23,448	25,906	32,553	31,613
Greece and Turkey	19,647	21,702	20,548	22,133	25,376
Holland	18,595	10,848	8,648	5,157	8,122
Italy	101,073	74,516	45,603	45,572	79,619
Portugal	10,937	11,335	10,614	14,064	8,373
Spain	6,187	2,979	2,249	4,099	4,063
Sweden, Norway and Denmark	22,681	24,486	24,918	28,292	20,120
Russia	22,090	15,110	17,295	15,068	15,141
United Kingdom	23,973	22,468	25,477	19,210	18,108
United States (c)	162,505	144,817	168,919	155,996	100,000
Other countries	6,810	9,887	18,484	(c) 25,833	25,167
Totals	558,162	462,299	467,319	475,508	475,745
Stock in Sicily at end of year	221,204	302,410	339,113	361,220	396,541

(a) In 1900 and 1901 by A. S. Malcolmson, New York; for following years, by Emil Fog & Sons, Messina.
(c) Australia, 4,756 tons; Brazil, 414; Canada, 808; East Indies, 3,182; North Africa, 3,928; South Africa, 5,465; South America, 1,943; Asia, Bulgaria, Egypt, Malta, Rumania, Switzerland and Syria, together, 5,337: total, 25,833 tons, as against 18,484 tons in 1902.

son, from intermittent labor troubles, and by a smaller demand from America and Great Britain, though exports to vine countries, notably France and Italy, have increased. Fearing the growth of the American industry, the Chambers of Commerce at Girgenti and Caltanissetta have asked a government investigation, while the local press in Italy proposes to raise a fund of $10,000 by public subscription, as a premium to the inventor of new uses for brimstone.

Nearly the whole output of the island is under the control of the Anglo-Sicilian Sulphur Company, which was organized in 1896 with an authorized capital of $5,175,000.

The company originally agreed to purchase all the sulphur produced by the miners for five years, dating from 1896, at an average price of $15.94 per ton for best unmixed seconds, f. o. b. ship. About three-fourths of the producers acquiesced in this plan, but at present 85 per cent of them have signed. To safeguard against overproduction, the company acquired the right to curtail output up to 18 per cent, guaranteeing the miners an extra allowance of 1 per cent for each 3 per cent of reduction. In 1901 the same arrangement, with slight modifications, was made for another five years. At the same time, the miners received the benefit of the repeal of the export tax. By its system of distribution, the company has compelled the outstanders, who control about 15 per cent of the output, to sell at a discount.

In 1897, the first fiscal year of the combination, exports of brimstone from Sicily showed an increase of over 16 per cent, resulting in a net profit of $246,770, or about $1.50 per ton on the business done by the Anglo-Sicilian Company. Three years later, in 1900, when the high record in exports was established at 557,668 tons, the profits of the company were more than doubled. In the last fiscal year, ending July 31, 1904, the net profits were $792,140, the largest yet recorded. From the profits earned during the eight years, from 1897 to 1904, inclusive, the company paid annually a regular dividend of 6 per cent on its $3,500,000 preferred stock, and sometimes made an extra distribution; in 1903 and 1904 it declared a total of 100 per cent on the $175,000 common. During the same period it accumulated $1,988,410 in reserve funds, of which $695,495 is held against depreciation of stocks of sulphur, an amount equivalent to $2.37 per ton on the 293,188 tons at the seaports in Sicily on July 31, 1904.

These large profits have not been realized on an increase in the volume of business alone, for consumers in America have paid an advance of from $3 to $7 per ton for their sulphur since the organization of the Sicilian syndicate. In the eight years under review the exports from Sicily to the United States aggregated 1,122,241 tons, which constituted about one-third of the total exported to all countries. These imports, duty free, supplied about 36 per cent of the consumption in America of sulphur in all forms, including pyrite. Taking the average price, f. o. b. New York, at $21.71 per ton for best unmixed seconds, and $18.98 for best thirds, the total value of the imports from Sicily, from 1896 to 1903 inclusive, was $23,477,888. Deducting freight from Sicily at $1.68 per ton, or $1,885,365, and agents' commission of $234,779, leaves a balance of $21,357,744, an amount sufficient to provide for all other expenses and leave a substantial profit.

In its overtures to the miners for a renewal of its agreement for another 10 years, the Sicilian combination has promised better terms. That the contract will be signed appears likely, since those interested in the Anglo-Sicilian Company have much capital invested, and the miners need to be protected against pecuniary loss from decreased exports to the more important markets. Whether the combination's profits will continue on the present large scale cannot be conjectured, although it may be said with some certainty that with a falling off in the demand from America, and with continued expansion in the consumption of pyrite, the outlook is not cheerful.

Mexico.—The Popocatepetl Company, promoted with the nominal intention of extracting sulphur from the volcano, but including among its activities the development of a summer resort at high altitude, the construction of an inclined railway and other side issues, has completed its organization with a capitalization of $5,000,000, and has obtained full possession of the mountain. The latest advices state that sulphur mining has not yet begun, and it is reported on good authority that the available supply of sulphur is only a small fraction of the quantity announced by the promoters as ready for attack. A few localities in northern and central Mexico produce small quantities of sulphur.

Peru.—Energetic steps are being taken by the Sociedad Azufrera de Sechur, of Lima, to introduce its product among American consumers. The Peruvian sulphur occurs not far from the Bay of Sechura in the north, and a railroad 45 kilometers long is nearly completed to Bayovár, which is soon to be made a port of entry. Material has been received from Europe for the construction of a pier at Bayovár, to facilitate exports. The company has a nominal capital of 100,000 libra ($486,650), of which about 50 per cent is said to have been paid in. The directors include some prominent people in Lima.

WORLD'S PRODUCTION OF SULPHUR.
(In metric tons.) (a)

Year	Austria. (d)	France. (c)	Hungary.	Germany.	Greece.	Italy (b)	Japan.	Spain.	United States.
1900...	862	11,551	123	1,445	891	544,119	14,439	750	4,630
1901...	4,911	6,836	137	963	2,336	563,096	16,548	610	6,977
1902...	3,721	8,021	105	487	1,391	510 333	18,287	450	7,565
1903...	4,475	7,375	135	219	(e)	497,615	25,914	1,680	35,671
1904...	6,288	(e)	(e)	209	(e)	511,066	(e)	(e)	193,492

(a) From the official reports of the respective governments. The sulphur recovered as a by-product by the Chance-Claus process in the United Kingdom, amounting to between 20,000 and 30,000 long tons annually, is not included. (b) Crude. (c) Raw mineral; limestone impregnated with sulphur. (d) Crude rock. (e) Not yet reported.

Markets and Trade.—The imports of all grades of sulphur into the

United States in 1904 was 130,421 long tons, valued at $2,512,688, a diminution of 60,510 tons, or $1,197,000 in value, from the corresponding importation of the previous year. The natural explanation of this sharp decline to the smallest figure recorded since 1895 at the end of a 10-year period of steadily enlarging importations, is found in the growth of the Louisiana industry, which, in 1904, more than trebled its previous year's output. The refined grades, lac and precipitated, constituting less than 0.2% of the total, showed an increase of a few tons; flowers, constituting about 1% of the total, decreased by only 522 tons, leaving crude brimstone to feel nearly the full effect of the collapse.

As in previous years, the major part of the arrivals came from Sicily, amounting to 77% of the whole in 1904 and 82% in 1903. The United States was, however, for the first time, surpassed by France as a market for Sicilian sulphur.

Imported brimstone, selling f. o. b. Sicilian ports at the equivalent of $18.78@$19.74 per long ton for best unmixed seconds in bulk, and $18.18@$19.14 for best thirds, paid an ocean freight to Atlantic ports of $1.62@$1.92. At New York, contracts for shipments were made at $21.25@$22.50 for best seconds and $20.50@$22 for thirds—prices that have netted small profit to the importers. Domestic sulphur of prime quality, guaranteed 99.5 per cent, sold at $21.50@$21.75 per ton f. o. b. New York; $21.75@$22 at Baltimore and Philadelphia, and $21.65@$21.90 at Portland. 'Louisiana seconds,' guaranteed 98 per cent pure, consist of prime quality adulterated with sufficient inert material to resemble Sicilian best unmixed seconds, and are quoted at 30c. lower, though they have had no sale as yet. Small lots of Louisiana sulphur have been exported to France, Germany and Great Britain, and are sold at comparatively higher prices than the domestic deliveries. It is said that, owing to the low cost of production and the purity of the sulphur, it can be sold in Italy at the Sicilian's cost of mining and preparing for market. Some Japanese sulphur arrived at San Francisco for gunpowder and acid factories, notwithstanding the war with Russia. Sicilian brimstone rarely reaches the Pacific coast, because consumption there is limited and the ocean freight is about four times greater than to Atlantic ports. The Nevada and Utah production is readily absorbed by the demand on the Pacific coast.

Pyrite.

Pyrite is used almost exclusively in the manufacture of sulphuric acid, for which its cheapness adapts it, while the more expensive brimstone is burned by paper manufacturers to bleach their pulp. Pyrite-burning furnaces also are coming to be employed for this latter purpose in Scandinavia and Germany, and experiments of the same nature are being made by some large paper manufacturers in the eastern part of this country. The saving by the use of pyrite would be large, as brimstone costs about twice as much as an equivalent amount of pyrite; a pyrite-burning plant, however, is somewhat more expensive than one adapted for brimstone, and the trace of arsenic, almost invariably present in American pyrite, is said to have a deleterious effect.

WORLD'S PRODUCTION OF PYRITE. (a).
(In metric tons.)

Year.	Belgium.	Bosnia.	Canada.	France.	Germany.	Hungary.	Italy.	Newfoundland
1900	400	1,700	36,316	305,073	169,447	87,000	71,646	Nil.
1901	560	4,570	31,987	307,447	157,433	93,907	89,376	7,653
1902	710	5,170	32,310	318,235	165,225	106,490	93,177	26,417
1903	720	6,588	30,427	322,118	170,867	96,619	101,455	42,000
1904	(d)	(d)	30,000	(d)	174,782	(b) 95,000	(d)	61,163

Year.	Norway.	Portugal.	Russia.	Spain. (c)	United Kingdom.	United States.	Totals.
1900	98,945	345,330	23,154	356,019	12,484	204,538	1,712,052
1901	101,894	443,182	30,732	404,815	10,405	238,661	1,922,622
1902	121,247	413,714	26,465	473,648	9,315	231,849	2,023,972
1903	129,939	376,177	(b)25,000	560,409	9,793	202,577	2,074,699
1904	(d)	(d)	.....	567,550	10,452	175,993	....

(a) From the official reports of the respective governments. (b) Estimated. (c) Exports; does not include cupriferous pyrite, of which the production is over 2,500,000 tons per year. (d) Not yet reported.

An interesting detail of pyritic ore-dressing practice is reported by the Arminius mine, of Mineral, Va. It was the suggestion of E. G. Spilsbury, and has been giving great satisfaction for five years. The Hartz jigs are provided with sheet-steel screens, punched with ¼-in. square holes. These punched screens are found to be many times more durable, even in the acid water, than woven brass wire-screens. The jig-bed is composed of ½-in. balls of malleable cast iron. These make a free and lively bed and are superior for the purpose to everything else that has been tried. The small sizes are better than the large ones.

Markets and Trade. United States.—Although both domestic production and foreign imports of pyrite showed large decreases from the previous year, the proportion of imported pyrite rose from 52 per cent of the whole consumption in 1903 to 61 per cent in 1904. Total imports in 1904 were 413,585 long tons, valued at $1,533,564, as against 427,319 tons, valued at

PRODUCTION, IMPORTS AND CONSUMPTION OF PYRITE IN THE UNITED STATES. (a)
(In tons of 2,240 lbs.)

Year.	Production.		Imports. (b)		Consumption.	
1900	201,317	$684,478	322,484	$1,055,121	523,801	$1,739,599
1901	234,825	1,024,449	403,706	1,415,149	638,531	2,439,598
1902	228,198	971,796	440,363	1,650,852	668,561	2,622,648
1903	199,387	787,579	425,989	1,628,600	625,376	2,416,179
1904	173,221	669,124	413,585	1,533,564	586,806	2,202,688

(a) These statistics do not include the auriferous pyrite used for the manufacture of sulphuric acid in Colorado. (b) Net imports, less re-exports of 3,060 tons, in 1902, and 1,330 tons, in 1903.

$1,636,450, in 1903. There were no exports in 1904. Imports were principally of Spanish ore; Canada's entire export, 16,321 long tons, valued at $49,911, or 55 per cent of her whole production, came to the United States.

Trade in pyrite has been unprofitable as a result of keen competition and low prices in the face of a diminishing consumption. Sales of 47 to 52% imported ore, paying a freight from Huelva, Spain, at $2.10@$2.40 per ton, were made at seaboard points at $3.68@$5.88 per ton for fine, and $4.66@$6.37 for lump ore, according to quality. Domestic ore, analyzing from 42 to 44% sulphur, was marketed at $3.66@$4.30 per ton for fine, and at $4.30@$4.83 for lump f. o. b. mines. Calculated on the sulphur content, and allowing for expense of burning, consumers of pyrite are paying from 25 to 50% less than is charged for brimstone.

Sulphuric acid, the manufacture of which in the East is controlled by a few concerns who are on friendly terms, held firm, 50° selling in bulk at $13.50@$14.50 per ton; 60° at $18@$20, and 66° at $21@$23, f. o. b. New York. Acid in carboys is worth from $3 to $6 per ton more. Manufacturing costs have been reduced by improvements, and much attention is now being given to contact processes, while one American patent has been issued for an electrolytic method.

United Kingdom.—Much the larger part of the demand for sulphur by the chemical and the artificial fertilizer industries is satisfied by imports of iron and copper pyrites from Spain. The amount of these sulphides imported during 1904 was 742,837 long tons, valued at $5,732,323, being an increase of 6,928 tons over 1903. On an average content of 47%, this was equivalent to 349,133 tons of sulphur, while the actual brimstone imported, all of it Sicilian, amounted to only 17,346 long tons, valued at $455,-582, a decrease of 572 tons from the previous year.

Use of Pyrrhotite.—A recent development in the sulphuric acid industry is the use of the lower sulphide of iron, ranging usually between Fe_6S_7 and $Fe_{11}S_{12}$, and containing theoretically around 39% of sulphur as against the 53.3% contained by the bisulphide, iron pyrite. Owing to its lack of easily dissociated sulphur, pyrrhotite has heretofore resisted all attempts at desulphurization by its own heat of combustion, but now this has been successfully accomplished at Sault Ste. Marie,[1] using the nickeliferous Sudbury ore, which contains, on the average, 15 to 20% sulphur, 1 to 3% nickel and 0.5 to 2% copper.

The ore, when received from the mine, is sorted into low- and high-grade in respect to sulphur; the former is smelted into matte in the ordinary way, while the latter is treated in the acid plant. This material has an average composition of 28% sulphur, 3% nickel, 0.5% copper, 50% iron. The roasting furnace is a modification of the Herreshoff, the external cylindrical form being abandoned and four shafts being built in a single block so as to reduce loss of heat by radiation. This modification, together with other pre-

[1] Ernst A. Sjöstedt, *Transactions* Canadian Mining Institute, March, 1904.

cautions at heat conservation, accounts for the success of the installation. The furnaces were constructed as muffles and were arranged for gas-firing, but with improvements in details and more extended experience, this method of firing has been discarded, while now, ore containing no more than 20 to 25% sulphur can be burned down to between 1 and 3% sulphur without the use of any extraneous fuel, giving a gas containing 6 to 10% sulphur dioxide. The present plant comprises four blocks with an aggregate capacity of 40 tons of ore per day.

Partly as a result of the success attained at Sault Ste. Marie, the General Chemical Company, one of the largest manufacturers of sulphuric acid in the world, has decided to utilize some of the pyrrhotite that occurs so abundantly in Virginia, and has begun the erection of a plant at Pulaski. A subsidiary company, the Pulaski Mining Company, has been incorporated with a capital of $500,000, and will work the mineral-bearing land, comprising 30 acres. The Herreshoff furnace, of the same construction as that used in Ontario, will be employed, and some economy is anticipated by the sale of the iron residues for the manufacture of pig iron. This is the first attempt of this nature in the United States.

TIN.

The world's annual output of tin has stood nearly stationary at about 90,000 tons for the last three years. In the face of this, consumption has grown rapidly, under the influence of the canning and tin plating industries, with the effect of reducing stocks previously accumulated. For this reason, discoveries of tin ore in all parts of the world are receiving careful attention, while the prevailing high price of the metal is stimulating search in new localities as well as development in proved regions. The United States in 1904, for the first time in recent years, made an output of tin ore, viz., 159 short tons, containing between 40 and 70% tin. Tin smelting has not yet become established in the United States, though preparations have been made. The International Tin Co.'s plant, located at Bayonne, N. J., has never been operated, owing to the cutting off of its ore supplies by the prohibitive export tax imposed on ore from the Straits.

The United States output in 1904 was contributed mainly by the tin belt of the Carolinas, with less amounts from South Dakota and the Buck Creek region of Alaska.

THE PRINCIPAL TIN SUPPLIES OF THE WORLD. (a)
(In long tons.)

	1898.	1899.	1900.	1901.	1902.	1903.	1904.
English production	4,684	4,013	4,268	4,566	4,392	4,300	3,910
Straits shipments to Europe and America	43,350	44,460	46,070	50,339	51,831	52,212	57,419
Australian shipments to Europe and America	2,420	3,337	3,178	3,276	3,400	4,780	4,600
Banka sales in Holland	9,038	9,066	11,820	14,978	14,978	15,070	11,363
Billiton sales in Java and Holland	5,342	5,057	5,820	4,387	3,897	3,650	3,235
Bolivian arrivals on Continent	1,000	813	1,900	9,670	10,150	9,790	12,779
Bolivian arrivals in England	3,464	3,940	5,037				
Straits shipments to India and China	2,551	1,484	1,785	2,656	1,882	3,123	3,300
Totals in long tons	71,763	72,557	79,878	89,865	90,530	92,925	96,586
Totals in metric tons	72,911	73,718	81,155	90,284	91,978	94,412	98,131

(a) This table is based on the statistics compiled by Wm. Sargant & Co., and by Ricard & Freiwald, but the figures of English production are taken from the British Blue Book. This table does not include the production of Germany, Austria, Spain, Portugal and other countries.

Tin Mining in the United States.

The Carolinas.—Of the various localities in which tin ore has been mined, those in the Carolina tin belt were the most active during 1904. The mine on the S. S. Ross estate at Gaffney, S. C., produced about a car-load of dressed ore, and about the same amount was shipped from the mine on the Jones plantation near Kings mountain, North Carolina. The latter mine is owned by the Carolina Tin Co., having its office at Charlottesville, Va. Its shaft is now 160 ft. deep, and 400 ft. of drifts have been run on

IMPORTS OF TIN INTO THE UNITED STATES.

Year.	Pounds.	Value.	Year.	Pounds.	Value.	Year.	Pounds.	Value.
1899....	71,248,407	$16,748,107	1901....	74,560,487	$19,024,761	1903....	83,133,847	$22,265,367
1900....	69,989,502	19,458,586	1902....	85,043,353	21,263,337	1904....	83,168,657	22,356,896

various levels. The vein is 3½ ft. wide. A small testing plant was put up to dress the ore, and the company has decided to sink a shaft to a depth of 300 ft. and to erect a dressing plant to treat 75 tons per day.

The American Tin Plate Co. holds an option on 5,000 acres lying between Bessemer City, N. C., and Gaffney, S. C., on which it is exploring. Tin occurs here mainly as stream tin, embedded in clay, but decomposed lode-stuff in place is found in some localities.

South Dakota.—Tin mining at the Harney Peak company's property near Hill City, S. Dak., is at a standstill, the company being in a receiver's hands. This mine produced, during 1904, 300 tons of spodumene, which was sent East to the Standard Essence Co. for the manufacture of lithia.

The Tinton Tin Co. is operating at Tinton, in Lawrence county, S. Dak., near the Wyoming boundary. Cassiterite is found in a granitic rock, which intrudes among mica and hornblende schists; the tin-bearing pegmatite is 245 ft. thick, and of this thickness 104 ft. is thought to contain 0.69% metallic tin. An adit 400 ft. long cuts this width of ore at 80 ft. below the surface. Open-cuts exhibit an extension of the deposit.

Tin Mining in Foreign Countries.

Australia.—The total shipments of tin from Australia in 1904 were 4,846 long tons, of which 4,616 tons went to London and 230 tons to the United States. It is customary to estimate that about 5% of the output is used in domestic manufactures, so that the total production was approximately 5,100 tons.

Tasmania, with its two established tin fields, accounted for a large part of the output. The Mount Bischoff mine, in the Waratah district, of the northwest, is described on a following page. In the northeast, around Derby, the most important are the Anchor, Briseis and New Brothers Home mines. The Anchor mine shows what careful management can do. The ore at this mine carries only 4.75 lb. black tin per ton, equivalent to 0.17% metallic tin, or about one-fifteenth the tenor of the Mount Bischoff ore and one-eighth that of the Dolcoath. Of this, only 4 lb. is recovered, the rest being lost in fine slime. During 1904, there were 91 stamps, crushing 136,000 tons of ore, yielding 243 tons of black tin. The deficit of £886 on the year's work is readily attributable to the large amount of experimentation on the recovery from slime. The mine is an open working, as at Mount Bischoff. The Briseis mine has been undergoing development and large faces are now ready for stoping. Its product in December was 38 tons of black tin.

PRODUCTION OF TIN IN THE WORLD.
(In metric tons.)

Year.	Australia (a)		Austria. (a)	Banka and Billiton. (c)	Bolivia. (a)	England (a) (f)	Germany (a) (e)	Singkep.	Straits Settlements. (c) (g)	Total.
	N. S. Wales. (b)	Tasmania.								
1900...	1,088	2,061	40	18,809	10,245	4,336	2,031	575	47,699	96,884
1901...	659	1,818	49	19,675	14,932	4,634	1,464	793	53,421	97,445
1902...	502	1,989	50	19,177	16,779	4,462	2,779	Nil.	54,555	100,293
1903...	948	2,414	34	19,020	9,946	4,349	3,052	Nil.	56,220	95,983
1904...	1,085	(e)2,000	38	14,811	12,983	4,198	4,216	Nil.	61,691	101,022

(a) From official reports. (b) Includes only metallic tin smelted from domestic ore. (c) Figures by Ricard & Freiwald. (d) Exports of tin and tin contents of concentrated ore shipped to England and Germany. Some unavoidable duplication thus occurs in case of Bolivia ore smelted in Germany, but the amount of this is only a small fraction of the total Bolivian exports. (e) Includes tin from ore from all sources. (f) Estimated at 58% of the domestic output of tin ore concentrate. (g) Shipments to England, the Continent, America, India and China. Japan in 1903 produced 19 tons and China 66 tons of tin.

The cassiterite of Mount Bischoff is associated with topaz, both crystalline and amorphous, in large dikes of an acidic porphyritic rock penetrating slate and sandstone. The topaz has replaced feldspar, the rock containing no alkali, and consisting practically of quartz and topaz. It is comparable to the Saxon *sneckenstein*, a topaz quartz-porphyry.

New South Wales in 1904 produced 1,068 long tons of metallic tin, besides 577 tons of tin ore, valued together at $923,925, the largest output for 15 years. Most of this was obtained from the alluvial deposits in the Tingha, Emmaville, Deepwater and Wilson's Downfall divisions in the northeast corner of the State. No new deposits were opened, but the old ones were unusually remunerative. Dredging for stream tin is now a firmly established industry. In the Tingha division six pump dredges recovered 247 tons of ore. The bucket dredge on Wylie creek obtained 59 tons. Several small plants were at work in the Kookabookra division, and some of the gold dredges saved tin ore. In all, 319 tons were recovered by dredging. The Wylie creek gravel carried 2 lb. ore to the cubic yard, and that on Cope's creek, 1¼ lb. to the yard. Other localities ranged below ½ lb. to the cubic yard of gravel.

The tin output of Queensland, averaging in value $121,000 per month, comes mainly from a field on the northeast coast, near Geraldton. Queensland's tin ore production increased from 3,708 long tons ($1,167,115) in 1903 to 3,923 tons ($1,297,325) in 1904. The Kangaroo fields and the Celera Creek fields have been largely taken up, and at Cloudy creek a syndicate has acquired 20 acres of alluvial at 3,500 ft. elevation. This is a red loam carrying 15% of tin ore to a depth of 35 ft. Other deposits have been located or are being developed at Mount Beresford, Hidden Valley, and Pine creek.

From the north coast of South Australia, near Port Darwin, in a field whose alluvial deposits have been worked by Chinese, a valuable lode discovery is reported, besides new extensions of the stream workings.

Bolivia.—The exports of tin from Bolivia during 1904 amounted to

12,779 long tons, of which 9,867 tons went to Great Britain and 2,912 tons to Europe, mainly to Germany. As the home consumption is insignificant, these figures may be taken as representing production. The ore is won by deep mining, and is crushed and concentrated in well equipped mills. The producers are grouped in the Department of Potosi, in the southwest corner of the Republic, and are situated high up in the Andes, where they utilize an abundant water power. The domestic tin-smelting industry has remained steady for five years, while in the same period the exports of *barilla*, concentrated tin ore, have more than doubled, as is shown by the following table:

ARRIVALS OF BOLIVIAN TIN IN GREAT BRITAIN. (Long tons.)

Year	Ore.	Tin content.	Bars.	Total tin.
1900	5 431	3,530	1,507	5,037
1901	9 086	5,905	1,730	7,635
1902	10,961	6,576	1,685	8,261
1903	10,401	6,240	1,614	7,854
1904	13,824	8,294	1,573	9,867

Cornwall.—The output of dressed tin ore, 'black tin,' from the Southern district of England was 6,000 long tons in 1904, as compared with 6,499 tons in the preceding year. Except for 9 tons from Devon, this was the output of the Cornish mines, of which Wheal Grenville, Dolcoath and Carn Brea are the most important.

Wheal Grenville.—The inflow of water, which a year ago threatened to flood this mine, has been controlled and working costs, particularly of pumping, have been greatly reduced. Development has opened up ore much richer than any met heretofore. The average cassiterite content has risen from 32 lb. per ton of ore, the average during the four months ended last October, to 42.5 lb. per ton, the average during January of the present year, the latter being equivalent to 1.68% metallic tin. In the same period the price per ton realized on the black tin rose from £76 11s. to £80 18s.

Dolcoath.—The net profits from this mine during the latter six months of 1904, after all improvements and development had been paid out of earnings, was £13,720, out of which a dividend at the rate of 5% per annum was

DOLCOATH MINING YIELD FROM ITS BEGINNING.

Year.	Tin Ore Crushed.	Black Tin Sold.	Product per Ton of Ore.	Average Value per Ton of Ore.			Average Price per Ton of Black Tin.			Amount Realized.
	Tons.	Tons.	Lb.	£	s.	d.	£	s.	d.	£
1895	28,717	1,015	79.19	1	7	8	39	3	5	39,769
1896	63,727	2,039	71.96	1	3	8	36	6	7	75,142
1897	73,565	2,095	63.78	1	1	7	37	17	11	79,397
1898	78,697	2,302	65.58	1	5	3	43	7	2	99,720
1899	82,740	2,079	56.28	1	16	8	73	0	3	151,874
1900	88,356	2,004	50.78	1	17	1	81	16	9	164,116
1901	96,578	2,036	47.21	1	9	10	70	13	7	143,808
1902	100,450	1,828	40.88	1	5	16	72	2	8	131,885
1903	98,910	1,740	39.43	1	7	0	76	14	7	133,458
1904	100,549	1,705	37.98	1	5	9	75	18	11	129,619

declared, leaving a comfortable balance for the prosecution of some more much needed development. The veins are becoming small and bunchy, so that more stopes are needed to maintain a steady output, and a greater amount of dead-work is required to develop them. The average proportion of tin mineral in the ore is now about 40 lb. per ton.

Carn Brea.—During 1904, development of this long dormant mine was pushed vigorously and with most encouraging results. Heavy exceptional charges caused a large deficit, but on the basis of actual working costs the mine met its expenses. A 6-ton sample from one of the new openings showed 118 lb. of black tin to the ton, as compared with 26.42 lb., the average contents during the latter half of the year. The vein on this level is wider than the drift, and extends downward into untouched territory.

Dutch East Indies.—The production of the Dutch islands during 1904, as estimated from their sales, together with the increase in stocks accumulated during the year, was 14,916 long tons, of which Banka contributed 11,701 and Billiton 3,215 tons. Singkep made no output during the year.

Germany.—About 100 tons is the annual output of tin ore (99 metric tons—$13,250—in 1904, and 110 tons—$14,250—in 1903), although the smelting of tin ores, imported chiefly from Bolivia, is a prominent industry. In 1904, Germany smelted 4,216 metric tons of tin, valued at $2,625,000, as compared with 3,052 tons ($1,849,250) in 1903. Of tin chloride, 816 tons ($327,000) were made in 1904, and 1,064 tons ($425,750) in 1903.

GERMAN IMPORTS AND EXPORTS OF PIG AND OLD TIN.

	1901.	1902.	1903.	1904.
	Metric tons.	Metric tons.	Metric tons.	Metric tons.
Imports...........	12,910	13,760	13,925	14,352
Exports...........	1,683	2,271	2,581	2,965
Excess of Imports...	11,227	11,489	11,344	11,387

Malay States.—The production of tin in the Federated States during 1904, as shown by Ricard & Freiwald's statistics of exports from Singapore, was 60,719 long tons, as compared with 55,335 tons during the previous year. Of this, 35,675 tons went to London; 7,239 tons to Europe; 14,505 tons directly to the United States, although part of the London shipments also were destined for this country; 3,300 tons to India and China. A notable feature of the Straits trade is the increasing proportion of the gross output that is exported as ore, while the shipments of native-smelted tin constantly diminish. About 70% of the total output in 1904 was in black tin or concentrated ore. This tendency may be explained by an impoverishment in the character of the raw ore. A lean ore cannot be smelted satisfactorily by the crude Chinese methods that have prevailed, while on the contrary it can be disposed of advantageously to the Straits Trading

EXPORTS OF TIN FROM THE MALAY STATES. (a)

State.	1903.			1904.		
	Tin.	Tin in Ore.	Total Tin.	Tin.	Tin in Ore.	Total Tin.
	Long tons.	Long tons.	Metric tons.	Long tons.	Long tons.	Metric tons.
Perak	9,700	16,270	26,392	8,800	17,626	26,832
Selangor	7,940	9,000	17,162	7,150	10,730	18,175
Negri-Sembilan	2,560	2,527	5,171	3,000	2,085	5,133
Pahang	367	1,140	1,529	340	1,300	1,662
Total Malay Sts.	20,567	28,937	50,254	19,290	31,741	51,802
Total, 1902	......	......	47,226	......	......	......
Total, 1901	......	......	47,728	......	......	......

(a) From the *Selangor Government Gazette.* Reported in Chinese piculs: 1 picul = 133.33 lb. = 60.5 kg.

Co., of Chinese proprietorship, which has good facilities for concentrating ores and for disposing of its product.[1] The entire output, except a few hundred tons, comes from alluvial deposits along the streams rising in the granite uplift which forms the backbone of the peninsula. The western slope appears to be the more prolific, as Perak, Selangor and Negri Sembilan contributed almost 97% of the whole output, the remainder coming from Pahang, on the east coast.

Siam.—Tin is the only metal whose ores are mined to any extent in Siam. The supplies all come from alluvial deposits whose origin is in the same granite axis that extends southward through the British and Dutch possessions. The production in 1904 was nearly 5,000 long tons. Eleven provinces on the east coast and ten on the west coast contain tin areas that are being worked.

Generally speaking, all the mining is in the hands of Chinese; the labor is Chinese, and the smelting is done locally by Chinese methods. The only exceptions are that one British and one Dutch company are working in Kedah; an American company is making a small beginning in Bangtaphan, and a British smelting company is establishing an ore-buying agency at Puket. The number of Siamese and Malays engaged in tin-mining is very small.

There is a great field for the expansion of the tin-mining industry in the Siamese possessions on the Malay peninsula, and considerable activity in prospecting on the part of European capitalists has lately been shown. At present, Puket island (on the west coast) is the most important tin-mining center in all the Siamese States; but Kedah, Takupur and Renong (also on the west coast) have a considerable mining industry. On the east coast, Lakon, Sri Tammarat and Jalar (port Patani) are the chief centers. The most promising districts for future developments are in Kedah, Rahman, Jalar, Takuatung and Renong. In the Burmese territory, on the northern west coast of the peninsula, tin-mining continues on a small scale; the output in 1903 was 110 tons.

South Africa.—A discovery of tin lodes in central Transvaal, in the

[1] In this connection see THE ENGINEERING AND MINING JOURNAL, LXXVIII, 1904, p. 255.

summer of 1904, is reported as being of prospective importance. The locality is 35 miles northeast of Hatherly, a railway station 13 miles east of Pretoria, on the main line to Delagoa Bay. A group of five parallel lodes is said to have been traced for 12 miles, and development on one of the veins showed good ore.

Recent explorations of the Tanganyika Concessions, operating in northern Rhodesia and in Congo Free State, have proved the existence of stream tin at intervals for 50 miles along the Lualaba river, the southern main tributary of the Congo. Samples from the most promising bed show an average of 6% black tin, and the gravel is easily accessible.

Tin Markets.

New York.—The average price of tin in New York during 1904 was about as high as that for the preceding year, due to the article continuing in a strong position in the relation of supply and demand. It is true, the American consumption proved somewhat of a disappointment, imports showing a falling off against last year of about 8,000 tons, but the European countries more than made up for this. Production in the Straits was about the same as last year. The Dutch Government announced that the quantity of Banka tin to be put up for auction during 1905 will amount to about 200,000 pikuls, being an increase of about 600 tons over the current year.

Strange to say, no tin has as yet been profitably mined on the North American continent, although there are some prospects of regular shipments of tin ore from Alaska. Fair quantities continue to be imported from Bolivia, but are sold at a discount, owing to inferior quality. Speculation during the year had full sway on both sides of the Atlantic, but the fluctuations were not quite as wide as during former years.

The year opened with Straits selling at 29½, but towards the end of January the market broke suddenly to 28⅛. February proved a very dull month, values ranging between 27¾ and 28¼. In the middle of March a sharp upward movement took place, caused by the scarcity of spot supplies, and 29c. was paid for early deliveries, while futures sold at ½c. discount. This squeeze, however, was only of short duration, and values fell back to 28⅛, at which figure the market ruled steady throughout April.

During May the market had a declining tendency and broke sharply about the middle of June, when 25½ was accepted for spot tin. During July the usual summer dullness prevailed, but at the end of the month there was one of the periodical displays of fireworks in the London market, the price advancing over £2 in one day. In some quarters the rise was attributed to a fear on the part of importers that, owing to the Russo-Japanese war, shipments from the Far East might be interfered with. Our market responded only a little to the upward movement abroad, 27c. being paid for early deliveries.

In August the prices fluctuated only within narrow limits, but in September an upward movement was again started, and prices rose to 28¼c. by the end of the month. During October and November values continued to advance, but consumers over here only covered their immediate requirements, being frightened off by the continuous manipulations of the London operators. At the end of November the latter succeeded in putting up prices to £16 5s. per long ton in London, 30c. here. From this figure values

AVERAGE MONTHLY PRICES OF TIN PER POUND IN NEW YORK.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
1900....	27.07	30.58	32.90	30.90	29.37	30.50	33.10	31.28	29.42	28.54	28.25	26.94	29.90
1901....	26.51	26.68	26.03	25.93	27.12	28.60	27.85	26.78	25.31	26.62	26.67	24.36	26.54
1902....	23.54	24.07	26.32	27.77	29.85	29.36	28.38	28.23	26.60	26.07	25.68	25.68	26.79
1903....	28.23	29.43	30.15	29.81	29.51	28.34	27.68	28.29	26.77	25.92	25.42	27.41	28.09
1904....	28.85	28.09	28.32	28.13	27.72	26.32	26.57	27.01	27.78	28.60	29.18	29.29	27.99

receded again to 28½, when it became apparent that consumption over here had improved to some extent, tin-plate mills especially taking large quantities.

In these circumstances, values during the second half of December rose steadily and the closing quotations for the year were 29⅜ to 29½ cents per pound.

London.—The year opened with a stock in London of 13,948 tons and a total visible supply of 14,283 tons. For cash sales £134 was reached, £134 10s. being paid on three months' deliveries. From this level there was a quick reaction to £126 for cash and forward metal, caused by free selling by Chinese holders, who had been holding metal in the Straits. Shipments from the East were liberal, the higher range of values bringing out old stocks which had accumulated. Consumption in Europe was not good, but America bought freely, as tin-plate mills were working to their full capacity.

February commenced with a London stock of 4,436 tons and a visible supply of 16,795 tons, the price for cash being £126 10s. At one time it rose to about £129, but fell away again to £123 5s. spot and £123 15s. forward, and closed about 10s. from the lowest. There were many reasons for this decline. Shipments from the East were larger than anticipated, and the commencement of hostilities between Russia and Japan led to a want of confidence which was expressed in most of the other markets. Trade also in this country left much to be desired. Deliveries were artificial, for, owing to the larger deliveries during the few previous months, consumers were now independent.

March saw the stock in London reduced to 4,042 tons, while the visible supply had shrunk to 16,460 tons. The warrant market remained quiet for the early part of the month at about £124 per ton. On a resumption of buying by the Chinese speculators, with a strong demand from America, values quickly jumped to £130 10s. spot, with forward selling at 5s. lower. Realizations and bear selling then caused a reaction, so that the month closed at £127 15s. for cash and three months. Deliveries on the Continent and in this country were good, and large shipments were going to America, where an impetus was given to trade by the unexpected acceptance of a reduction in wages by the tin-plate millmen on export orders.

April began with a further large shrinkage in London stocks, which were only 3,453 tons, the visible supply being 16,433 tons. Prices did not move much, however, the highest for cash being £128 15s., the lowest £126 7s. 6d., while three months' deliveries ranged from £129 to £126 2s. 6d., closing at £126 10s. spot, £126 forward. Free selling on Chinese account caused heavy shipments against sales made during the month. Chinese operators began to realize that the output of tin in the Straits was not going to decrease as much as they anticipated; they therefore showed more desire to liquidate their holdings. Prices would have suffered to a greater extent had not the trade with America been on such a large scale.

May saw a fresh diminution in the London stock, which was only 2,984 tons, the visible supply being 15,974 tons. Prices, however, suffered a severe relapse, owing to large sales by Chinese operators, declining to £122 spot and £121 10s. three months, but before the close of the month recovering to £123 and £122 15s., respectively. Consumption in Europe continued good, while America showed some signs of falling off.

June opened with a visible supply of 16,836 tons. The market was dull, values falling until £116 10s. was reached for cash and £116 for three months, but ultimately improving to the extent of 10s. per ton. Sales on Eastern account, and a slackness of demand from America, were the chief depressing factors. European demand was good, but shipments from the East gave promise of being large.

July saw a falling off in the visible supply to 16,070 tons, the London stocks being 1,856 tons. A renewal of the American demand and large purchases by the Chinese caused a quick improvement in values, which rose to £124 15s. for cash, and £123 5s. for three months, and closed with a slight setback at £122 10s. for cash and £122 15s. for three months. The Straits shipments, being smaller than estimated, helped the advance, and, notwithstanding the inclusion of 2,000 tons Banka, the statistics published at the beginning of August showed only a small increase, the visible supply being given as 16,237 tons, and the London stock 2,210 tons. Trade throughout the month was on a small scale, with unimportant fluctuations, the extreme values being £121 to £123 17s. 6d. cash and £121 17s. 6d. to £123 17s. 6d. forward. The business in the Straits was active, large stocks changing hands; this was generally taken to indicate that exporters in the East, having sold ahead without covering, were obliged to buy on the other side to fulfill their obligations. The home and Continental trade continued on a good scale, but the demand from America was spasmodic.

September showed 14,659 tons visible, and 2,071 tons London stocks, the large reduction indicating the good consumption ruling at the time; this caused an improvement during the month from £124 5s. cash and £124 17s. 6d. three months to £128 10s. and £129, respectively. Under realizations of speculative holdings, prices gradually declined, and closed at £127 17s. 6d. spot and £128 7s. 6d. forward. America was quiet during the early part of September, but sent large orders during the closing days of the month. Shipments from the Straits were small, and selling from that quarter was only on a moderate scale.

The inclusion of Banka tin in the October statistics caused an increase in the visible supply to 15,213 tons, English stocks being 1,783 tons. Values on the first of the month were £128 cash and £128 10s. three months, but active speculative buying caused a steady improvement to £132 15s. and £131 15s. The close was slightly below these figures at £132 10s. and £131 10s. The forward price showed a tendency to fall below the price of spot, large purchases being made by bull operators, who commenced to uplift cash warrants from the market. The rise was due more to professional buying than to trade requirements, the Continental and American demand being disappointing. There was also large selling from the East, which caused the decline in prices.

November began with the visible supply reduced to 13,721 tons, the nearest price at the opening being £132 10s. cash and £131 10s. three months. A large business was done throughout the month, but the fluctuations were unimportant. The East sold freely; America, the Continent, and England bought on a large scale, while the leading dealers tried to depress prices with the view of influencing the Banka sale in Holland; but by the close of the month values had risen to £137 cash and £135 15s. three months.

In December the visible supply was 15,419 tons, and London stock 2,078 tons. During the month, trade was greatly interfered with by the uplifting of the bulk of the warrants, so that cash metal was practically unobtainable except at high premiums over forward. The backwardation at some moments was as much as £1 10s. for one day, and £5 for three months. This was felt most keenly by dealers whose books were not square for dates, but consumers were caused but little inconvenience. The opening prices were £134 10s. cash and £134 three months, but free selling caused a reaction to £131 15s. and £129 10s., from which point values subsequently rallied to £135 and £131 respectively. The closing quotations of the year were £134 for spot, £133 12s. 6d. for three months' metal, with the tendency downward.

Tin in the United States.[4]

BY F. LYNWOOD GARRISON.

Tin is the only one of the common commercial metals that is not regularly

[4] The Engineering and Mining Journal, LXXVIII, 1904, p. 830.

produced in the United States. Considering the diversified geological character of the country, this is a remarkable fact, since productive tin mines exist in Europe, Asia, South America and Australasia. It may, therefore, be easily understood why discoveries of this metal in the United States are certain to arouse exceptional interest.

Tin-bearing rocks and tin minerals have been found in a number of scattered localities throughout North America, but in only a few places have they been developed to any extent—at Harney Peak, in the Black Hills of South Dakota; at Temescal, ten miles south of Riverside, in California; and to a small extent at the Cash mine, in Rockbridge county, Virginia. All these ventures were commercial failures. The history of the Dakota tin mines is interesting in several respects; it is however, voluminous, and may be sketched here in only the briefest manner.

About 1879 some cassiterite grains were found in the streams of the Black Hills, and in 1883 the ore was discovered in place near Harney Peak, which constitutes part of the granite core of a great uplift. The granite is coarsely crystalline, and is characterized by numerous crystals of tourmaline, columbite and tantalite, with particles of cassiterite (tin oxide) scattered through it. The tantalum minerals closely resemble tin oxide, and gave the rock the appearance of containing more metal than was actually the case, leading to mistaken opinions as to its richness in tin. The tin appears to occur chiefly in the greisen[5] dikes, and possibly to some extent also in the metamorphic slates and schists. No true fissure veins are said to have been found; the tin ore shows a disposition to segregate with quartz in irregular bodies. Though much exploration and some actual mining was carried on in these South Dakota deposits, no improvement in the richness of the ore-bodies was experienced. Notwithstanding this fact, large sums were expended in machinery, development work and the purchase of adjoining claims that were, at the best, but questionable prospects, and the British company that was organized in 1887, with a large capital, to control and operate these deposits, was foredoomed to failure.

A careful sampling of the Etta mine, the most important of the properties belonging to this company, is stated to have shown an average yield of under 40 lb. cassiterite (or black tin) to the ton of ore, that is, about 1.3% of metal, which is a fair yield for any tin mine, and yet these deposits failed absolutely to develop into a commercial proposition.

The 20-ton mill at Tinton, near the Wyoming line, has been recently in operation, and several carloads of tin concentrate were shipped to Wales for treatment. It is said that the Spaniards knew of the existence of tin in what

[5] Greisen is described by Von Cotta as "a crystalline granular compound of quartz and mica." It is characterized as a granite without feldspar and its mica is chiefly of the lithia variety. It is usually associated with fluorides such as topaz, tourmaline and apatite. In Europe it is commonly associated with the tin deposits of Cornwall and Bohemia. It is also present in most, if not all, the American deposits, but some confusion seems to exist in distinguishing between it and pegmatite, which is essentially a granite composed of orthoclase, quartz, white mica and frequently tourmaline. The roughly determining element therefore between the two is the absence of feldspar in the greisen and its presence in pegmatite.

is now San Bernardino county, California, but it was not until 1868 that any serious attempts were made to develop the deposits. In that year a company was formed in San Francisco for this purpose, and considerable money was spent, with disappointing results. After passing through a period of litigation, the property was taken up in 1890 by a British company, known as the San Jacinto Estate, Ltd. The mines are situated a few miles south of Riverside, at Temescal, and they are commonly known by that name.

The mines have recently been leased by a new corporation, the United States Tin Mine Co., who intend to re-open the old workings, following the reported discovery of higher grade ore than has been met heretofore.

The geology of the district is similar to that of Cornwall. The rocks in the productive area are granite, porphyry, quartzite and slate. The ore is found in small veins of quartz, feldspar and tourmaline, similar to the 'tin capel,' or lode granite of Cornwall. Some of the orebodies are in the granite, others in the porphyry, and a few run into the slate. The deposits in the granite gave the best returns. The average yield has been variously given as 2 to 3.5% of metal to the ton of ore as mined. If these returns are correct, which is doubtful, it is evident that this mine cannot be considered poor for a tin deposit, since, as will be shown later on, such figures compare favorably with results obtained at successful tin mines in other parts of the world. There were probably several causes that contributed to the failure of this mining venture, such as high price of labor or extravagant management.

The high price of labor and fuel must have been a serious burden in the case of both the Dakota and California tin-mining ventures, and these factors deserve special attention in connection with the proposed tin-mining operations in the York regions of Alaska. There, such difficulties, together with the Arctic climate, are obviously serious, and, unless the deposits are exceptionally rich, or have other compensating advantages, not evident at present, failure is likely to result. The greatest tin-producing region in the world, the Malay peninsula, is provided with an abundance of cheap labor, and has an unexcelled position for transportation and fuel supply. However, the deposits are not particularly rich, and if less advantageously situated, might not pay to work.

The presence of gold and silver in some of the Alaska tin deposits has been reported, and it may prove a factor which will more than offset the disadvantages just indicated. According to the statements thus far received, the most promising tin deposits in the York region are the placers on Buck creek, which are reported by Edgar Rickard[6] to yield 8 lb. of 60% tin ore per cubic yard of gravel. Hess[7] reports as high as 27 lb. of 60% tin ore to the cubic yard of gravel. Assuming a cubic yard of gravel to weigh 1.5 tons, we have a ratio of about 18 lb. of 60% ore to the ton, equivalent to 10.8 lb.

[6] The Engineering and Mining Journal, 1903, LXXV, p. 30.
[7] *Bulletin* 229, United States Geological Survey, 1904, p. 32.

of metal to the short ton, or 0.54%, a small yield as compared with that from some other localities.

The tin lode deposits of the Lost River district in the York region of Alaska are, according to Collier, apparently both extensive and promising of good results upon development.[8] Near Tin creek, a tributary of the Lost river, the main tin-bearing ledge outcrops as a white dike cutting the Port Clarence limestone. It has been traced a distance of about one mile, and is supposed to have an average width of about 100 ft. This dike consists of greisen, and has crystals of cassiterite disseminated through it. The limestone to the north of it is reported to contain many stringers of tin ore projecting for several hundred feet.[9] Small quantities of gold and traces of silver have been found in the tin ore, rendering the deposit unusual, if not unique.

The dike appears to carry cassiterite through its entire width. The content of tin is stated to run up to 17%, and to average about 6% of metal. Considering the great size of the dike, it appears improbable that the tin minerals will be found sufficiently concentrated to yield over 1% metal to the ton of ore mined. But if the deposit proves as large as is supposed, and the cassiterite is evenly distributed throughout the greisen, it must be one of the greatest tin lodes in the world, and the presence of gold will to some extent offset the disadvantages of the locality.

In the Southern States, tin has been found in a number of places, but only a few occurrences have received any serious attention. On Irish creek, in Rockbridge county, Virginia, are a number of interesting tin deposits, among which is the once famous Cash mine. They lie on the western slope of the Blue Ridge mountains, in the extreme northeastern corner of the county. The characteristic rock is coarse granite, with outlying patches of slate. The granite is traversed by eruptive dikes, but the tin appears to be confined to quartz lenses and streaks in the granite, and is associated with arsenopyrite. It is stated that metasomatic replacement of the granite by the tin oxide has occurred in the immediate vicinity of the ore-bearing quartz stringers or 'leaders'; this is characteristic of many tin deposits in granite. An expensive mill was erected on this property by a Boston company about fourteen years ago, but it does not appear to have been operated except experimentally. These runs yielded from 3 to 3.5% tin in the ore—probably a much greater return than could be expected if mine and mill were regularly operated.

The King's mountain deposit, in Cleveland county, North Carolina, is probably part of a belt of stanniferous rocks which extends in a general southwest direction into South Carolina. None of the deposits in this zone has yet been developed to any extent, though some ore has been produced near King's mountain. The prevailing rock is granite associated with

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[8] *Op. cit.*, pp. 19-21.
[9] The Engineering and Mining Journal, December 31, 1903, pp. 999-1,000.

metamorphic schist, slate and quartzite. The proximity of greisen is characteristic here also.

The tin deposits near Gaffney, in Cherokee county, South Carolina, are evidently in the same belt of tin-bearing rocks as those of King's mountain. During 1903 some development was carried on and several tons of ore were shipped for testing. The results appear to have been satisfactory, as the work is being continued, 50 to 60 tons of concentrate having been shipped to New York in 1904 for treatment. The Gaffney deposits have so far yielded encouraging results.

It is evident that tin cannot be considered a rare metal in the United States, for there are large areas of tin-bearing rocks in the country, especially in the South. It is of the greatest importance to have reliable data from other countries as to the yield, cost of production, etc., at mines that have been, and are now, producing tin in large quantities. The disastrous results of attempts to mine tin in the United States have been due more to ignorance than to any other one cause.

In order to appraise the commercial value of tin deposits in the United States, it is helpful to know the results obtained elsewhere in this branch of mining. Frecheville[10] gives the average richness of a number of Cornish mines for the ten years from 1871 to 1881, in pounds of black tin per long ton, as follows: Dolcoath, 59 lb.; Cook's Kitchen, 43 lb.; Tincroft, 53 lb.; Carn Brea, 35 lb., which are approximately equivalent to 1.8%, 1.3%, 1.6% and 1% respectively in metallic tin. According to other authorities, the average yield in Cornish mines during a long period was not over 45 lb. of black tin to the long ton, or 1.95%, equivalent to about 1.5% metallic tin. At Altenberg, in Saxony, the average yield for a period of many years was 0.3 to 0.5% black tin (cassiterite), or 0.2 to 0.4% metal per ton. At Schlackenwald, in Bohemia, the yield is said to average from 0.4 to 0.5% black tin, or 0.25 to 0.4% metallic tin to the ton. In the Zinnwald, Bohemia, the average seems to have been about 0.5% black tin, or 0.4% metal.

In Bolivia, with the richest tin deposits in the world, the average yield ranges from 3 to 5% metallic tin in the undressed ore. The yield of the Mount Bischoff mine in Tasmania is given[11] at about 2.75% black tin, equal to 2.25% of metal. At Durango, Mexico, according to Ingalls, the average tenor is something like 3.75% black tin, or about 2.25% of metal.[12]

In the Malay peninsula, nearly all the tin is obtained from gravel, the detritus from the granite and other crystalline rocks that constitute the backbone of the peninsula. The tin has been concentrated by nature in the gravel beds and bars. In this district, including the neighboring islands of Banka and Billiton, where the deposits are of similar character, about two-thirds of the world's supply of tin is obtained. Taking the region as a

[10] 'Main Lode of Dolcoath,' *Transactions* Royal Geological Society, Cornwall, 1887, Vol. X, p. 154. Also *Bulletin* 229, United States Geological Survey, p. 52.
[11] Kayser, *Transactions* Federated Institute Mining Engineers, 1897, Vol. XIII, Pt. 3, p. 582.
[12] *Transactions* American Institute Mining Engineers, 1895, Vol. XXV, p. 160.

whole, the general average yield appears to be about 3.5% black tin (oxide), equal to 2.4% of metal in the gravel washed. Penrose[13] states that the average yield of the alluvium of the Malay peninsula is 1% black tin (cassiterite). Two per cent is considered exceptional, and 3 to 4% remarkably rich.[14]

It is a suggestive fact that none of the attempts to mine tin from rock in the Malay peninsula has been more than partially successful, as the ore is in too scattered a condition to pay to work. According to Penrose, it seems probable that deposits may yet be found in the rock that can be profitably worked.[15]

According to Rolker, the tin yield at Siak, in Sumatra, is 2.7 lb. per ton, or 0.12% of black tin, the average metallic contents of the black tin being 70 to 72%. Calculated on the total amount of ground excavated, including stripping, this would be 0.476 lb. of black or 0.348 lb. of metal ('white tin') per cubic meter excavated.[16] In Banka, according to Van Diest, this same amount yields 2.2 to 3.3 kg. black, or 1.75 to 2.03 kg. (2.95 to 4.46 lb.) of metal.[17] Rolker states that in Sumatra the panning tests in prospecting run higher; thus on panning 10,000 lb. of gravel from different creeks, 80% of it gave an average result of 1.13 lb. metal to the long ton of stream gravel, or 1.75 lb. per cubic meter.[18]

It will be observed from the data given above that the yields reported from all the mentioned American deposits compare favorably with those from the most productive tin districts in the world. It would be unfair to assume they are intentionally inaccurate; the truth is that not enough ore has been produced regularly by any one American tin mine to render it possible to obtain a correct average. With a general upward tendency in the value of tin and the undoubted possibility of decreased costs in operating with more improved methods, there is reason to expect that renewed attempts to mine tin in the United States will be successful, especially in localities favored with cheap labor, fuel and mild climate, conditions which are found in the Southern States.

The Mount Bischoff Tin Mine.[19]

BY SYDNEY FAWNS.

This is situated in northwest Tasmania, about 45 miles from the coast, on the top of Mount Bischoff, which is 3,500 ft. above sea-level. The port is Emu Bay, on the north coast; the railway (narrow gauge) freight rate is $14.40 per ton.

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[13] R. A. F. Penrose, 'Tin Deposits of the Malay Peninsula,' *Journal of Geology*, Vol. XI, No. 3, p. 144.
[14] The average production of the Pahang Corporation is given at 2 to 2.75% black tin, containing from 71 to 72% metal, i. e., about 1.5% metal to the ton mined. The Engineering and Mining Journal, Vol. LXXVIII, p. 254.
[15] *Ibid*, p. 145.
[16] *Transactions* American Institute Mining Engineers, 1891, Vol. XX, p. 64.
[17] *Ibid.* Quoted by Rolker, p. 64.
[18] *Ibid*, p. 65.
[19] Abstract from *Proceedings* of Mining and Metallurgy, January 19, 1905.

Mr. Thureau,[20] the late Government Geologist of Tasmania, considers that the stanniferous gossan is due to direct hydrothermal action; but later developments in the mine do not bear out this theory. Baron Von Groddeck,[21] late Director of the Royal Prussian Academy of Mines at Clausthal, has analyzed the tin-bearing porphyry; he concludes that the tin matrix is not a quartz porphyry, but a porphyritic topaz-rock, and that, like the topaz rock at Auerbach, in Germany, this deposit forms in itself a lode of tin ore. The Mount Bischoff deposit has been recently described by W. von Fricks in a paper[22] in which he writes as follows: "The tin deposits appear in an area of quartzite and clay-slate with dikes of quartz porphyry. Granite is present, but at some distance from the mine. These deposits are in part fissure veins carrying cassiterite, pyrite, arsenopyrite, fluorite, wolframite, tourmaline and siderite. The latter mineral is notable, because it is not usually present in veins of this character. Another part of this deposit is formed by replacement, chiefly of porphyry dikes. All rocks in the vicinity of the mine are much altered. The schist and slate contain some tourmaline, and are in part changed to typical 'tourmaline-fels' by complete replacement, only a few grains of the original rock remaining."

The method of mining is open-quarry. In soft ground a miner can excavate 12 tons a day, but only 4 tons in the harder porphyry. The rate of wages is $1.92 per day for miners, and $1.68 to $1.80 per day for truckers and laborers.

At the Waratah dressing-sheds, water is the sole motive power; for that and for dressing purposes 41,600 gallons of water are used hourly. To obtain this, a series of dams has been constructed at a cost of $107,496. Permanent supply can be relied on, as it is an exceedingly wet climate, although very healthful, the rainfall being 86 in. per annum.

The dressing-sheds are 1¼ miles from the mine, in the valley of the Waratah river. Transport from the mine costs under a cent per ton. The ore, before transport, is reduced to a diameter of 2.5 in. by rock-breakers. At the mill this is hand-fed into a battery, with stamps of the California type, 75 heads being in use. Each stamp has a falling weight of 5 cwt., with a drop of 8 in., and works at 72 blows per minute. The ore crushed is about 8,440 tons per month. The screens are woven steel wire, 14-mesh, 19 in. long by 20 in. wide, two on each mortar, and are in use 18 days. The shoes weigh 128 lb. and last six months; the dies weigh 70 lb. and last twelve months. The ore is more easily crushed than the Cornish tin ore; output per stamp is 4.546 tons of ore in 24 hours.

The crushed ore passes through a classification by double-trough rising-current classifiers, 30 in number; these are used in pairs, separating the coarse ore from the slime, the overflow carrying the latter away. From the classifiers the coarse ore passes into 30 two-compartment Hartz jigs; then to

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[20] Tasmanian Gov. Report, 1879.
[21] *Geology of Tasmania*, Johnson, p. 241.
[22] *Zeitschr.* d.d. Geol. Ges. Bd. U., p. 433, 1899.

rotating tables. These are made of wood, to the upper surface of which is fastened sheet iron, 1-16 in. thick; upon this is laid cement 1 in. thick, the outer rim being secured by a ½-in. tire of pine wood. A mixture of 25% turpentine and 75% coal tar is laid on the cement, and requires renewal only once in two years. The tables are from 10 to 15 ft. diam., with a slope of 1 in 12. The slime is swept off by jets of clean water, which require 23 gal. per hour. The tables are rotated by worm gearing once in 2½ min., the table treating 7 cwt. of slime per hour and requiring ⅛ h. p. to drive it. The slime carries, before treatment on this table, from 0.10 to 1%; the concentrate, from 15 to 20%. The cost of each table at Mount Bischoff is $461. Kayser concave buddles are 14 ft. and 20 ft. in diam., working at a speed of 6½ rev. per min., and require ¾ h. p. each. The slime and sand fed to these buddles carry 0.25% of mineral. First buddling raises the concentrate to 7%, and re-buddling to 60%. These machines save 4.75% of the ore recovered from the mine. Fifty tons of ore are saved annually by one man and a boy at the slime sheds further down stream, where the tailing is buddled, passed through a Chilean mill and classified on rotary tables. The loss in tailing averages 0.01 to 0.2% of tin.

The average content of the ore is 1.322%. The cost of mining, crushing and dressing a ton of stanniferous material is as follows:

	Cents
Mining, including new works, maintenance and other expenses	69.672
Trucking	11.132
Dressing	19.924
Slime shed	2.342
Ringtail shed	4.222
Management	14 958
Machinery	4.104
Development	5.254
Diamond drilling	14.448
Waterworks	0.062
Ore bagging	1.054
Stores	11.260
Sundries	1.434
Total	$1.59.866

During the first six months of 1904, 636 tons of concentrate was obtained, and the total since the formation of the company is 62,866 tons. No. 1 quality assays 70½% and No. 2 quality 65% of metallic tin. The Mount Bischoff company has its smelting works at Launceston, the nearest large town, the ore being shipped there from Emu bay. These works also do all the smelting for the Tasmania tin mines, either buying the ore—the price being fixed daily on the value of the metal in London—or smelting at a uniform toll of $14.40 per ton. The furnaces are reverberatory. The charge for each furnace is 50 cwt. of ore and 10 cwt. of small coal; eight hours are allowed for complete reduction. The metal is tapped into a brick-lined vessel, the slag being skimmed off; the tin is then refined in a large kettle by poling, and the dross is removed. The refined metal assays 99.80%, and is shipped to England in the form of ingots weighing 75 lb. each. The slag assays 5.3% and is re-smelted. When treating ore for the public, a deduction of 2% or more is made to cover loss in smelting. Public ore accounts for 45% of the total output.

Mr. H. W. F. Kayser has had the management since 1875. The first dividend was paid in 1878; since then dividends have been paid regularly, the total amount up to June, 1904, being $9,180,000 from an output of 62,866 tons of tin ore.

TUNGSTEN.

BY A. SELWYN-BROWN.

The advantages of tungsten steel in machine tools, armor plate, projectiles and other applications has led to careful search for the tungsten minerals, and these have been found in some abundance. The production of tungsten ores in the United States in 1904 was 740 tons, valued at $184,000, as compared with 292 tons ($43,639) in 1903, and 184 tons in 1902. As imports of tungsten ores enter free of duty, no record is available; in 1904, ferro-tungsten-chromium alloy was imported to the value of $29,439, as compared with $18,136 in the previous year.

Current market prices of tungsten ores in New York, for concentrate carrying at least 60% WO_3, not more than 0.25% P, nor more than 0.01% S, are on the basis of $7 per unit of tungstic acid, or $420 per ton. Concentrate of higher grade has been quoted at $7.50 per unit.

Tungsten Mining in the United States.

Arizona.—There are several tungsten deposits of economic importance in the Little Dragoon mountains, Cochise county. The ore is found in veins in a granite intrusion in pre-Cambrian crystalline schist and in a gravel bank. The vein material is (1) tungsten ore, principally hübnerite, in aplite veinlets, and crystalline quartz occupying fissures in the granite.[1] (2) Tungsten ore, hübnerite and wolframite, due to the alteration of the incasing wall rock and distinctly flanking the vein itself, sometimes on one side and sometimes on both sides of the vein. The demarkation between vein and vein walls is not generally distinct.

The ore-bearing gravel banks are rarely more than a foot in depth, and show from one to two inches of reddish black sand lying close to the bed-rock. These deposits are worked like gold placers, which they resemble in every respect.

Colorado.—The chief producing centers for tungsten ores in the United States in 1904 were in Colorado and South Dakota. The mines in Boulder county, Colorado, shipped crude tungsten ores and concentrate amounting to about 375 tons, valued at $125,000, in 1904. These shipments constituted nearly three-quarters of the total production of the United States.

The Boulder county wolframite contains very little phosphorus, and no sulphur or arsenic; one assay showed 0.047% of phosphorus in the concentrate. The ore is concentrated to 55 or 60% tungstic acid, the balance being mainly iron and silica.

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[1] Forbes Rickard. 'Notes on Tungsten Deposits in Arizona,' The Engineering and Mining Journal, August 18, 1904.

Concentration thus far has been done with the ordinary stamp mill and gravity tables. The result has been a large loss through sliming. The loss is placed at 25% by one operator in the district, although it was reported much higher than this on some of the properties. It is likely that improved and specially adapted concentration methods will be introduced into the district, now that the industry is established on a good basis.

The Great Western Exploration and Mining Co. is one of the most important operators in the field, and is reported to have supplied nearly two-thirds of the output of the district to date. Its mill is at the junction of Gordon and Oldham gulches, and consists of a stamp mill and the ordinary separating tables.

The Colorado Tungsten corporation has several properties, chief of which is the Crow tract of 480 acres, in the Middle and North Boulder creeks area, and a mill at Boulder of the ordinary type of stamp mill and tables.

The Wolf Tongue Mining Co. is another important operator in the district. This company has been working at the Clyde mine, and the ore has been treated at the leased mill at Nederland. This company is closely identified with the Firth-Stirling Steel Co., of Pittsburg.

The Boulder County Mining Co. has a large area in the tungsten district, and is milling its product at the new mill of the Boulder county mine.

Tungsten ores are reported elsewhere in Colorado, but as yet no deposits to compare with those of Boulder county in extent have been discovered. The San Juan district produces some hübnerite and small amounts of scheelite have been discovered in several Colorado localities. On none of these discoveries has any serious development occurred.

Nevada.—Veins of hübnerite in a quartz gangue occur in a foothill of the Snake mountains, near the base of Wheeler peak, 12 miles south of Osceola. The veins are probably pegmatitic in a quartz-porphyry or other altered granite.

South Dakota.—Wolframite occurs in an impure dolomite, in the Black Hills, South Dakota. It is found in flat, horizontal, but irregular masses up to 2 ft. in thickness that cover large areas, one of which measured 30 ft. square.

Tungsten Mining in Foreign Countries.

Australia.—Tungsten deposits occur in many districts in Australia and Tasmania.

The New South Wales mines produced 89 long tons, valued at £8,432, in 1904, as against 9 tons, valued at £608, in 1903. Mining operations were confined to the Hillgrove district, where scheelite occurs in numerous veins in a gneissic granite. Sometimes the occurrences appear to be true fissure veins, while at others they seem to fill contraction fissures in the granite.

In the Mole Tableland, New South Wales, wolframite occurs in irregularly shaped quartzose greisen in an acidic granitic boss intruding slates believed to be of Carboniferous age. Associated with the wolfram are fluorspar, quartz, emeralds, topaz, monazite, tourmaline and bismuth.

The northern part of Queensland is one of the principal sources of the world's supply of tungsten. In 1904 Queensland mines produced 1,539 long tons of tungsten ore valued at £161,635. Most of this ore was obtained in the Herberton and Hodgkinson districts, where there is a wolfram-bearing area of 3,500 square miles, comprising, among numerous other centers, Wolfram camp, near Kingsborough, on the Hodgkinson, the oldest, and still the chief center of tungsten mining in the State; Bamford, near Petford railway station, where wolframite is found in very rich lenses; and Mount Carbine, a comparatively new field, about 30 miles from Mareeba, where the ore occurs in a large number of well-defined lodes having every appearance of permanence.

Bolivia.—Between 60 and 70 tons of wolfram ore are annually produced in Bolivia. The deposits are chiefly in the tin-mining districts at La Paz, Oruro, Potosi and Chorolque.

Germany.—Tungsten is obtained in small quantities in Germany by reworking the old dumps on the tin mines in the Altenburg district, Bohemia. The production in 1904 amounted to 23 tons, valued at $8,250.

India.—A deposit of wolframite is found in the Tenasserim district of Burma, north of Therawih, on the banks of the Tenasserim river, in a district that has not been much explored. The deposit is reported to be extensive, and is favorably situated for working.

New Zealand.—Tungsten occurs in the auriferous quartz-reefs on the Marlborough and Otago fields, New Zealand. It is in the form of scheelite, and is concentrated in the gold mills after the extraction of the gold.

West Australia.—Wolfram occurs in small quantities in several parts of the Geralton and Pilbarra mining districts in West Australia. Scheelite is found in Fraser's mine, Southern Cross; Lindsay's mine, Coolgardie, and Hannan's hill, Kalgoorlie. Its occurrence has also been noted on the Greenbushes tin field.

ZINC.

BY W. R. INGALLS.

The production of spelter in the United States in 1904 was 181,803 short tons, valued at $910,833, as against 158,502 tons the previous year.

PRODUCTION OF SPELTER IN THE UNITED STATES.

States.	1899.	1900.	1901.	1902.	1903.	1904.
Illinois, Indiana and Wisconsin..	49,290	37,558	44,896	49,672	49,526	47,607
Kansas	55,872	57,276	74,270	87,321	(a)88,283	(a)108,627
Missouri	15,710	20,138	13,083	10,548	9,894	12,056
South and East	8,803	8,259	8,603	10,698	10,799	13,513
Total tons of 2,000 lb	129,675	123,321	140,822	158,237	158,502	181,803
Total tons of 2,240 lb	115,781	110,028	125,734	141,283	141,520	162,324
Total metric tons	117,644	111,794	127,751	143,552	143,792	164,921

(a) Includes production of Colorado.

The output of zinc oxide for 1904 was 59,613 short tons, an increase of only 51 tons over 1903. This does not include the product of the United States Reduction and Refining Co., at Canon City, Col., which in 1904 made 6,781 tons of zinc-lead pigment.

PRODUCTION OF ZINC OXIDE IN THE UNITED STATES.

Year.	Quantity.		Value.		Year.	Quantity.		Value.	
	Short Tons.	Metric Tons.	Totals.	Per Short Ton.		Short Tons.	Metric Tons.	Totals.	Per Short Ton.
1899....	39,663	35,982	$3,331,692	$84.00	1902....	52,730	46,929	$4,023,299	$76.30
1900....	47,151	42,775	3,772,080	80.00	1903....	59,562	54,034	5,005,394	83.69
1901....	46,500	42,266	3,720,000	80.00	1904....	59,613	54,081	4,523,414	75.88

IMPORTS OF ZINC OXIDE INTO THE UNITED STATES. (in pounds.)

Year.	Sheets, Blocks, Pigs and Old.		Manufactures.	Total Value.	Oxide.	
					Dry.	In Oil.
1900......	2,013,196	$97,772	$36,836	$134,608	2,618,808	38,706
1901......	775,881	30,920	42,643	73,563	3,199,778	128,198
1902......	1,238,091	46,713	37,191	83,904	3,271,385	163,081
1903......	728,614	30,900	18,938	49,838	3,487,042	166,034
1904......	933,474	44,455	11,789	56,244	2,585,661	224,244

This statement does not cover completely the United States production of zinc, since large amounts of zinc oxide are made direct from ore. and considerable quantities of ore are exported for foreign smelting.

EXPORTS OF ZINC ORE AND ZINC OXIDE FROM THE UNITED STATES.

Year.	Ore.			Oxide.		
	Short tons.	Value.	Value per ton.	Short tons.	Value.	Value per ton.
1900	42,062	$1,134,663	$26.98	5,656	$496,380	$87.76
1901	44,146	1,167,684	26.45	4,561	393,259	86.22
1902	55,733	1,449,104	26.00	5,358	433,722	80.93
1903	39,411	987,000	25.04	7,215	578,215	80.14
1904	35,911	905,782	25.22	8,157	628,494	77.05

EXPORTS OF SPELTER FROM THE UNITED STATES.

Year.	Plates, Sheets, Pigs and Bars.		Wares.	Total Value.
	Short Tons.	Value.	Value.	
1900	22,411	$2,217,963	$99,288	$2,317,251
1901	3,390	228,906	82,046	310,952
1902	3,237	300,557	114,197	414,754
1903	1,521	163,379	71,354	234,733
1904	10,147	1,094,470	117,957	1,212,447

The notable increase in the production of zinc—the record being the largest up to date—has been chiefly due to the enlarged output from the Joplin district, which rose from 235,000 tons in 1903 to 262,500 tons in 1904. Although Joplin no longer holds its former position as the sole source, of any great consequence, of Western spelter, it is still, nevertheless, the most important source, about 75% of the metal originating within its limits. The increased production of spelter has been absorbed by an increased consumption, especially during the second half of the year, during which there was a strong rise in price.

The statistics, besides noting the largest production of spelter on record, indicate also the highest range of ore prices over a long period, the average for ore containing 60% zinc, at Joplin, having been about $37.40 per ton. The prosperity has not been, however, so great as the statistics might be construed as indicating, because the cost of production has increased in the Joplin district, where the miners have to obtain a price that is high compared with a few years ago in order to realize any profit from the average class of mines. Nevertheless, the year was certainly profitable to the miners, while to the smelters it was rather unfortunate, the margin between zinc in ore and as spelter not having been so small in any year since 1899, when the pinch was of much shorter duration.

The causes for the situation in 1904 were quite evident. In the first half of the year the consumptive demand was sluggish and the price for the metal ranged low in consequence. It could not go very low, as compared with former records, because of the increased cost of production, both mining and smelting. It is probable that 4.5c. for spelter at St. Louis is about bed-rock under present conditions, a point at which there is no money for any of the

Kansas and Missouri interests; a point from which a further decline would begin to restrict materially the Joplin production. Spelter fell to that point about the middle of 1904. Caught between a metal market that would not rise and an ore market that could not fall, the smelters competing among themselves to secure the ore requirements for their furnaces had to see their margin for profit dwindle to nothing.

The strength of the European market during midsummer relieved the situation somewhat, a rise in the London price to about the American level enabling the smelters to sell for export a considerable portion of the stocks

AVERAGE MONTHLY PRICE OF SPELTER PER POUND IN NEW YORK.

Year.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	Cts,	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
1900....	4.65	4.64	4.60	4.71	4.53	4.29	4.28	4.17	4.11	4.15	4.29	4.25	4.39
1901....	4.13	4.01	3.91	3.98	4.04	3.99	3.95	3.99	4.08	4.23	4.29	4.31	4.07
1902....	4.27	4.15	4.28	4.37	4.47	4.96	5.27	5.44	5.49	5.38	5.18	4.78	4.84
1903....	4.87	5.04	5.35	5.55	5.63	5.70	5.66	5.73	5.69	5.51	5.39	4.73	5.40
1904....	4.863	4.916	5.057	5.219	5.031	4.760	4.873	4.866	5.046	5.181	5.513	5.872	5.100

of metal which they had been carrying since the end of 1903. The market was brought thereby into a good position for a sharp rise, when the demand for domestic consumption began to strengthen, in the early autumn; but the competition among the smelters for ore caused the price of ore to advance correspondingly, so that many of the smelters were no better off than they had been.

The producers of western spelter are by no means on an equal footing. Some produce only prime western spelter; others produce special brands of spelter, which command a premium; others produce sulphuric acid as well as spelter. Formerly the advantages of some of these concerns were offset by the relative cheapness of smelting with natural gas in Kansas. This difference is not now what it used to be, the cost of smelting in Kansas having increased because of the greater cost of the natural gas and some other items; wherefore the concerns which extract the most value from the ore are able to make the market for it, and compel the other smelters to go elsewhere for their supply. The direct cause of this has been, of course, the insufficiency of the Joplin ore supply to meet the present demand for spelter for consumption.

There have been in 1904 about 20 blocks of furnaces in Kansas on ore from west of the Rocky Mountains, chiefly from Colorado. This signifies the smelting of about 100,000 tons of ore during the year. It is the development of this new ore supply that has enabled several of the smelters to live. Although it is a lower grade and more impure ore than the Joplin product, costing more per ton to smelt, and giving a lower percentage of extraction, it can be bought, delivered at the works, at prices which afford a larger profit than can be had from the Joplin ore under present conditions. There is a strong prospect, therefore, that the use of this new ore will continue to increase. The spelter made from it is, in the main, equal to the ordinary brands of prime western.

Besides the Kansas smelters, there was a considerable use of the Rocky Mountain ore by the Mineral Point Zinc Company and the Grasselli Chemical Company; also by the United States Zinc Company, which succeeded in putting its works, at Pueblo, Col., into successful operation, overcoming the initial difficulties, and became an important factor in the Colorado ore market.

The increase in the demand for zinc ore from the districts west of the Rocky Mountains naturally stimulated great activity in all of them. Leadville continued to be the chief point of production, but important supplies were drawn from Creede, Kokomo, the San Juan and Clear Creek cañon, in Colorado; from Magdalena, N. M., where the Kelly and Graphic mines were large producers, and from the Slocan, in British Columbia. Preparations

PRODUCTION OF ZINC IN THE WORLD. (a) (In metric tons.)

Yr.	Austria.	Belgium	France.	Germany	Holland.	Italy.	Russia.	Spain.	United Kingdom	United States.	Totals.
1900	6,742	119,315	36,305	155,799	16,698	547	5,963	5,611	30,207	111,794	488,981
1901	7,558	127,170	37,600	166,283	17,144	511	6 090	5,354	29,877	127,751	525,338
1902	8,309	124,780	36,282	174,927	20,760	485	8,280	5,569	40,244	143,552	563,188
1903	b8,949	c155,297	d27,462	182,548	....	e500	9,901	...	44,110	143 792	572,559
1904	9,159	139,984	a49,083	193,058	13,101	e500	10.607	...	46,218	164,921	626,631

(a) Statistics compiled from official reports and the metal circular issued by Henry R. Merton & Co. (b) Includes output of Italy (c) Includes output of Holland. (d) Includes output of Spain. (e) Estimated.

were made to concentrate the ore at Park City and Horn Silver, Utah, and at the Alice and Emma mines, at Butte, Mont., and those mines will probably be producers in 1905, as will also one or two mines in the Wood River district of Idaho.

East of the Rocky Mountains there has been greatly increased activity in the old Wisconsin zinc region, the output of which showed a noteworthy gain in 1904. The prospects of this region are excellent, and its mines being able to produce a high grade of ore, now that the problem of efficiently separating the associated blende and mundic has been solved, will satisfactorily augment the supply of that kind of ore. The mines of Arkansas failed again to come to the front in any remarkable manner. Considerable new work was done in Kentucky. Some explorations with churn drill were made in the Holston River district of Tennessee, it is said, with satisfactory results; but no important production was derived from that source in 1904. In Virginia, some new developments were carried on by the Bertha Mineral Company. In New Jersey the Franklin mine was alone operated, the scheme of delimiting the great orebody by means of stope-drifts being further prosecuted; it is still a year or two short of completion.

The new plants of the United States Zinc Company, at Pueblo, Colo.; the Grasselli Chemical Company, at Clarksburg, W. Va.; the Cockerill Zinc

Company, at Altoona, Kan.; the Laharpe Spelter Company, at Laharpe, Kan.; the Chanute Zinc Company, at Chanute, Kan., and Wm. Lanyon, at Caney, Kan., were completed in 1904 and were put more or less into full operation. The Mineral Point Zinc Company planned to erect a new plant at Depue, Ill., near Lasalle-Peru.

The Zinc Market.

New York.—The year under review was a fairly prosperous one for the zinc industry of the United States, home consumers absorbing practically all the metal that was produced, and it was not until late in the fall that some stocks began to accumulate. At that time a sale of about 6,000 tons for export was consummated, and shortly after this transaction had become known values advanced sharply; and when the iron and steel industry became more active, the demand for home consumption grew so large that at the end of the year a rising market existed.

Galvanizers, brass mills and sheet-zinc manufacturers have been very busy throughout the year, and a fair quantity of spelter was again used for electrical purposes.

Production has about kept pace with the consumption. While the output of zinc ore in Missouri does not show much change, larger quantities of Colorado ores are being used by the domestic smelters, with the result that the exports of this class of material will no doubt fall off considerably in the future. Two new works were built in the Kansas gas belt, and an old plant which had been idle was started up again.

The year opened with spelter quoted at 4.70 St. Louis, 4.87½ New York. During January, the market ruled quiet and steady, but in February an upward movement commenced, which in the first place was started by the higher ore prices caused by a reduced output in consequence of cold weather, but which was, later on, accentuated by a large demand on the part of consumers, especially for galvanizing purposes. The advance culminated in a quotation of 5.05 St. Louis, 5.22½ New York, by the end of April.

As May progressed, it became evident that the iron and steel business did not come up to expectations, and this fact naturally reflected on the spelter market. Producers became demoralized, and by the beginning of June values had declined to 4.57½ St. Louis, 4.75 New York, at which quotations the market remained steady throughout the month.

A curtailment in the ore output caused a small advance during July, but sales were rather slow and stocks began to accumulate in the hands of smelters. At the end of August it transpired that an export sale had been made, and this news suddenly changed the aspect of the market. Prices advanced quickly to 4.85 St. Louis, 5c. New York. It also developed that home consumers were rather poorly supplied, and as the iron and steel trade showed signs of improvement, purchases were freely made for spot as well as future delivery. The consequence was further sharp advances, which culminated

MONTHLY AVERAGE PRICES OF SPELTER.

	New York.		St. Louis.	
	1903.	1904.	1903.	1904.
January	4.865	4.863	4.688	4.673
February	5.043	4.916	4.681	4.717
March	5.349	5.057	5.174	4.841
April	5.550	5.219	5.375	5.038
May	5.639	5.031	5.469	4.853
June	5.697	4.760	5.537	4.596
July	5.662	4.873	5.507	4.723
August	5.725	4.866	5.550	4.716
September	5.686	5.046	5.514	4.896
October	5.510	5.181	5.350	5.033
November	5.038	5.513	4.886	5.363
December	4.731	5.872	4.556	5.720
Year	5.375	5.100	5.191	4.931

in a price of 5.87½@5.92½ St. Louis, 6.05@6.07½ New York, which are the closing quotations of the year.

Missouri. (By Jesse A. Zook.)—The highest price paid for zinc ore during 1904 was $52.50 per ton, in the week ending October 1. The price of zinc ore at the latter end of 1903 began dropping from $40 in October to $35 at the close. The past year began with the price at $36, and it advanced through the first four months to $40 in April, when a decline set in, continuing until $35 was reached at the end of June. The policy of restricting the output to the needs of the smelters, maintained for two weeks in July, sent the price to $41 in three weeks, continuing, with an occasional drop backward, until it reached $52.50 in October. The smelters seemed to have scared themselves, and they dropped the price to $49 and to $44 the succeeding two weeks. This price ruled for three weeks; then it went up to $46, and the following week to $50, where it remained.

AVERAGE MONTHLY PRICE OF ZINC BLENDE ORE AT JOPLIN, MO.

(Dollars per short ton.)

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1900	30.23	29.36	28.45	28.42	26.92	25.00	24.23	25.67	24.25	24.25	24.45	25.40	26.50
1901	23.72	23.96	23.70	24.58	24.38	24.22	24.68	23.88	22.82	21.63	26.15	28.24	24.21
1902	26.75	27.00	28.00	28.85	29.23	34.10	34.37	32.50	33.00	33.58	32.10	29.25	30.73
1903	31.50	32.50	35.75	37.75	36.60	36.50	36.00	36.00	35.50	34.40	30.75	30.00	34.44
1904	33.33	33.63	35.40	35.75	34.87	32.93	33.37	37.55	40.18	43.65	43.31	46.20	37.51

NOTE.—The figures above given are the base prices for 60% ore.

For the year 1904 the zinc shipments aggregated in value $9,601,200. The lead shipment sold for $1,886,150, giving a total value of $11,487,350 for the two ores, an increase of $2,015,955 over 1903 and of $1,132,050 over 1899, the previous record-breaking year.

Averaged by weeks, the shipment of zinc ore was 5,040 tons, selling at $181,154.71 per week. The lead average was 648 tons, selling at $35,587.73 per week, giving a combined value of $216,742.44 for both ores each week. The average price of zinc ore for the year was $35.92 and of lead $54.80 per ton.

Progress in the Metallurgy of Zinc.

BY WALTER RENTON INGALLS.

The literature of the nine months to the end of March, 1905, has been rich, especially in European contributions. Most important has been the great treatise on 'Métallurgie de Zinc,' by Prof. A. Lodin, besides which has been published 'Die Darstellung des Zinks auf Elektrolytischen Wege,' by Dr. Emil Günther. In the 'Jahrbuch für das Berg- und Hüttenwesen im Sachsen' for 1904, Rudolf Hoffmann, vice-foreman of the Muldnerhütte, contributed a long paper on progress in the metallurgy of zinc, with special reference to Freiberg conditions. In America, Prof. H. O. Hofman has contributed his valuable results of studies on the decomposition of zinc sulphate and the magnetic separation of blende and marcasite. The technology of zinc, which previously had been rather neglected, has thus come during the last three years into the possession of a rich literature.

The metallurgy of zinc is frequently spoken of as a backward art, the smelting process still being expensive as compared with that of lead and copper ores, while the proportionate extraction of metal is greatly inferior. This idea rests, however, on false standards of comparison. The zinc smelter, as a rule, deals with ore which has already been concentrated to a high degree, so that his practice is comparable to that of the smelter of galena concentrate, or black tin ore, rather than to that of the silver-lead or copper smelter, who has to treat a very large quantity of ore for a comparatively small production of metal. In other words, while the copper smelter makes commonly a concentration of 20:1 and even 50:1, the zinc smelter makes a concentration of only 2:1 or 3:1. In handling the less quantity of raw material it is generally permissible to utilize wheelbarrow and shovel to a greater extent, but if the cost of the process be referred to the basis of the crude ore raised from the mine, the smelting expense may not appear unduly heavy.

The smelting of zinc ore is attended by severe limitations, arising from: (1) The volatility of the metal at a temperature below the reduction point of the oxide, (2) the strongly endothermic character of the reaction, and the necessity of effecting it in small retorts, inevitably fragile, which must be arranged in the furnace in a way entailing great loss of heat by radiation, (3) the intermittent nature of the process and (4) the multiplicity of details involved in it. No other metallurgical process, perhaps, is quite so much dependent upon the human factor. In consideration of all these conditions, it must be conceded that the best practice in zinc smelting is not greatly inferior, either in expense or in metal extraction, to the practice in smelting rich copper, lead or tin ores. This is not meant to imply that extensive room for improvement does not exist, but although the prevailing method is capable of betterment in various details, so far as can be now foreseen, nothing of extraordinary importance is to be looked for in that direction, unless it be in mechanical charging and further improvement in the character of the retorts; any great advance must be toward the continuity of the smelting process, which indeed has been the ideal of many zinc metallurgists for nearly half a century.

Several new methods of revolutionary character are now under consideration, or are in process of trial. Among these is the one proposed by Dr. Oskar Nagel for smelting zinc ore in a blast furnace, under the action of water gas. The process of this inventor is described in United States patents No. 699,969 and No. 766,279. Up to the present time, the process has been tried only in a small experimental way, but on a sufficient scale, it is said, to prove the accuracy of the forecasted reactions, and the possibility of condensing spelter instead of the troublesome blue powder. The process is to be tried on a large scale at the Grillo works, at Hamborn, Westphalia, but it is uncertain as to when the plant there will be ready for trial.

The Lungwitz process of smelting zinc ore in a blast furnace, under high pressure, in order to recover the spelter in a molten state in the furnace, is also to have a practical trial at Warren, New Hampshire. It was expected that the furnace erected there would be put into operation last Fall, but for various reasons the experiment was deferred until this Spring. The Lungwitz method is based on correct theoretical principles, but the practical difficulties connected with their application are serious. The furnace at Warren, New Hampshire, has been constructed with good engineering advice, and the result of this trial is to be awaited with much interest.

Ore Dressing.—The most material progress in the metallurgy of zinc during the last five years has been in the methods of concentrating low-grade ores, and especially the mixed ores in which the sulphides of lead, zinc and iron occur together. It is natural that practical developments should occur chiefly in this direction. Smelting is always an expensive process, while concentration is a cheap process. It is generally profitable, therefore, to condense the mineral values of an ore to the smallest possible bulk by the cheap process, in order to save in treatment by the costly process, providing that the losses of mineral be not too high. There is always one line in the combined treatment of an ore between the mine and the metal warehouse which will show the maximum of economy, and both miner and smelter will aim to follow that line. The results both of practice and theory show that it is ordinarily most profitable to concentrate the crude ore to a very high degree, especially in the case of zinc ore.

Heretofore, the Joplin district of Missouri has been the only zinc producing region of the United States that has afforded a concentrated blende, assaying upward of 60% and averaging about 58% zinc. At least two other districts, however, are now giving ore as high in zinc as the average Joplin product. These are Creede, Colorado, and the Wisconsin area. The ore of Creede is a non-ferruginous blende, associated with galena and a quartzose gangue, and, being free from pyrites, it is feasible by careful concentration to make a high grade of zinc product. As a matter of fact, carload shipments from at least one mill assay 57 to 62% zinc, 1.5 to 3% lead, 1 to 2% iron, and 3.5 to 6.5% insoluble matter.

Similarly, ore containing approximately 60% zinc, and only about 1% lead, and 2% iron, is now produced from the mixed blende-marcasite concentrate of Wisconsin, by the Blake electrostatic separator, and by magnetic separation of the minerals after a preliminary roast sufficient to render the marcasite magnetic.

The first great step in the separation of the mixed sulphide ores, such as occur at Leadville, Colorado, was the introduction of the Wilfley table, about 10 years ago. These ores had previously been concentrated by the ordinary method of jigging and washing on vanners or round tables, but with indifferent success, the process being profitable only with comparatively high-grade ore. In order to treat successfully the lowest grade of ore, fine grinding was necessary, followed by an efficient means of washing a fine pulp, such as was afforded by the Wilfley table. By means of fine grinding, and the Wilfley table, it became possible to make a zinc concentrate assaying about 40% zinc. Magnetic and electrostatic devices have now made it possible to produce a concentrate assaying approximately 50% zinc.

In concentrating an ore assaying 24% zinc, 25% iron, 6% lead, 4% silica, and 8 oz. silver per ton, by crushing to 30 mesh and washing on Wilfley tables, according to the practice at Leadville at the present time, the product of 1 ton of crude ore is approximately 800 lb. of zinc ore, assaying 37 to 39% zinc, 15 to 18% iron, 2.5% lead, 3 to 5% silica, and 4 oz. silver per ton; and 860 lb. of iron-lead ore assaying 14 to 18% lead, 26 to 30% iron, 11% zinc, 3% silica, and 9 to 10 oz. silver per ton.

In treating the same ore by the Blake separator, there is produced 660 lb. of zinc ore, assaying 50% zinc, 7% iron, 1% lead, 6% silica, and 3.5 oz. silver per ton; 1,100 lb. of iron-lead ore, assaying 35% iron, 9% lead, 8% zinc, 2% silica, and 11 oz. silver per ton; and 200 lb. of dust assaying 28% zinc, 8% lead, 19% iron, 3% silica, and 7 oz. silver per ton. This dust is assumed to have no value, since it cannot be handled on the Blake separator, but undoubtedly it can be concentrated wet with a fair saving of value.

Comparing the results of wet with those of dry concentration of the same ore, it appears that the former gives the following products:

0.40 ton zinc ore, valued at $10 per ton	$4.00
0.43 ton iron-lead ore at $8	3.44
Total recovery per ton of crude ore	$7.44

Dry concentration by the electrostatic process gives:

0.33 ton zinc ore, valued at $18 per ton	$5.94
0.55 ton iron-lead ore at $7.50	4.12
Total recovery per ton of crude ore	$10.06

This shows a difference of $2.62 per ton in the value of the products by the two processes, due chiefly to the enhancement of the value of the zinc ore by concentration from 38% up to 50% zinc. The value of the zinc ore in the above is computed on a moderate basis, which is of course much lower than the present market price. The cost of concentration by the two methods will not be widely different in properly designed mills, although at the present time it is rather in favor of the simple method of wet concentration. A possible further credit in favor of the dry process may lie in the 200 lb. of dust which is not now treated.

It is extremely doubtful if any hydrometallurgical or electrometallurgical process, even under the most favorable conditions, could show a commercial superiority over the present combination of standard methods in the treatment of such an ore as has been referred to. Starting with an ore containing 24% zinc and 6% lead, separated at a cost of about $1 per ton, approximately 0.33 ton of zinc ore, containing 50% zinc, or nearly 69% of the zinc in the original ore, and 0.55 ton of lead-iron ore containing 9% lead, or approximately 82.5% of the lead in the original ore, are obtained. Carrying the computation forward to the final extraction of the metals, good practice should yield about 60% of the original zinc and 78% of the original lead at an aggregate cost not to exceed $7 per ton of crude ore, disregarding freights, interest, amortization of plant, etc. A complete analysis of this problem would be quite complicated, but the above figures will give a rough indication of the present state of the art.

The Blake Separator was described in the last volume of The Mineral Industry. Since that time, no essential change has been made in its form, but improved means for supplying the electric current have been devised, and in the course of extensive practical work with the machine, its field of usefulness and its limitations have become better understood. The operation of the Blake separator depends upon the different behavior of those minerals that are electrical conductors, and those that are non-conductors. Sufficient difference in electrical conductivity to allow of separating almost any mineral from another by this method exists naturally, or can easily be produced artificially. This statement is true on a laboratory scale, but it may not be always commercially possible. The conversion of a non-conductor into a conductor by some simple method, such as coating the non-conducting particles with a conducting film, is a new development in the process which has not yet been applied commercially.

No definite statement can be made as to the conductivity of any given mineral because it is not always the same in specimens from different localities. For example, blende from Broken Hill, Australia, can readily be separated from Joplin blende because of its superior conductivity, but for the same reason the Broken Hill blende cannot be successfully separated from galena and other conducting minerals with which it is associated.

It is, however, possible to classify the minerals roughly, and the following list indicates their usual behavior, but the latter can be determined specifically only by an actual trial.

Conductors—Native metals, pyrite, chalcopyrite, galena, graphite, molybdenite, copper glance, silver glance, gray copper, most sulphides, most copper minerals, most iron minerals, most silver minerals, most manganese minerals, tellurides, black sands.

Non-Conductors—Quartz, calcite, limestone, porphyries, slates, sandstones, garnet, spinel, zinc blende, zinc carbonate, barytes, gypsum, granite, fluorspar, most silicates, most gangue rocks.

The above list and the following remarks are taken from a pamphlet by Mr. W. G. Swart, who has been most instrumental in developing the practical working of the Blake separator and deserves great credit for his engineering in connection with this useful machine:

"Usually it is difficult, commercially, to separate one conductive mineral from another on account of the extreme rapidity of action, but a separation is ordinarily possible between two non-conductive minerals. For example, blende can frequently be completely separated from quartz, garnet or barytes, all being non-conductors. Often where two minerals are of close conductivity, one or the other may be rendered conductive by artificial means, such as heating, roasting or chemical treatment. Since the conductivity of static electricity depends on the surface of the particles, and not on their interior, it is only necessary in such cases to change in some way the surface of the desired particle. More than 200 different methods of doing this have already been developed, varying according to the ore and the object to be attained.

"Each standard double separator has a nominal capacity of 12 tons in 24 hours. This varies within wide limits, depending on size of crushing, amount of dust present, percentage of products, etc. On some ores the capacity falls to 5 tons, and on others it rises to 23 tons. As a general thing the coarser the crushing the greater the capacity; dust diminishes the capacity. Ores which yield equal weights of the separated products usually give the highest capacity. Sizing sometimes raises the capacity, sometimes not. Each standard double separator requires about 1 horse power, including the generation of the electricity. The static electricity, which is the agent employed for the separation, is now produced, not by friction, but by induction, which is independent of atmospheric conditions. Machines have been running continuously for two years standing on a wet floor and in the same room with Wilfley tables, launders, wet elevators, etc., but this is an extreme case and cannot be too strongly condemned. The process is essentially a dry one, and the dryer it is kept the better the results. Moisture always causes a leakage of static electricity, and should be guarded against in every possible way.

"The Blake separator has handled, commercially, material as coarse as 6 mesh, and fines all of which would pass 100 mesh. Coarse crushing is preferable, but it must be fine enough to liberate the minerals to be separated. Close sizing is not essential, but as in other concentrating methods is apt to improve results. A good range of sizes is as follows: From 6 to 12 mesh; from 12 to 20 mesh; 20 mesh and all finer. This must, however, be determined for each individual ore. In one case, a Blake machine is separating in one operation the combined products from five Wilfley tables, each working on a different size and all are finer than 24 mesh. Sizing is more important on coarse material than on fine.

"As a general rule, dust interferes with the separation and should be removed before the ore reaches the machines. This is especially necessary with ores containing lead or copper, as such dust affects the health of the workmen. In some cases remarkably good work has been done on dry crushed ores without removal of dust, but this is exceptional. One man on each shift can attend 10 machines as readily as one, if the feed and the products are handled automatically. Good labor is necessary.

"Following are some results obtained commercially on various classes of zinc ore:

Class of Ore.	Products.	% Zinc.	% Lead	% Iron.	Size.
Leadville, Colo. Zinc Middlings from Wilfley Tables.	Original Iron Con. Zinc Con.	30.48 9.04 51.20	3.21 8.00 0.62	21.60 35.11 6.40	20 mesh.
Joplin, Mo. Zinc Middlings from jigs.	Original Iron Con. Zinc Con.	49.53 2.92 62.31	2.52 9.92 trace	10.78 37.44 1.57	10 mesh.
Benton, Wis. Zinc Middlings from jigs.	Original Iron Con. Zinc Con.	29.15 5.07 58.4	5.16 8.40 0.23	20.90 38.88 2.16	6 mesh.
Silverton, Colo. Zinc Middlings from Wilfley Tables.	Original Iron Con. Zinc Con.	23.12 9.04 49.73	8.00 15.56 2.08	23.87 30.35 4.77	24 mesh.

The Leadville blende contained 4.87% combined iron.

The Flotation Process.—In Australia, electrostatic separation has proved inapplicable to the ores of Broken Hill, but the latter are capable of separation both by the electromagnetic and the flotation processes, a concentrate assaying from 40 to 45% in zinc being produced by either method. The technical details of the flotation processes have not yet been publicly described, and probably will not soon be, in view of litigation pending between the owners of the Delprat and the Potter processes over priority of the invention.

A recent communication in the news columns of The Engineering and Mining Journal throws light upon the results obtained by the Potter process. According to this communication, the Block 14 Company, during a five weeks' run in the Autumn of 1904, treated 2,450 tons of tailing, assaying 17.6% zinc, 6.3% lead, and 7.6 oz. silver per ton. The first-class concentrate amounted to 739 tons, assaying 42% zinc, 5.5% lead, and 11 oz. silver per ton. Of middling product, 95 tons, assaying 22.5% zinc, 13% lead, and 13.5 oz. silver per ton, was also produced. These figures indicate a recovery in the first-class concentrate of 72% of the zinc and 26% of the lead, the concentrate amounting in weight to 30% of the crude ore. Evidently the flotation of zinc-blende in a slightly acid bath is more active than the flotation of galena, but so clean a separation of galena as is obtained by the electrostatic process apparently is not possible. Ore designed for separation by the flotation process should be very finely crushed, wherefore it would appear that this process may be a valuable adjunct to the electrostatic and electromagnetic processes. Indeed, the best results in the treatment of mixed ores are in most cases to be expected from the combination of three or four of the new processes.

Ore Supply.—The zinc ores of the Rocky Mountains, from British Columbia to Mexico, have already come into extensive competition with the ores of the Joplin district, which heretofore has been affording approximately 75% of the production of Western spelter. The miners of the far West have a great advantage in the high grade of their ore as raised from the mine, which advantage is offset only by their inability to make as high a grade of concentrate as in the Joplin district. However, as previously pointed out, a concentrate almost equal to that of Joplin is already being produced in certain districts of the far West, and in the other districts improvements in the methods of separation are leading to the production of a better grade of ore, thus to a considerable extent removing a portion of the disadvantage.

Whereas, in the Joplin district, ore containing only 3% of zinc and 0.5% of lead is mined and milled, it being necessary to work 20 or 25 tons of crude ore to obtain 1 ton of concentrate suitable for smelting, in Colorado, Utah, New Mexico and elsewhere, numerous large mines are yielding ore that assays 15 to 40% of zinc, 15 to 40% of lead, besides some gold and silver. The cost of mining and milling the ore is somewhat higher than in Missouri, because of higher price of labor and material, but it is not so much higher as to offset the advantage from the higher grade of the crude ore. Thus, while mining and milling can be done in Missouri for $1.10 per ton of crude ore, the cost in Colorado is $2.50 to $3.00 per ton, but apportioning the cost of production on the tonnage of marketable ore, the showing is still more strongly in favor of Colorado and similar localities, because fewer tons of crude ore are required to make a ton of concentrate. Thus, if it be necessary to work 25 tons of ore in Joplin to obtain 1 ton of concentrate, the cost of mining and milling being $1.10 per ton, the cost per ton of that concentrate is $27.50, disregarding royalties, etc. On the other hand, a ton of ore mined and milled in Leadville yields nearly nine-tenths of a ton of valuable products, or disregarding the iron-lead product, it requires only three tons of crude ore to produce one ton of concentrate containing 50% zinc, the cost of that ton of concentrate being $7.50 to $9.00, which cost is nearly met by the value of the iron-lead product.

Roasting.—In roasting furnaces, there have been no developments of immediate importance. Almost all of those zinc smelters in the United States who have engaged in the manufacture of sulphuric acid have adopted the Hegeler furnace, chiefly because it has been perfected into thorough working condition by long use at Lasalle, and because of reluctance to try new experiments in new works. The Hegeler furnace is, however, only a partially mechanical roaster, needing a great deal of labor in the management of its mechanism, since it does not operate automatically, as do most mechanical furnaces, which merely require supervision. For this reason, the cost of roasting in the Hegeler furnace is rather high, unless it be installed in very large units, and even then the cost is high as compared with some other forms of mechanical furnace. On the other hand, the use of large units of roasting capacity in connection with sulphuric acid manufacture is less desirable than the employment of smaller units, since an accident, or shut-down for repairs, may interrupt the entire process. For example, the roasting of ore at the sulphuric acid plant of the United Zinc and Chemical Company, at Iola, Kansas, which has a capacity of 15,000 tons of 60° B. acid per annum, is done in a single Hegeler furnace. At the works of the United States Zinc Company, at Pueblo, Colorado, the Hegeler furnace is also employed, although there the sulphur gases are wasted, the purpose being simply to minimize the loss of zinc, it being well known that the loss in muffle roasting is less than in roasting in reverberatory furnaces.

In the meanwhile, attention has been directed to the application of the McDougall type to blende roasting, and patents on modifications of this furnace, with a special view to blende roasting, have been taken out by A. R. Meyer (U. S. patent No. 750,877); O. Hofmann (U. S. patent 768,-748; F. Meyer (U. S. patents Nos. 731,114 and 761,691); and W. R. Ingalls (U. S. patent No. 786,567, April 4, 1905). Furnaces of this type have already been tried at the Argentine works of the United Zinc & Chemical Company. Results have not yet been entirely successful, but it is believed that failure has been due to mechanical defects rather than to fault of the type. It is certainly feasible to adapt this furnace to the roasting of zinc-blende as thoroughly as may be required, and with the minimum consumption of fuel, minimum of repairs, and no greater cost for labor than in the straight line mechanical furnaces.

The chief experience with this type of furnace has been obtained with the Herreshoff and Klepetko furnaces at Butte, Montana, and with the Klepetko at Salt Lake City, all of them employed for the roasting of copper sulphide ore, without the use of carbonaceous fuel and without any effort to burn the ore lower than 7% sulphur, conforming to the requirements of the subsequent matte-smelting process. The conditions in blende roasting are quite different, of course, but the experience with the Klepetko, Herreshoff and other furnaces employed for copper sulphide roasting will be instructive.

The Klepetko furnaces at Butte were originally constructed with eight hearths. The central shaft was air-cooled and carried eight solid, cast-iron arms. The heat was sufficient to cause the arms to bend under their own weight. Air-cooling having proved inadequate, water-cooling was substituted and the number of hearths was reduced from eight to six. Running the overflow water at 80° C., 20 gallons of water per minute are required by a furnace, according to Prof. H. O. Hofman. This enables an approximate estimate of the quantity of heat lost in the cooling of the stirring mechanism, perhaps not wasted, because in this case there may be no other use for it, but perhaps worth saving in some form. Twenty gallons of water weigh 166.8 lb. The daily consumption of water is therefore 240,192 lb. (108,950 kg.). Assuming the feed-water temperature at 15° C., this would correspond to $108,950 \times 65 = 7,081,750$ calories. Assuming coal of 7,000 calories, burned at 75% efficiency, or 5,250 calories utilized, the heat carried off in the cooling water would correspond to 1,349 kg., or about 2,968 lb. Under the conditions stated, the furnace roasts about 80,000 lb. of ore per day, wherefore the coal equivalent of the heat lost would be 3.7% of the weight of the ore. According to Sorensen, the heat carried off by the cooling water at the Salt Lake City smelter is equivalent to the combustion of about 2,400 lb. of good coal per furnace per day.

This loss of heat would cease to be an insignificant matter if the roasting conditions required the use of extraneous fuel, and especially if the capacity of the furnace were smaller, for example 20 lb. per sq. ft. per 24 hours instead of upward of 80 lb., and would suggest the desirability of an improved method of air cooling, wherein the air would be forced mechanically through the stirring mechanism and would be led from the top of the latter into a duct in the wall of the furnace communicating with the lowest roasting chamber, so that there would be a transfer of heat to the place where most needed, with only slight actual loss.

At Butte, a battery of six or eight furnaces is attended per eight-hour shift by 1/3 foreman, 1 furnace-man, 1 helper, 1/6 oiler, 1/9 repair-man and 1 trimmer. At Salt Lake City, a battery of eight furnaces is run by two furnace-men and two helpers per shift. The coal consumption is *nil*, whereas in burning the same ore in a straight-line reverberatory furnace the coal consumption was approximately 50% of the weight of the ore. The cost of roasting at Salt Lake City in 1902 averaged 34c. per 2,000 lb. of ore, including power, repairs, labor and proportion of general expense, the actual operating expense being only about 23c. per ton. The furnaces used at Butte also operate without fuel, against a consumption of 15 to 20% in burning the same ore to the same degree in hand-raked or mechanically raked single-hearth furnaces, and do the work at a cost of 35c. per ton, as compared with $2 in the hand furnaces and 78c. to $1.25 in other forms of mechanical furnaces. The Herreshoff furnace runs also without fuel, but the roasting cost is higher than with the Klepetko, because of its smaller size. It is to be remarked that the low costs quoted above are attained at places where the wages of metallurgical workmen are at the highest in the United States.

The most striking result attained with the McDougall furnace has been achieved by Sjöstedt at Sault Ste. Marie, Ontario, where he has succeeded in burning pyrrhotite containing only 20 to 25% S, down to between 1 and 3% S, obtaining at the same time a gas with 6 to 10% SO_2 by volume, without the use of extraneous fuel. A Herreshoff furnace was originally tried, but failed to answer the purpose, the heat developed by the ore being insufficient to maintain combustion and the gas being too dilute. Improvements in the design and construction of this furnace led, however, to successful results. The modifications consisted in means for minimizing the loss of heat by radiation, application to the best advantage of the heat generated by the ore, exclusion as far as possible of an excess of air, and application of extraneous heat in case of need. Four single furnaces were combined in a block, the height of the roasting chambers was reduced to the minimum possible by a special construction of stirring arm, the latter being made round, with a perfectly secure device for locking it to the central shaft and means to prevent any inflow of air from the central shaft into the roasting chambers. The air required for the combustion of the ore was admitted through special pipes provided with valves for its control. The furnace was designed in muffle form to provide for the use of extraneous heat, the latter to be obtained from water-gas made in Dellwick-Fleischer generators. Water-gas was indeed used as auxiliary fuel in this way at the outset, but by gradually improving the details of the furnace and gaining experience in their management it finally became possible to dispense with it.

The roasting plant at Sault Ste. Marie comprises four blocks of these kilns, which have an aggregate capacity for roasting 80,000 lb. of pyrrhotite (16-mesh size) per 24 hours. Altogether upward of 10,000 tons of pyrrhotite have already been roasted, wherefore the plant may be considered to have passed the experimental stage.

The use of the McDougall furnace for blende roasting has, up to this time, been tried at only one plant in the United States, but the successful employment of the Haas furnace for this purpose at Oberhausen, Westphalia, and the experience in burning pyrrhotite at Sault Ste. Marie, combined with a consideration of the theory of the subject, leave little doubt that the application of the modern American types to blende roasting will be entirely satisfactory after some experimental adjustments to the special conditions. These modern furnaces differ from the original McDougall furnace in their mechanical construction, wherein the serious defects of their prototype have been entirely overcome, and in their size, the original McDougall furnace being only 6 ft. in diameter, while the Herreshoff is 9 ft. 4 in., and the Klepetko is 14 ft. 4 in. The question of size is important in several respects, which may be summarized as follows:

(1) The capacity is increased largely with increase of the hearth diameter. Thus the areas of hearths 6, 8, 10, 12 and 14 ft. in diameter are respectively 28, 50, 79, 113 and 154 sq. ft. On the other hand, the circumference increases only in the ratio 19:25:31:38:44, and for each increase of 2 ft. in diameter the length of the stirring arms has to be increased only 1 ft., the central shaft, driving mechanism, etc., remaining substantially the same, wherefore the larger the furnace the less is the first cost per square foot of hearth. The limit of successful air cooling was exceeded in the Klepetko furnace of 14 ft. 4 in. diameter, but it is questionable if this would have been true with the best system. However, it would probably be unwise to go beyond a diameter of 12 ft. 4 in. with air-cooled stirring mechanism until the practicability of a greater diameter has been proved.

(2) The large furnaces requiring no more labor than the small, the cost per ton of roasted ore diminishes as the size increases. Since the length of the stirring arms, the parts most frequently requiring renewal, increase at one-half the ratio of addition to the hearth area, the cost of maintenance is less per ton of ore with a large furnace than with a small one. The same is true as to the motive power.

(3) The external surface increases at smaller ratio than the hearth area, wherefore the loss of heat by radiation is proportionately less from a large furnace than from a small one. Thus a furnace of 9 ft. 4 in. internal diameter, 10 ft. 10 in. external and 10 ft. height, with 5 hearths, has 342 sq. ft. of hearth area and 524 sq. ft. of external surface, while a furnace 12 ft. 4 in. inside, 13 ft. 10 in. outside, has 598 sq. ft. of hearth and 735 sq. ft. of external surface. Whereas the hearth ratios are approximately 1:1.75, the surface ratios are only 1:1.40. The difference is vastly more in favor of the larger furnace with respect to the superficial area of the stirring mechanism. The larger the furnace, other conditions being the same, the more economy should there be in fuel, or the greater the ability to burn ores of low grade in sulphur.

The modern McDougall furnaces are the simplest of the mechanical furnaces. They can be satisfactorily tended by any ordinarily intelligent labor. Machinery is at a minimum and the parts most subject to destruction are easily and cheaply replaced. Neither the furnace masonry nor the stirring mechanism is subject to strains from sudden and unequal expansion or contraction from the alternate heating and cooling of parts. They are more economical of labor, fuel and power than any other mechanical furnace. They can desulphurize to any desired degree, their capacity being governed chiefly, as in other furnaces, by hearth area, speed of the rakes, and means of conserving and applying heat. The movement of ore toward the center or the periphery of the alternate hearths practically overcomes the difficulty of securing an equal travel for the ore, which is met with in circular furnaces of a single hearth. The successive falls of the ore from one hearth to the next tend to effect a thorough mixture, while the oxidization of the ore appears to be promoted by showering through the ascending current of hot air.

With all these advantages there are some drawbacks. These appear to be chiefly (1) the accretions which form on the roofs of the roasting chambers and in the drop-holes (especially while roasting pyrites), the removal of which constitutes the principal work of the furnace-men, and (2) the comparatively high percentage of ore-dust carried away from the furnace. At Butte, both in the Herreshoff and Klepetko furnaces the proportion of dust appears to be 4 to 6% of the weight of the ore. This necessitates the installation of proper dust chambers or other means for its collection and involves the rehandling of so much material. It also remains to be seen how these furnaces will behave while roasting ores that tend to build up badly on the hearth.

Chemistry of Roasting.—Prof. H. O. Hofman has determined the decomposition temperature of zinc sulphate to be 739° C. Ordinary zinc sulphate becomes almost completely anhydrous at about 263° C., the expulsion of water progressing rapidly with rise in temperature above 100° C. The decomposition of anhydrous zinc sulphate begins at 528° C. All his experiments pointed to the conclusion that, contrary to the statements in almost all of the older metallurgical treatises, stable anhydrous basic zinc sulphates do not exist. The sulphur trioxide of the normal sulphate passes off gradually without any decided interruption, as the temperature is raised to complete decomposition. When anhydrous zinc sulphate, partly decomposed by heating, is treated with hot water, the undecomposed salt is quickly hydrated and dissolved, leaving behind basic salt, which dissolves with the greatest difficulty by continued boiling. The decomposition of zinc sulphate when heated with carbon begins at 409° C., but is weak and lasts only a short time. It grows stronger with increase of temperature, but weakens perceptibly after a few hours. At 528° C., carbon appears to become decidedly active, but even then the effect is, at best, very slow and imperfect, as it is opposed by the direct reduction of zinc sulphate to zinc sulphide. Under the most favorable conditions, 19.86% of sulphur in zinc sulphate was reduced to 3.47%, of which 1.41% existed as sulphide, and 2.06% as sulphate.

Tests of samples of Joplin blende showed that decrepitation began at 290° C. and ignition at 480° C. Tests of ferruginous blende from Warren, New Hampshire, showed an ignition point of 515° C. Ferruginous blende from New Mexico took fire at 534° C. The results of experiments on these ores showed that the ignition point of blende increased very nearly in proportion to the percentage of iron, the ores investigated showing an increase of 4.19° C. per 1% of iron. In roasting, it appeared that ferruginous blende gives up its sulphur less easily than the blende that runs low in iron. The irony blende, under suitable conditions, furnishes a larger proportion of soluble zinc sulphate than blende low in iron, and the formation extends over a longer roasting period.

W. McA. Johnson, in 'Electrochemical and Metallurgical Industry,' III, i., p. 14-16, also reported investigations as to the decomposition temperature of zinc sulphate, which he found to be 739° C., the same as Prof. Hofman's figure. The temperature attained in the ore-roasting furnace being always 200° C. and sometimes 300° C. higher than 739° C., it is evident that no undecomposed zinc sulphate can exist in the roasted ore if the latter has remained long enough in the furnace and has been sufficiently rabbled. Lead sulphate is of course formed, but the assumption that all the lead in roasted ore exists as sulphate is incorrect. Lime will take up 95% of sulphur as sulphate and magnesia from 80 to 90% in the temperatures usually employed in roasting zinc ore, viz., 900° to 1,075° C.

Prof. Hofman made a few experiments to determine by synthesis the conditions under which zinc ferrate may be formed in roasting ferruginous zinc ores, the probability of the formation of such a compound having been pointed out by several metallurgists. His experiments tended to show that various compounds of zinc and iron may be formed, not merely a single definite compound of the formula $ZnFe_2O_4$. His experiments were, however, quite inconclusive.

Distillation.—The pending experiments on the smelting of zinc ore in blast furnaces have previously been referred to. They appear to be based on ideas that are sounder than those that were followed in earlier attempts, but there are so many confusing factors that may enter into this problem that no opinion should be expressed without an exhaustive study of the conditions.

In the meanwhile, so long as distillation must be conducted in the historic manner, the mechanical and commercial success of the operation depends upon the design and construction of the furnace, to afford the longest possible campaign and the minimum loss of heat; also upon the preparation of the retorts, with a view to making them as dense and durable as possible.

Many types of furnace construction are in use, including some that date back three decades or more, but the Rhenish type in its several modifications appears now to have become the most approved form. This furnace is built with regenerative checker-works for both gas and air, as at Engis, Prayon, Overpelt and Pueblo; with regenerative checker-works for air only, as at Monteponi, although the Ferraris furnace employed there does not belong strictly to the Rhenish type; and with counter-current heat recuperation, as at Stolberg and Palmerton. All of these furnaces afford long campaigns and are economical in their consumption of coal. It is difficult to say definitely which one is the best, since they do not often receive competitive trials under the same conditions.

The regenerative furnaces of the Siemens system are undoubtedly the more economical of coal, but the advantage in that respect may be offset by the increased extraction of metal that is effected by the steadier temperature of a well designed counter-current system of heat recuperation. The difficulty of keeping the flues of the latter type tight, under the expansive strains of the furnace, is an inevitable drawback.

In the preparation of the retorts, the best results are obtained by hydraulic presses, as employed at all of the most modern smelteries. It is sought now to improve the quality of the retort material by the use of siloxicon, or silicon carbide, which in many respects is highly desirable, but so far is too expensive.

Chemistry.—W. McA. Johnson reports in 'Electrochemical and Metallurgical Industry,' III, i., p. 15, the results of investigations in the laboratory of the Lanyon Zinc Company on the reactions in zinc distillation. Iron decomposes zinc sulphide at 1,167° C. The reaction is very slow at that temperature, but if the iron be molten it proceeds with great vigor. At a temperature slightly above the melting point of cast iron, i. e., 1,250° C., zinc sulphide is almost completely decomposed by the theoretical quantity of iron.

Carbon begins to decompose zinc sulphide at 1,200° C., but it is much slower than iron in its action. At 1,300° C., however, the decomposition of zinc sulphide by carbon takes place, given sufficient time. This reaction is not advantageous to the condensation of the zinc vapor, since it reverses to some extent in the condenser, forming zinc sulphide and soot, which prevent particles of molten zinc from coalescing.

Electric Smelting.—Spelter is now produced in Europe in small quantity by smelting in an electric furnace, under the patent of C. G. P. de Laval, in which the laboratory of the furnace is heated by an arc between electrodes which pass through it. No details as to the thermal efficiency of this furnace and the various technical results have yet been published, but spelter from it is regularly on the market, brand 'G. D. L.,' and is guaranteed not to contain more than 0.1% of impurities. Analyses show only 0.03 to 0.06% lead, 0.01% iron, and no arsenic or cadmium. These show it to compare very favorably with the brand 'Extra pur A' of the Société de la Vieille Montagne and with the various brands of American high-grade spelter. At present the 'G. D. L.' spelter is sold at a slight discount from the other high-grade spelters, although it is well within the requirements for that class of metal.

Cadmium in Spelter.—Attention has been called to the remarkably high percentage of cadmium in some American spelters, certain brands showing as high as 0.5%. Opinions differ as to whether the presence of that impurity is objectionable in the employment of such spelter in brass manufacture.

A REVIEW OF THE LITERATURE ON ORE DEPOSITS IN 1904 AND 1905.

BY J. F. KEMP.

The province of the historian, rightly conceived, is not alone to chronicle the current events of a period, but to detect the entrance of new ideas and to trace their influence through subsequent time. The new ideas or principles when first appearing may not be conspicuous. A well known and justly esteemed teacher of the history of philosophy, through whose classroom passed many men now in middle life, used to liken the pioneers in human thought to those more lofty peaks which catch the rays of the rising sun while yet the surrounding and lower mountains are wrapped in shadow—gradually, however, as the sun rises higher, all become equally illumined.

The brief space of a year gives no great length of time through which to trace the progress of thought in matters relating to ore deposits. Nevertheless, if the entrance of new conceptions has been early detected, their progress and recognition may be followed in their wider development. One such idea relates to the depth to which the ground-waters extend in the earth, as shown by actual experience in mining rather than by the speculations of the study and library. Formerly we were inclined to take this continuance to the heated depths of the earth as a matter of course. At the Richmond meeting of the American Institute of Mining Engineers, in February, 1901, the point was made that, in regions not obviously those of expiring vulcanism, all deep shafts showed that the ordinary ground-waters were comparatively shallow and limited to one or two thousand feet from the surface. This point was afterward fully corroborated by T. A. Rickard[1] from extended data regarding deep mines, and still more emphatically by J. W. Finch.[2] Even if we admit that the greater part of this water has fallen as rain, the new facts restricted its field of activity to so shallow a zone as to rule out the meteoric waters from the rôle of the universal and all-embracing filler of veins which extend to profounder depths.

It therefore became necessary to cast about for some other agent, and those waters which are believed to be yielded by the cooling and crystallizing igneous magmas, and which in America are called 'magmatic' and in Europe 'juvenile,' were cited and supported as the natural alternative. This conception, which had still earlier gained adherents for certain types of ores unmistakably connected with expiring igneous activity, and which, as a matter of

[1] 'Ore Deposits; a Discussion,' p. 59, New York, 1903.

[2] 'The Circulation of Underground Aqueous Solutions and the Depositions of Lode Ores,' *Proc.* Colorado Scientific Society, 1904, VII, p. 193. Reviewed in THE MINERAL INDUSTRY, 1903, p. 390.

fact, had found expression by de Beaumont as far back as 1847, has continued the past year to be seriously considered by observers, some of whom have been mentioned in previous annual reviews in THE MINERAL INDUSTRY and others of whom are more recent accessions. It is not for the purpose of controversy that emphasis is laid upon these matters, but rather as affording a true picture of the progress of events. At the same time with the mention of certain papers in this connection, attention may be called to the results of areal work and the record of observations which they also contain.

J. W. Spurr appeals to expiring vulcanism and its attendant circulations as the most reasonable explanation of the deposition of the ores in the new mining districts of Western Nevada, now attracting so much attention.[3] Tonapah, Gold Mountain, Goldfield, Bullfrog, Kanich, and the districts of the Silver Peak quadrangle are passed in review, and the following conclusion is reached:

"In both cases the mineralization has been ascribed, as the result of close study, to the final processes of rock solidification subsequent to intrusion, the residual solution and gases resulting from consolidation having been the agents which produced the mineralization; the metals also are in all cases considered to have been derived, together with the mineralizing solutions, from the respective magmas. In this whole district, therefore, the effect of the concentrating action of ordinary circulating ground-waters does not enter perceptibly into our conclusions, and, so far as we yet know, it is negligible except for some minor effects in rearranging the ores in the oxidized zone."

A. C. Spencer, in a paper on the Treadwell mine, Alaska,[4] while realizing the speculative nature of the suggestion, nevertheless, in searching for the most reasonable view, expresses himself as follows, p. 50:

"Speculation as to the causes of fracturing and the source of vein-forming waters, for the region at large, leads to the suggestions that the former have been attendant upon recognized continental uplifts in the region, since the invasion of the Coast Range diorites, and that the latter emanated from a great reservoir of igneous rock underlying the whole region at great depth, during its consolidation from a molten condition."

In the *Bulletin* of the Institute for September, 1905, Mr. Spencer follows up the same theme for a wider range of country, and reaches a similar conclusion.[5] He had previously been impressed with the close relationships between pegmatite veins and certain deposits of magnetite in the old Archean rocks of New Jersey.[6]

Waldemar Lindgren, coming back to America with his field of view widened by observations in Australia, has prepared a paper upon the gold veins

[3] J. W. Spurr, 'Genetic Relations of the Nevada Ores,' *Trans.* Amer. Inst. Mining Eng., *Bull.* 5, September, 1905, pp. 939-969.
[4] A. C. Spencer, 'The Geology of the Treadwell Ore Deposits, Douglas Island, Alaska,' *Trans.* Amer. Inst. Min. Eng., 1904, XXXV, pp. 473-570.
[5] The Magmatic Origin of Vein-forming Waters in Southeastern Alaska,' pp. 971-979.
[6] A. W. Spencer, 'Genesis of the Magnetic Deposits of Sussex Co., N. J.,' *Mining Magazine*, December, 1904, p. 376.

of Victoria.[7] After an outline of the views held by the local observers, some of which were similar to his own, he concludes as follows:

"With some confidence I would formulate the hypothesis that the gold and the quartz in this type of veins have been deposited chiefly by 'eruptive after effects'; in other words, chiefly by hot ascending waters originally contained in the granitic magma and released from it by decreasing pressure, due to its irruption into the upper parts of the lithosphere. It is quite possible that atmospheric waters may have played a certain part by aiding the precipitation and effecting forms of concentration in the deposits."

The probable derivation of many of the hot springs of Europe from magmatic, or, as the Europeans call them, juvenile, waters, is a theme which has received attention abroad. The anniversary address of Prof. Edouard Suess at Carlsbad, two or three years ago, has awakened much interest in the subject. Professor Suess concluded that the Carlsbad springs, alike from their composition, from their invariable character, winter and summer, wet and dry, and from the insufficiency of the catchment basin in the tributary region, could only be explained as of magmatic origin. Since then Rudolf Delkeskamp has continued in much the same line, and at a meeting of the Balneological Society (*i. e.,* the society of those interested in 'baths' or health resorts at hot springs) in Aix la Chapelle,[8] March, 1904, makes a strong argument for this source of the waters of other well-known springs.

Two important works of a general character have appeared during the past year. The long promised and eagerly awaited monograph of President C. R. Van Hise,[9] upon 'Metamorphism,' has been finally issued. By no group of readers has it been anticipated with greater interest than by those who follow mining geology; and while much of the volume, from the nature of the theme, has but remote bearing upon their problems, yet much also is vitally connected with ore deposits, and one hardly knows where to draw the line. The book is an encyclopedia to which reference will be made constantly for data and for theoretical exposition. With untiring persistence the author has followed up chemical reactions to the final stages, and has sought to bring processes and changes to this definite form of expression.

The concluding two hundred pages are specially devoted to a discussion of the origin of ore deposits, and present in a carefully revised and much improved form the material which was contributed to the American Institute of Mining Engineers in February, 1900.[10] President Van Hise strongly upholds the cause of the meteoric ground-waters as distinguished from the magmatic. He represents, therefore, the views which have generally prevailed in America in former years, and is, so to speak, an exponent of the orthodox creed as contrasted with the 'new theology' or 'higher criticism.' He no doubt cor-

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[7] 'Characteristics of Gold Quartz Veins in Victoria,' THE ENGINEERING AND MINING JOURNAL, March 9, 1903, p. 458.

[8] Rudolf Delkeskamp, 'Die Bedeutung der Geologie für die Balneologie' (The significance of geology in the development of hot springs), *Zeitschrift für prakt. Geologie,* June, 1904, p. 202.

[9] *Monograph* 47, United States Geological Survey.

[10] 'Some Principles Controlling the Deposition of Ores,' *Trans.* Amer. Inst. Min. Eng., XXX, p. 27.

rectly considers the iron ores as the most abundant and important of all ore deposits, but one cannot avoid the feeling that in consequence the phenomena which all admit in the case of this metal have had undue weight in discussing those deep-seated circulations which lead to the filling of veins. To the damaging fact that deep shafts reveal a shallow zone of ground-water, the author replies that cementation has plugged the cavities where circulated the once existent meteoric waters to the limit of the zone of fracture, and that therefore they now are shallow. Several mining geologists, however, since the original presentation of President Van Hise's paper in 1900, have been endeavoring to discover the evidence of this cementation in those cross-cuts which often penetrate the fresh rock from deep levels, and are not satisfied that it is visible. On the contrary, they are convinced that cementation is largely a subjective conception, and that, with the establishment of the comparatively shallow nature of the ground-water, the very foundations were removed from the idea of deep-seated meteoric waters. President Van Hise places importance upon the relatively small amount of the magmatic waters, as he regards them, and upon their relatively brief periods of activity. Others would, however, with much reason question the correctness of their small amount, but would gladly admit the relatively brief period of their activity as coinciding perfectly with what we know of vein formation. Aside, however, from these differences in theoretical views, no one can read this splendid product of tireless industry without recognizing in it one of the most notable contributions to the literature in recent years.

The past year has been also marked by the appearance in Germany of the first volume of a work long expected by those who are interested in the subject of ore-deposition. Many students of mining in former years were educated under the teaching of Prof. Alfred W. Stelzner, at Freiberg, a vigorous worker in geological fields. Professor Stelzner died in 1895, leaving a copious series of notes and completely written lectures upon which his instruction had been based. These were entrusted by his heirs to Dr. Alfred Bergeat, now Professor of Geology and Mineralogy in the mining academy at Clausthal, and under Dr. Bergeat's editorship the manuscript has been prepared for the press.[11]

The ore deposits are classified as follows:

I. *Protogenic.*

A. Syngenetic. *a.* With eruptive rocks. 1. Eruptive ore deposits.
b. With sedimentary rocks. 2. Stratified ore deposits.

B. Epigenetic. *a.* Through the filling of cavities previously formed.
3. Fissure veins.
4. Cave fillings.

[11] 'Die Erzlagerstatten,' on the basis of posthumous lectures, manuscripts and illustrations of Alfred Wilhelm Stelzner, edited and prepared for the press by Dr. Alfred Bergeat. Leipzig, Arthur Felix, 1904.

b. Through impregnation of the porous wall-rock by chemical processes.

5. Metasomatic deposits.
Replacements.

II. *Deuterogenic.*

C. Concentrations in rocks by change of place and migration, with parallel chemical rearrangement. During the process, some components of the mother rock may be removed.

6. Metathetic (eluvial) deposits (residual or ablation deposits in American usage).

D. Ore deposits mechanically concentrated from earlier ones, and with greater or less transportation.

7. Alluvial deposits or placers.

The first volume treats only of the Syngenetic deposits under the Protogenic; the others are reserved for the second. The treatment is full, clear and written with an admirable poise, and the pages reveal a mind which had thought long and philosophically upon the questions. Nevertheless, it would often impress a reader that sedimentary processes have sometimes been carried to a great extreme and not always wisely applied. Lenses of pyrite, parallel to the schistosity, were formerly regarded as interbedded sediments; yet experience in several American cases has made the conception a difficult one.

Professor Bergeat has performed his task with tact and judgment, and has brought the several topics up to date, with added paragraphs which are starred so that they may be recognized as his. The terms selected in the scheme of classification are satisfactorily clear to a reader of training in the classics, but they would be of small or no significance to others, and it is well to refrain from making unintelligible with Greek derivatives ideas which, when stated in the vernacular, are easily and quickly grasped by those actively engaged in mining. In making this statement, however, one must realize that only classic derivatives pass current in all modern languages.

In connection with the chemistry of ore deposits, one or two important suggestions have been made and several investigations have been carried on. In February, 1903, Dr. E. Kohler published a valuable paper[12] in which he described the power which clays and other substances have of abstracting metallic oxides from solutions which are filtered through them. The process is called adsorption, and seems to depend on the attraction of two solids for each other, somewhat as in the so-called solid solutions of the physical chemists. It has an intimate bearing, as Mr. Weed has shown, upon the precipitation of copper compounds throughout the clays of certain mines and the

[12] 'Adsorptionsprozesse als Faktoren der Lagerstättenbildung und Lithogenesis.' *Zeitsch. für prakt. Geologie,* February, 1903, p. 49. See also W. H. Weed, 'Adsorption in Ore Deposition,' The Engineering and Mining Journal, February 23, 1905, p. 364.

enrichment of the selvage. The investigation has been carried further in the laboratories of the United States Geological Survey by Dr. E. C. Sullivan, who has used solutions of copper sulphate. When a solution containing in 100 c.c. of water 252 grams of copper as the sulphate was shaken up with powdered orthoclase, or albite or shale or microcline, it was found that there was a remarkable interchange of bases instead of adsorption. The copper entered the silicates, and an exact molecular equivalent of the K_2O, Na_2O, CaO, MgO or MnO went into solution. The feldspar proved much more efficient than kaolin, and removed from 60 to 100% of the copper from the liquid.[13]

C. H. Smyth, Jr., has been making observations for some years past upon the pyritous layers in the lowest beds of the Oneida conglomerate of New York.[14] He is able to show that the pyrite has eaten its way into the quartz pebbles, or has replaced them, so that they mold around its crystals, and, although obviously older, yet take the shape of the pyrites perfectly. The pyrite on entering and crystallizing has made a place for itself by the removal of the quartz. The chemical reagents suggested are hydrogen sulphide, iron carbonate and alkaline carbonates.

The observations are of particular interest in connection with the recent investigations by Messrs. Hatch and Corstorphine of the Transvaal banket.[15] As all mining people are aware, the gold in the Transvaal reefs occurs in association with rounded masses of pyrite in a conglomerate chiefly of quartz pebbles. The gold has been variously thought to be of ancient beach placer origin; to have been precipitated upon the conglomerate while yet the sea was depositing it; and to have been infiltrated. The authors support the last named view, which they fortify by some strong arguments.

F. Klockmann[16] has drawn an interesting distinction between those pyritous orebodies which are of primary deposition in but slightly altered sediments, and those which have undergone metamorphism and which appear in schists and slates. The former have little else than quartz, calcite and sometimes barite as gangue minerals; the latter have the silicates, hornblende, mica, quartz, feldspar, epidote, zoisite, and many more. The paper is suggestive as a guide to observation and interpretation in American cases. Dr. Klockmann in an earlier paper argues against the introduction of certain magnetite bodies into their wall-rocks by contact metamorphism, but supports the view of the presence of the iron oxide in place before the intrusion of the eruptive.[17]

A very interesting and important paper has been prepared by J. A. Reid

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[13] E. C. Sullivan, 'The Chemistry of Ore Deposition,' *Jour.* Amer. Chem. Soc., XXVII, p. 976. August, 1905. 'Economic Geology,' I, p. 67.

[14] 'Replacement of Quartz by Pyrite and Corrosion of Quartz Pebbles,' *Amer. Jour. Sci.*, April, 1905, p. 277.

[15] Frederick H. Hatch and Geo. S. Corstorphine, 'The Petrography of the Witwatersrand Conglomerate, with Special Reference to the Origin of the Gold,' *Trans.* Geol. Soc. of South Africa, 1904, VII, p. 140.

[16] F. Klockmann, 'Ueber den Einfluss der Metamorphose auf die mineralogische Zusâmmensetzung der Kieslagerstätten.' *Zeitsch. für prak. Geologie,* May, 1904, p. 153.

[17] 'Ueber Kontaktmetamorphe Magnetitlagerstätten, ihre Bildung und systematische Stellung.' *Zeitsch. für prak. Geologie,* March, 1904, p. 73.

upon the Comstock Lode.[18] But little has been written in recent years about the Comstock, probably because the several elaborate monographs have spread the impression that the subject was exhausted. Development work has, however, continued in a quiet way, and some new facts have been afforded. On a basis of these and on a resurvey of the surface for corroborative details, Mr. Reid adds important matter. With greater clearness than hitherto the existence of faults is established, forming an east-and-west series across the lode, and responsible for the ravines Crown Point, Bullion, Spanish, Ophir and Cedar. Emphasis is also placed on the two other faults, the Silver City and Sierra Nevada, which cause the forking of the lode. In studying Mr. Reid's map, on p. 185 of his paper, it should be noted that his north-and-south arrow has been drawn east and west by mistake. Mr. Reid shows that the bonanzas have been found in the past in blind crevices which opened upward from the lode into the hanging wall. They pinch out before reaching the surface, and suggest the possible existence of others farther down the dip. It is also shown that Mt. Davidson is a four-sided fault block, with other fissures bounding it on the three remaining sides. In these the possibility of future discoveries is mentioned, and the encouragement afforded by some prospects which are already located. Mr. Reid mentions new data which corroborate the petrographic conclusions of Hague and Iddings. He gives also two new analyses of the waters, one of the uprising, deep-seated, and the other of the descending, vadose and enriching. All in all, the paper is important and suggestive.

The long anticipated monograph of J. M. Boutwell upon the Bingham district has appeared.[19] The size of the volume, over 400 pages, and the abundant plates will indicate the thoroughness with which the work has been done. The rapidly growing importance of Bingham as a source of copper, and the proposed utilization of the mineralized porphyries on a scale scarcely attempted hitherto in copper mining, give additional interest and importance to the work. In the opening pages Mr. Emmons summarizes the main features of the geology of the Oquirrh range. For this he has drawn not alone upon recent observations, but upon his early work with the Fortieth Parallel Survey. Mr. Keith follows with the details of local geology. As is generally known, we have at Bingham a heavy section of quartzite containing several separated strata or beds of limestone, all belonging to the Carboniferous. Two kinds of eruptives penetrate the series, one subdivided into monzonite and monzonite-porphyry, the other into andesite and andesite-porphyry. The sediments constitute a synclinal trough with an overturn on the east, and all pitching gently north. They are crossed by two main sets of fault fissures, a northeast and an east-and-west.

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[18] 'The Structure and Genesis of the Comstock Lode,' *Bulletin* of the Dept. of Geology, Univ. of California, IV, pp. 177-199, August, 1905.

[19] 'Economic Geology of the Bingham Mining District, Utah,' by John Mason Boutwell, with a section on areal geology by Arthur Keith, and an introduction on general geology by Samuel Franklin Emmons. *Professional Paper* No. 38, United States Geological Survey, 1905, p. 413, plates 49, figs. 10.

Mr. Boutwell's work fills the greater part of the report, and treats of the history, general features, occurrence of ores, genesis, alteration and details of mines. The discussion of the phenomena is written in an extremely fair and open-minded spirit, and has been most carefully and conscientiously prepared. The ores occur in three ways: (1) Copper sulphides disseminated in porphyry plainly introduced in solution. They will be the object of mining and concentration in the immediate future. (2) Lode ores, chiefly yielding lead and in strong fissures with some lateral extensions. These were much sought in early days. (3) Copper ores in huge replacements in limestone—the chief objects of mining today. Mr. Boutwell reaches the conclusion that the ores must have been introduced by hot, ascending solutions, whose most probable source was in the depths of the monzonite mass before it had fully chilled. Yet the disseminated ores in the upper portions of the monzonite show that in this part solidification had already taken place before the solutions entered it.

Much attention has been recently given by the United States Geological Survey to the lead and zinc deposits of the Mississippi valley, and to the fluorite veins on its eastern slopes. Thus G. I. Adams has written of those in Northern Arkansas,[20] and E. O. Ulrich and W. L. T. Smith of the 'Lead, Zinc and Fluorspar of Western Kentucky.'[21] H. F. Bain has described the 'Fluorspar of Southern Illinois'[22] and the 'Zinc and Lead Deposits of Northwestern Illinois.'[23] All these are careful pieces of work, with valuable discussions of the probable methods of introduction of the minerals. The Arkansas and Northern Illinois regions lend themselves best to the descending meteoric waters and to a gradual concentration of materials from the sediments; the fluorspar veins, both from the nature of the mineral and because of the neighboring basic dikes, suggest the influence of eruptives. From U. S. Grant, under the auspices of the Wisconsin Geological Survey, has come its *Bulletin* No. 9 upon 'Lead and Zinc Deposits in Southwestern Wisconsin' (1903), and more recently, in co-operation with the United States Geological Survey, a series of maps based on the topographical sheets.

The United States Geological Survey has continued its work in Alaska on a comprehensive scale, and has endeavored to place in the hands of the large and growing body of people interested in the resources of this vast area information suited to their needs. Six or eight *Bulletins* have been issued the past year treating of different districts, while one, No. 263, is more general in its scope.[24] Mr. Purington visited the gold-producing districts, and gathered the necessary data regarding methods, costs and conditions to make a very valuable miners' guide to Alaska.

Two *Professional Papers*, No 25 on 'The Encampment District, Wyo.,'[25]

[20] 'Zinc and Lead Deposits of Northern Arkansas.' *Professional Paper* 24, pp. 118, pl. 27.
[21] *Professional Paper* No. 36.
[22] *Bulletin* 255. Pp. 75, pl. 6.
[23] *Bulletin* 246. Pp. 56, pl. 5.
[24] C. W. Purington, 'Methods and Costs of Gravel and Placer Mining in Alaska,' *Bulletin* 263.
[25] 'The Copper Deposits of the Encampment District, Wyo.,' by Arthur C. Spencer, pp. 107, pl. 2, fig. 49.

and No. 26[26] upon the Black Hills, S. D., possess great interest, not alone for readers with connections in the two districts, but for those who follow the general development of the science. The Black Hills monograph especially affords interesting structural details, both with regard to the forms of eruptive rocks, the supply fissures which have introduced the ores, and the shapes and relations of the orebodies themselves. Professor Irving has had constant recourse to the microscope in acquiring his facts, and has developed many acute observations regarding the minute details of the ores and wall-rocks. In Mr. Spencer's district the intersection of two sets of fissures has been found to be of prime importance in ore precipitation and localization.

The little book on 'Ore Deposits: A Discussion,' issued by THE ENGINEERING AND MINING JOURNAL in 1903, has been followed by several others of similar scope and size. The one by T. A. Rickard upon 'The Copper Mines of Lake Superior' is timely, and will prove of interest and value to a wide circle of readers. It marks a type of book almost unfamiliar in America, in that in interesting and popular form a subject is treated by one who can speak with full knowledge and authority. It reminds one of the geological, metallurgical or mining books of travel which have been occasionally written by distinguished Europeans, and from time to time by them about America.

Just as the present volume of THE MINERAL INDUSTRY is going to press, the first number of a new semi-quarterly journal, entitled 'Economic Geology,' under the editorship of Prof. John D. Irving, of Lehigh University, South Bethlehem, Pa., has appeared. It is to be devoted to the purely scientific side of the subject, and will occupy in America somewhat the same field as does the *Zeitschrift für praktische Geologie* among the German-speaking peoples.

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[26] 'Economic Resources of the Northern Black Hills,' by J. D. Irving, with contributions by S. F. Emmons and T. A. Jaggar, Jr. Pp. 222, pl. 20.

PROGRESS IN ORE DRESSING AND COAL WASHING IN 1904.

BY ROBERT H. RICHARDS.

FINE CRUSHING MACHINERY.

Krupp Tube-mill in the Waikino Mill in New Zealand.[1]—The Krupp mill is a revolving cylinder, 21 ft. long and 3½ ft. in diameter, lined with ⅞-in. white metal. A spur wheel at one end works against the driving gear underneath. The mill is charged with about 3½ tons of flint stones of 3 in. diameter, and in full working operates at a speed of 28 r. p. m. Sand from the stamps is fed into one end, and in passing through, it is ground (or crushed) between the numerous balls of flint, arriving at the discharge end mainly as a pulp, owing to the great hardness of the flints. The discharge goes to a cone separator, whence the fine sand passes to cyanide vats. The coarse sand is elevated and returned to the tube-mill. These mills grind the sand to such a fine pulp that an extraction by cyanide of 97% of the gold is said to be possible. They also permit the use of coarser battery-screens, enlarging the stamp capacity 25 to 50%.

Tube-mill and Filter-press.[2]—The use of tube-mills has changed completely the aim in stamp-mill crushing. Formerly the effort was to crush without making slime; now the aim is to subdivide the ore as finely as possible, so that the gold may be quickly dissolved by the cyanide, while the filter-press allows this solution to be forced through the pulp under heavy pressure.

The Operation of a Tube-mill.[3]—Experiments with a Krupp tube-mill, using interchangeable gratings in the drum-heads, have permitted the action of the flint balls on the ore to be observed. There is no appreciable grinding action, as hitherto believed, but the ore is crushed between the balls by beating or stamping. In the experiments the mill was first operated without material, and then with such material as could make no dust; different speeds were tried. Fig. 1 shows the drum turned slowly until a few balls began to move on the surface. As the speed was increased the mass was raised, the motion of the balls on the free side became more lively, and the whole became visibly loose. Fig. 2 is a view of the drum revolving at 32 r. p. m. The looseness increased with the speed to a certain point, when the balls formed a solid ring, revolving with the drum without any relative motion. Fig. 3 shows the drum revolving at 66

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[1] THE ENGINEERING AND MINING JOURNAL, Vol. LXXVIII, 1904, p. 434.
[2] *Ibid*, Vol. LXXVIII, 1904, p. 579.
[3] *Ibid*, Vol. LXXVIII, 1904, p. 791.

r. p. m. At a proper crushing speed, the balls in contact with the drum on the ascending side are carried upward without changing their relative position until they separate from the wall at a certain height and describe a distinct curve of projection. The balls farther inward behave in the same

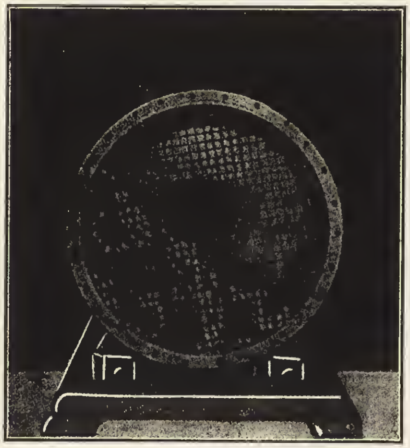

FIG. I. BEGINNING OF ROTATION.

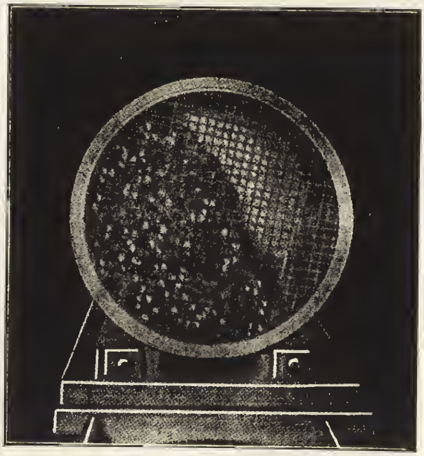

FIG. 2. 32 REVOLUTIONS PER MINUTE.

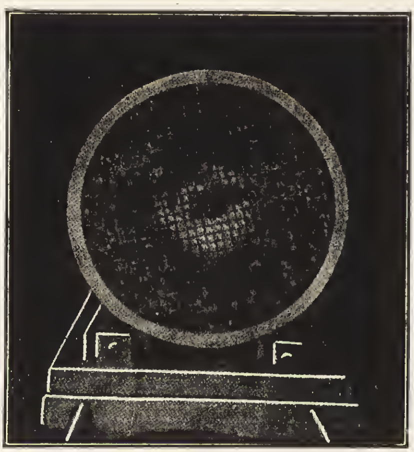

FIG. 3. 66 REVOLUTIONS PER MINUTE.

KRUPP TUBE MILLS. (EACH TUBE IS I METER IN DIAMETER.)

way, but they show hardly any curve of projection in descending and separate into layers. A hollow oval space on the ascending side is formed in which a few balls roll without mixing with the others.

Next, a large quantity of material that would make no dust was introduced. The material moved just the same as the balls, entered the spaces between, and ascended and descended with them. Very little material entered the oval hollow space. There was practically no grinding, but only a crushing or stamping action. Crushing depends upon the height of the fall, and this upon the speed of the drum. (Compare Fig. 1 and 2.) The weight and number of balls also affect the crushing, the weight of balls and height of their fall being supplementary factors. Harder material requires heavier balls or a higher fall. The larger the number of balls acting on a certain quantity of material, the better the crushing. If more material is to be crushed to a certain fineness in a given time, the number of balls, and hence the length of the drum, must be greater. Again it was shown that the discharge of material took place at a higher level than the feed. The progress of the material from the feed to the discharge end, therefore, does not depend on a difference in height between inlet and outlet.

Re-grinding in Tube-mills at El Oro, Mexico.[4]—Experiments have been made to determine: (1) Best method of producing a fine product; (2) Desirable rate of feeding in re-grinding; (3) Fineness of products that need re-grinding; (4) Results of leaching each grade of fineness; (5) Effect of oxidation by air agitation and by chemicals. The tube-mill was found to be the best machine for fine grinding. The sand and the slime were examined separately. Some results of the sand experiments follow:

(a) Of different rates of feed—1, 1½, 2 and 3 tons per hour—the last shows the greatest profit.

(b) At this rate, grinding can be done at 53c. per ton of sand.

(c) The grades of sand suitable for re-grinding include all not passing 200 mesh. (This amounts to 51% when using a 35-mesh screen in the stamp mortar.)

(d) Such re-grinding makes about 50% of the ore amenable to agitation; the rest leaches freely if thoroughly separated.

(e) Such re-grinding gives an extra recovery of $4.02 per ton of sand reground, with a net profit of $3.49; with one-half re-ground, it results in an extra recovery of $2.01, with a net profit of $1.74 per ton of ore stamped. The ore experimented upon carries $14 in gold and 4.75 oz. of silver per ton.

Special tests on the slime show that the use of mercuric chloride avoids the extra cost and time of air agitation and gives 25c. better extraction. Roasting affects favorably the extraction of silver, but not of gold. The grinding of the sand is a simple matter, but the problem of extraction from the slime, especially of the silver, is more complex, and several points remain for investigation.

The items of cost of grinding are in cents per ton: Power, 18c.; liners and pebbles, 31c.; depreciation, 4c.; total, 53c. per ton.

Tube-mills in South Africa.[5]—In October, 1904, 33 tube-mills were or-

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[4] The Engineering and Mining Journal, Vol. LXXVIII, 1904, p. 943.
[5] The 'South African Mines, Commerce and Industries,' Vol. II, 1904, p. 712.

dered for 13 producing mines on the Rand, whose battery equipment was 1,530 stamps. At most of the mines, the concentrate was to be re-ground to obtain an improved extraction, in which case one tube-mill to 50 or 60 stamps would be installed. In other cases, an increased capacity was the object, when there would be 3 tube-mills to 50 stamps. Increased capacity is obtained by using coarser screens in the mortars and letting the tube-mills do the fine crushing.

Tests of Re-grinding Machines at Anaconda, Mont.[6]—The machines tested were a Krupp ball-mill, a Chilean mill, a Huntington mill, and a Gates rolls. In any comparison of re-grinding machines, the condition of the ore fed to them is of great significance. A ball-mill is better adapted to work on coarse material from a rock-breaker, discharging it in a finely pulverized condition, than it is for re-grinding particles that are already reduced to a size approaching that of the machine's discharge. The Chilean mill has a large capacity and is well adapted for re-grinding lean tailing, but poorly suited to rich tailing or middling. For 10 days a ball-mill and a Chilean mill were fed with jig tailing, the product of each mill going to other jigs; the tailing from the jigging of the ball-mill product carried 0.925% copper and of the Chilean mill product, 0.525% copper. Usually a middle product should be re-ground in rolls or in a Huntington mill, the former for coarser and the latter for finer material. Huntington mills and rolls make less slime than the ball- or the Chilean mill. Rolls do their best work when the mineral is set free by a crushing to 1.5 or 1.25 mm. The following table gives a summary of speed and capacity:

	Krupp Ball-Mill, No. 8.	Hunting-ton Mill, 5 ft.	Chilean Mill, 6 ft.	Gates Rolls 15x36 in.
Capacity, tons per hour.........	5.0	3.0	6.0	9.0
Screens used, holes in mm.......	1.5	1.5	1.5	1.5
Speed r. p. m......	21	65	34	108

Concentrating Machinery.

The Buss Concentrating Table.[7]—This table has a top similar to a Wilfley, but it is supported on a number of nearly upright strips which allow the table to move forward and back in the arc of a circle, rising on the forward and falling on the back stroke. The movement is imparted by an eccentric and rod. The rod is not level, as in ordinary jerking and bumping tables, but slants upwards, so that the resulting motion, with a raising of the table on the forward stroke, imitates that of the Cornish vanning shovel. On account of the regular reciprocating motion, the table works noiselessly.

[6] The Engineering and Mining Journal, Vol. LXXVII, 1904, p. 403.
[7] *Ibid*, Vol. LXXVIII, 1904, p. 186.

The Sperry Vanning Buddle.[8]—This machine was designed for the treatment of slime, and the principal points in its design are: Fixed points of feed and delivery; a circular vanning motion; adjustment of the size and speed of the vanning motion; adjustment of the speed of rotation; adjustment of the slope of the top while the buddle is in motion. Fig. 4 gives a plan of its top, showing the feed box at the center and an annular trough around the table, sloping to one point of outflow for the tailing. The feed comes on the table during one-half a revolution, then, after a short inter-

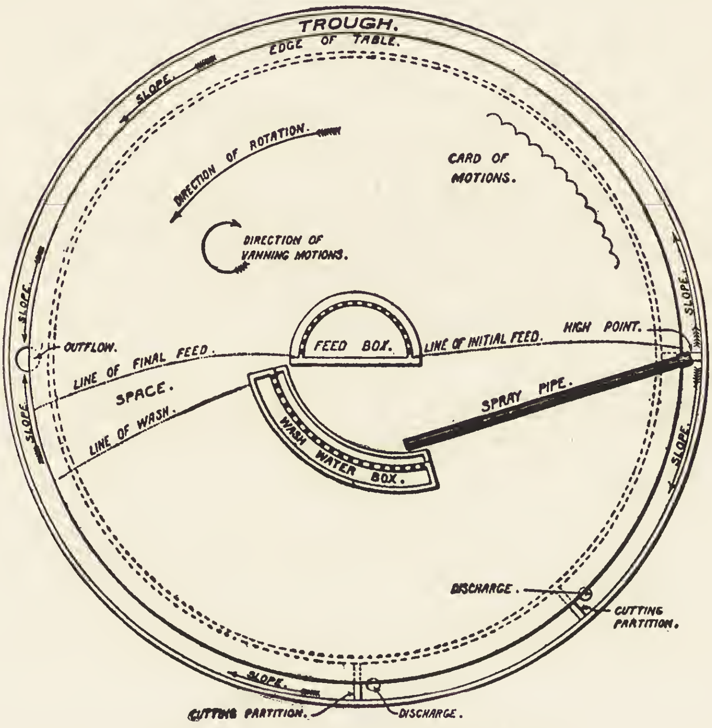

FIG. 4. TOP PLAN OF SPERRY VANNING BUDDLE.

mission, the pulp is washed with water as far as the spray pipe. The wash water carries the tailing to the trough and thence to the outflow, while the spray pipe later washes off the concentrate to a part of the trough separated by a partition. The pitch of the table between center and circumference may be varied from 3/4 to 1 1/4 in. to the foot. The speed of rotation is from 3/4 to 1 r. p. m. The vanning motion varies from 160 to 210 strokes per minute, the higher number being for materials of widely different specific gravities, and the lower for those more nearly the same. The size of the vanning motion is from 1/4 to 3/4 inch.

[8] *Transactions* American Institute Mining Engineers, Vol. XXXIV, 1904, p. 572.

Fig. 5 shows how the two movements are obtained. The rotating movement is imparted by a hollow shaft, *h*, resting in a cast-iron base, *b*, and having a worm gear, *g*, attached to it, to get the necessary reduction of speed. The upper end of the hollow shaft is a hub flange, *f*, which carries a six-armed spider and frame, *s*. Within the hollow shaft is a solid shaft, *r*, concentric with and extending above the hollow shaft. The extended part, *e*, serves as a crank-pin, being out of center with the hollow shaft. On this crank-pin is an eccentric sleeve, *v*, secured by a set screw. By placing the eccentricities of shaft and sleeve in opposition, their eccentricities are neu-

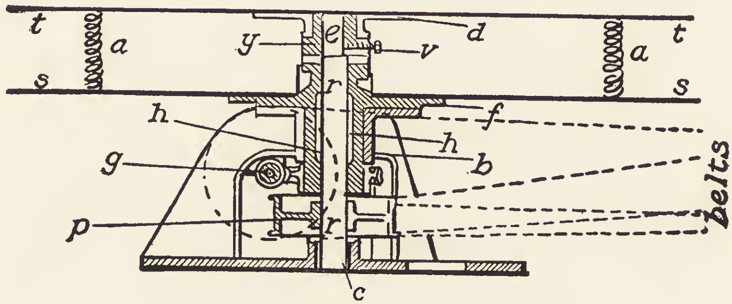

FIG. 5. MOVEMENT OF THE SPERRY VANNING BUDDLE.

tralized, and by combining them, they produce a maximum displacement. Over the sleeve is a hub flange, *d*, carrying another six-armed spider frame, *t*, connected to the lower spider frame by spiral springs, *a*. The upper spider frame carries the top of the table. When the hollow shaft turns, it revolves the lower spider frame, and the motion of rotation is transmitted through these spiral springs to the upper frame. The solid shaft, however, is free to turn in everything but the eccentric sleeve, so that it can revolve without imparting motion to the lower frame, while to the upper frame it gives a small, circular, gyrating, vanning movement. The solid shaft extends below the hollow shaft and rests in a step, *c*. On this lower extension is a pulley, *p*, by which the shaft can be revolved in either direction; it is better, however, to have the vanning motion opposite in direction to the rotation of the table. The two movements are thus completely independent.

A comparison of results from the treating of Joplin zinc sludge on a Wilfley table and on a Sperry buddle shows the advantage of the buddle:

		Weight, lb.	Per cent of Zinc.	Saving in per cent of Total Zinc.	Concentration Ratio.
Wilfley Table.	Zinc Sludge Concentrate.	164 18	6.6 34.62	...... 57.62	...... 9.1:1
Sperry Buddle.	Zinc Sludge. Concentrate. Concentrate.	163.25 22.75 45.8	14.6 52. 37.9	..... 57.62 72.9	...... 10.84:1 7.8 :1

The concentration ratio for the Sperry is reduced to the same basis of calculation as for the Wilfley on account of the wide difference in value of the samples.

The Hancock Jig.[9]—This jig has been largely used in Australia for treating lead and copper ores, and in August, 1904, one of them was installed at Clifton, Arizona, by the Arizona Copper Company. It has been introduced with success in Montana and lately is being tried in Nevada. At the Moonta mines, South Australia, ore crushed to 20 mesh, and containing 2 to 4% copper, was concentrated to 20% copper at a cost of but 10c. per ton for jigging. Only 2 h. p. was required to treat 175 tons per day. At Clifton, the Hancock jig takes the place of 8 Harz jigs, treating material through a ½-in. trommel and having a capacity of 35 tons of sulphide ore per hour. The chief advantages claimed for the jig are close saving, small power requirements, and a light water supply, or only enough to carry off the concentrate and tailing, as there is no overflow; this latter point is of great advantage in arid districts. A description of the working of the jig, and complete drawings of it, are given in Prof. Richards' work on 'Ore Dressing,' Vol. I, p. 504.

Mechanical Defects in Sieves.[10]—In the testing of fine sieves, such as 100-mesh, the same sample was tested for fineness in different laboratories, with results varying from 84 to 94 per cent as to the amount passing through a given mesh, showing a range of 10 per cent, whereas the results should have checked within 2 per cent. Such variation is due to defects in the sieves. To facilitate counting the meshes of the different sieves, enlarged photographs are taken, in which also any individual variation immediately becomes apparent. Since most samples of cloth closely approximate the nominal mesh, the individual variations in the sieve itself are due to strains in the cloth while making the sieve.

The most common defects in sieves are as follows: Incorrect number of meshes to the linear inch (a rating of 200 gave only 170 by count); variation in the size of meshes in different parts of the same sieve; different gauges of wire in cloths from different manufacturers; unevenness in the mesh due to straining or displacement in making the sieve.

A committee of the American Society of Civil Engineers recommends as the limits of variation in sieves, 96 to 100 meshes for No. 100 sieve, and 188 to 200 for No. 200 sieve. Any sieve falling outside these limits should be discarded, also any whose weave has been badly displaced by pulling. A sieve with only a few imperfections, such as an occasional wide mesh, can be corrected by soldering the wide meshes. Since the photographic examination in no way injures them, a large number of sieves may be obtained from the manufacturer, the satisfactory ones accepted, and the rest returned.

Wire cloth of iron, steel, brass, or copper, from the coarsest to No. 100,

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[9] *Mining Reporter,* Vol. L, 1904, p. 294.
[10] American Society for Testing Materials, Vol. IV, 1904, p. 543.

is made in the United States, while finer meshes are imported from France, Germany and Scotland, Scotch cloth being considered the best. Even No. 100 can be imported with economy. No. 100 cloth is made in warps 3 ft. wide by 300 ft. long, and may remain on the loom for six months.

General Milling Practice.

Slime Treatment in the Joplin Region.[11]—The extreme brittleness of galena and blende, especially when associated with a tough gangue, causes excessive sliming of the Joplin ores, and special apparatus is needed for a close extraction. The milling method of the district, however, is quick and

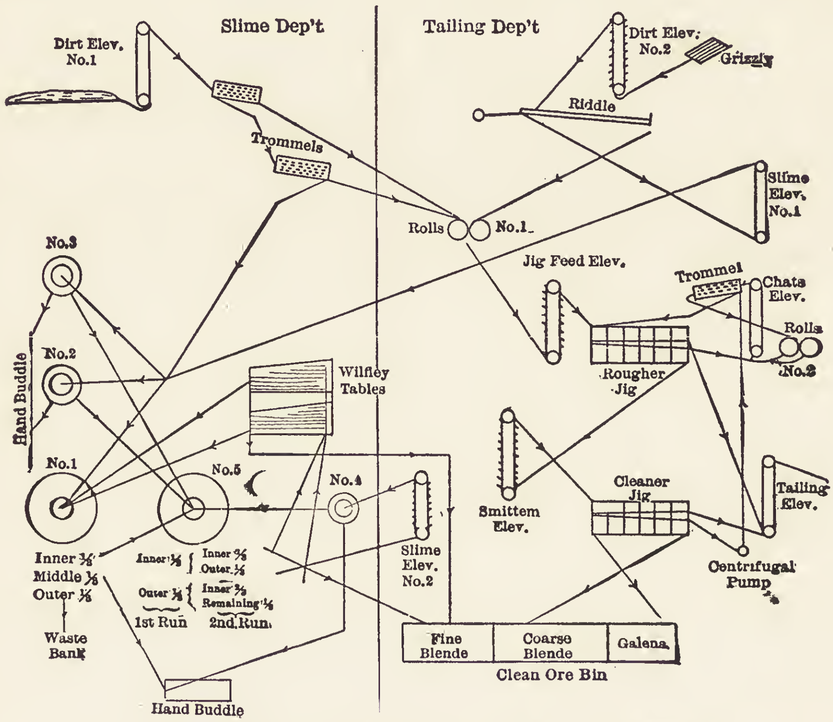

FIG. 6. DIAGRAM OF SLIME TREATMENT, SLUDGE MILL, GALENA, KANSAS.

coarse concentration. Special concentrating plants called 'sludge mills' have been designed to treat tailing, sand, and slime. The latest one is at Galena, Kansas, and consists of a power plant, a tailing mill, and a slime department. A diagram of the two latter parts is given in Fig. 6. The tailing mill treats low-grade refuse from the waste dumps of the old concentrating mills. The apparatus in the slime department consists of trommels, buddles, and Wilfley tables, receiving a part of its material from the tailing mill, and returning part of its product to the latter.

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[11] The Engineering and Mining Journal, Vol. LXXVII, 1904, p. 683.

The material sent to the *tailing mill* (Fig. 6) is raised by *dirt elevator, No. 2,* and discharged upon a *riddle* or flat screen, 3 ft. by 10 ft., with 0.75-mm. round holes. The oversize goes to the *No. 1 rolls,* which are 20 in. diam. by 12 in. face and run at 50 r. p. m. The undersize is raised by *slime elevator No. 1,* and fed to the *rougher buddles,* No. 1, 2 and 3 in the slime department. The discharge from the *No. 1 rolls* is fed to the *rougher jig,* which is 6-cell and single-acting, and is fitted with 5-mesh brass-wire screens. It makes 75 one-inch strokes per minute. This jig is useful only for low-grade minerals and waste products from coarse concentration. It produces overflow, discharge and hutch. The overflow is raised by the *tailing elevator* and runs to waste. The discharge, carrying included grains, is raised by the *chats elevator* to a trommel having 1-mm. round holes. The oversize from the trommel goes through the *No. 2 rolls* and is again elevated to the trommel. The undersize is fed back upon the rougher jig. The unfinished hutch product of the rougher jig, containing blende and galena, goes to the *smittem elevator* and is fed to the cleaner jig, the first hutches of which give clean galena and the later hutches clean blende, both products going to the *clean ore-bin.* The discharge from the cleaner jig is raised by a *centrifugal pump* to join the discharge of the chats elevator. The overflow of the cleaner jig is tailing and goes to waste.

The material sent to the slime department is elevated by *dirt elevator No. 1* to a trommel with 1-mm. round holes, the undersize going to a second trommel with 0.75-mm. round holes. The oversizes from both trommels unite and pass to the No. 1 rolls in the tailing mill. The undersize from the second trommel goes to the *rougher buddles,* No. 1, 2 and 3. Of the complex residues of No. 2 and 3 buddles, part is treated by a *hand buddle* and the rest goes to the *No. 5 finishing buddle.* From No. 1 buddle, the outer ⅓ goes to waste, the middle ⅓ goes to a *hand buddle,* and the inner ⅓ to No. 5 finishing buddle. The product of the No. 5 finishing buddle is divided into an inner ½ and an outer ½. Of the inner ½, the inner ⅔ is fine blende and goes to the clean-ore bin, and the outer ⅓ goes to a Wilfley table to be cleaned. Of the outer ½, the inner ⅔ goes to a *slime elevator, No. 2,* and is fed to *No. 4 buddle,* which delivers part to the hand buddle and part back to No. 5 finishing buddle. The outer ⅓ (from No. 5 buddle) goes to a Wilfley table. The concentrate from the Wilfley tables is fine blende, which goes to the clean-ore bin, while the tailing is fed back to No. 1 buddle. This scheme of treatment appears to require too much handling of middling products by keeping them circulating. Also, it would seem as though the tailing from the two Wilfley tables should be poor enough to go to waste.

The capacity of the mill (per 24-hour day) for rough material is 275 tons of tailing and 150 tons of sand. The percentage of mineral in tailing ranges from 1 to 3, and in sand from 3 to 5 and even to 10 per cent.

The minerals treated are various and come from all parts of the district, even being hauled 4 or 5 miles. The price paid varies with the value of the mineral and the length of haul. Tailing is seldom hauled over ¾ mile, while sand may be hauled 2 or 3 miles. The respective prices for rich sand, tailing, and poor sand or dirt are 25, 15, and 10c. per ton.

A considerable waste is indicated by the amount of flour blende on the banks of the stream below the mill. The cause of the loss is the rapid handling of large quantities of low-grade material without efficient slime-treating apparatus. But any saving along this line ought to be made in the main concentrating mill rather than in auxiliary special mills designed to handle waste products from the main plant.

Milling at Park City, Utah.[12]—The Silver King mill was described in THE MINERAL INDUSTRY, Vol. XI, p. 649, and is the only mill in the district using filter-presses in the treatment of slime. Wilfley slimers are also in use here as well as in several other mills, doing the work of the canvas table. The ore passes through breaker, rolls and screens, and is jigged to five sizes. The jig products constitute 75 per cent of the total recovery. The jig tailing is re-ground in Huntington mills to 20-mesh and is classified, the fine going to Frue vanners and the coarse to Wilfley tables. The tailings of both vanners and tables are screened, the undersize going to Wilfley slimers and the oversize being re-concentrated on other tables. The middling products of the tables are also re-treated on other tables.

All the slime from the mill is run into V-shaped settlers and then into receiving tanks, whence it is forced by compressed air into filter-presses. The latter squeeze out a large part of the water, leaving the pulp compressed in circular slabs. These slabs, amounting to 12 tons per day, are chopped up and dried, the moisture being reduced to 12 per cent; if drier than this, loss in handling would result. The concentrates from the tables, vanners, and slimers are dried to 3 per cent moisture and sent to the smelter separately from the filter-press product. The ratio of concentration for the whole mill is about 3 tons into 1. The following table gives the values per ton of the different concentrates produced:

Concentrate.	Per cent Lead.	Oz. Silver	Gold value.
Jig	49	65	$3.50
Slimers	17.7	28	2.
Tables	24.	27	3.
Vanners	18.	26	2.
Filter press	11.	19	2.50

At the *Keith-Kearns* mine is a concentrating plant using breaker, rolls, jigs, Huntington mills, hydraulic classifiers, Wilfley tables and slimers. The general scheme of the mill is the same as that of the Silver King, except that there is no filter-press treatment. The jig product amounts to 65% of the

[12] THE ENGINEERING AND MINING JOURNAL, Vol. LXXVII, 194, p. 604.

entire mill-saving. The slimers give a product running 50% lead and 25 oz. silver per ton.

At the *Ontario* mine is a new concentrating mill on the same principle as the Keith-Kearns, but operated by electric power. The ore is suited to jigging, and the jig concentrate contains 50% lead, 76 oz. silver per ton, 7% zinc, and 10% iron.

Utah Copper Company's Mill.[13]—This company has just completed a concentrating mill in lower Bingham cañon, Salt Lake county, Utah. The ore is chalcopyrite disseminated through porphyry. By Gates breakers, rolls, and Chilean mills, the whole product is reduced to 30-mesh and is then classified in Allis-Chalmers hydraulic classifiers, which are divided into several compartments, discharging their differently sized materials to various groups of tables. The overflow goes to a series of V-shaped settling tanks. There are 32 Wilfley, 2 Card and 2 Overstrom tables, 2 Wilfley slimers, and 18 Frue vanners. The tables take the material as sized by the classifiers, while the product of the settling tanks goes to the vanners and slimers. The mill is designed to treat 500 tons per day. It began operating in April, 1904. In May, 1904, the company reported that they were treating 600 tons daily, giving a product that assayed 35 to 40% copper, $7 to $9 per ton in gold, and some silver.

New Concentrator at Cananea, Mexico.[14]—Up to May, 1904, the Greene Consolidated Copper Company had been operating a mill of 300-ton daily capacity at a cost of $1.25 per ton. At the beginning of May, a new addition to the mill was started up, giving a total capacity of 1,000 tons per day. A new mill of fire-proof construction, on the same plan as the other, was to be ready to operate in January, 1905. The combined capacity of the plant is now 2,000 tons per day. A complete description of the new plant is given in the reference.

The Baltic Mill, Lake Superior.[15]—The ore is an amygdaloid containing 1.25% copper, mostly in the native state. Much of the metal is finely disseminated through the ore, although 20% of mass copper is picked out in the rock-house at the mine and sent directly to the smelter. The ore is loaded into 40-ton, bottom-discharge cars and conveyed by the Copper Range Railroad to the mill at Redridge, nine miles from the mine, on the west shore of the peninsula. Two trains of 20 to 24 cars are shipped daily.

The mill, the scheme of which is shown in Fig. 7, has four Nordberg steam stamps of a daily capacity of 400 tons each. The circular mortar boxes have an all-round discharge through screens punched with 5/8-in. holes. The ore from the mortar flows over a hydraulic copper-trap to a trommel with 3/16-in. circular holes, the oversize being returned to the stamp. The ore then goes by launders, *A* and *B*, to hydraulic classifiers, and jigs, of which there are 24 to each stamp. The slime from the classifiers goes to the

[13] The Engineering and Mining Journal, Vol. LXXVII, 1904, p. 557.
[14] *Ibid*, Vol. LXXVII, 1904, p. 1,044.
[15] *Mining Reporter*, Vol. L, 1904, p. 687.

launders, *C*. The tailing from the jigs runs to waste. The head sieves are scraped three times per shift and the mineral shipped to the smelter as No. 1. The scrapings of the tail sieves are called ragging or No. 3 mineral. The hutchwork of all the jigs goes to pointed boxes, *E*, to free from excess of water, and then to Wilfley tables, 4 to each stamp. The concentrate from the Wilfleys is packed in barrels for shipment to the smelter. The middling product goes back over the tables and the tailing runs to waste. The slime from two stamps is treated on Overstrom tables, but from the other two on Wilfleys and revolving tables, not shown in the figure. The tailing of the revolving tables runs to waste, while the heads are treated on Wilfleys.

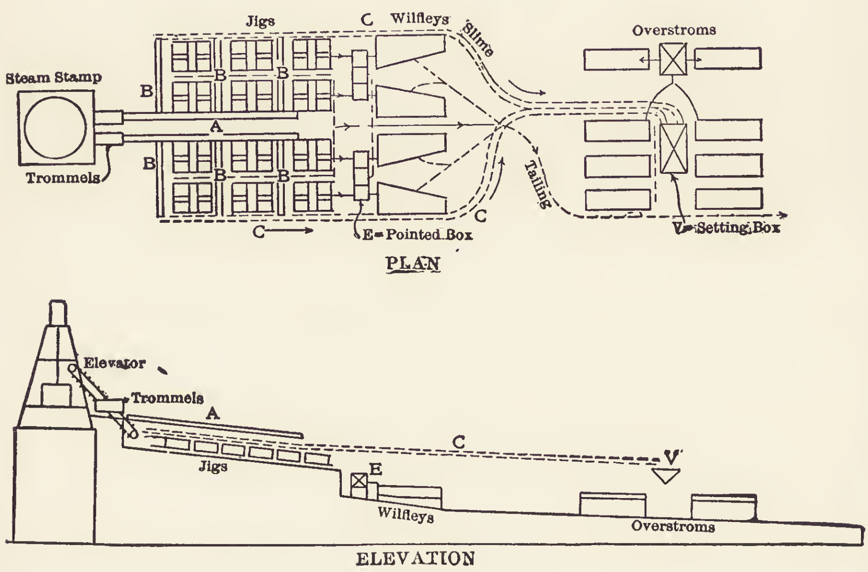

FIG. 7. BALTIC MILL.

The Wilfley concentrate contains 78% and the tailing 0.35% copper. The mineral from the copper-traps and the jig scrapings runs 90% copper. The coarse jig tailing carries 0.15% and the fine 0.25% copper. The tailing from the revolving table averages 0.30% copper. The labor employed numbers 66 men in two shifts under a superintendent. The water is not carefully considered, 8,000 gallons being used per ton of rock stamped. Tailing runs into the lake. The cost of milling is 22c. per ton of rock stamped. The cost of mining and milling was $1.732 per ton in 1902, when the rock carried 22.842 lb. of copper per ton, the copper selling for 11.87c. In March, 1903, the rock carried 24.16 lb. of copper per ton and the selling price of copper was 14.57c. per pound.

The Steeple Compound Steam Stamp.[16]—This stamp was introduced experimentally by the Osceola mill in February, 1904, and by the Centennial, two months later. The Osceola put in one head at that time and has since put in five more. The stamp has received general approval, and on the strength of its success, one or more heads have been ordered by the Trimountain, the Quincy, and the Tamarack, all of these stamps having been designed by B. V. Nordberg. The Calumet & Hecla will instal two heads, one designed by Nordberg and the other by E. D. Leavitt. In altering to this type of stamp, the only change occurs above the base of the cylinder, frame, mortar and block remaining identical. The cost of the change is about $10,000, and a fuel saving of 25 per cent is said to be guaranteed.

Potter Process for Treating Zinc Tailing.[17]—This process, as worked at Block 14 mine, Broken Hill, Australia, and also the concentrating machine, are fully described in the references. From 35 to 94 per cent of the zinc is recovered. The process consists in bringing zinc tailing into a bath of warm dilute acid, in which the sulphides are buoyed up by the adhering bubbles of hydrogen sulphide that is generated, while the gangue goes to the bottom. A supposed improvement was made by adding an inert salt, such as salt-cake, to the acid bath, so as to increase its buoyant effect, but when the first parcel of concentrate was shipped to Belgian zinc works, it was found that the salt-cake, fluxing with the clay, destroyed the retorts, and the smelters refused to take a concentrate that had been treated with salt-cake.[18]

Magnetic Concentration.

Magnetic Concentration of Zinc Ore in Virginia.[19]—The principal zinc deposits now worked in Virginia are found in the valley of the New river. The ores consist chiefly of hydrated zinc silicate (calamine) and zinc carbonate (smithsonite). In the Wythe mine, at Austinville, a good grade of limonite, with lead carbonate and sulphide, is associated with the zinc. The lead concentrate is separated, by jigging, from the zinc-iron ore, which is then roasted in order to magnetize the iron ore. After cooling, it is passed without sizing over a Payne magnetic separator. This separator has two cylinders mounted vertically one over the other. The upper cylinder makes a clean concentrate containing 48% iron. The lower cylinder takes the material not attracted by the upper one and makes a clean zinc concentrate containing 38% zinc, and some iron middling carrying 5% iron, which is passed through the machine again.

At Delton, Va., the ore contains an intimate mixture of limonite and calamine which requires fine crushing to unlock the mineral. The ore then goes to two pairs of Payne magnetic separators, the first pair producing a rough zinc concentrate and clean iron tailing, while the second pair, which

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[16] The Engineering and Mining Journal, Vol. LXXVIII, 1904, p. 922.
[17] *Ibid*, Vol. LXXVIII, 1904, p. 394.
[18] *Ibid*, Vol. LXXVIII, 1904, p. 499.
[19] *Ibid*, Vol. LXXVII, 1904, p. 1,001.

re-treat the rough zinc concentrate, produces a clean zinc concentrate and a certain amount of middling, which is returned to the first pair of machines. The concentrate averages 43% zinc, and as high as 46% has been obtained.

The Odling Magnetic Separator.[20]—This machine marks a distinct advance in magnetic separation. While former experiment has confined itself to dry processes with sizing before treatment, the Ulrich machine being a good example, the Odling separator treats unsized material and wet pulp. With most ores, comparatively coarse grains can be treated, and at the same time slime can be successfully handled. The power required is light, 1 h. p. for a machine treating 1 ton per hour. A description of the machine is given in the reference. Here are some results of concentration. An ore containing magnetite and chalcopyrite, 5.6% copper, gave a coarse concentrate with 15.3% copper and a fine concentrate with 17.1% copper. The coarse tailing carried 0.9% and the fine tailing 0.4% copper. Broken Hill zinc middling, 24.1% zinc and 8.9 oz. silver, gave a blende product with 33.1% zinc and 10.75 oz. silver, the tailing carrying 5.6% zinc and 4.9 oz. silver per ton. Vanning the blende product brought it up to 43.4% zinc.

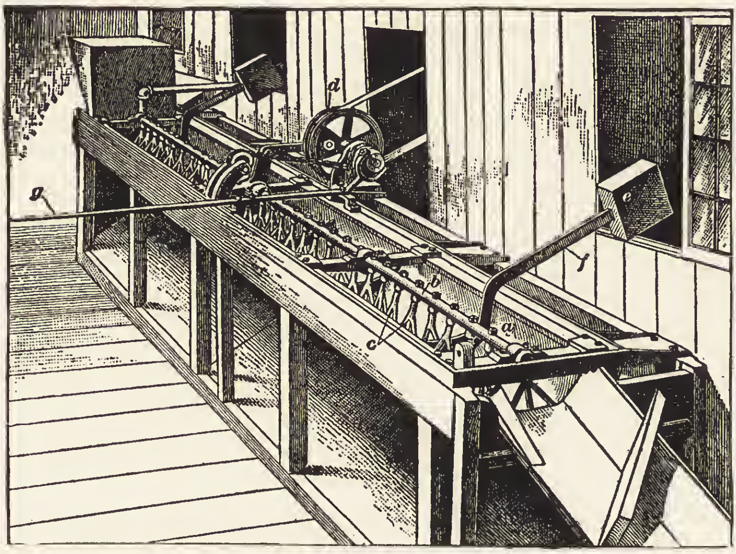

FIG. 8. SCAIFE TROUGH WASHER.

COAL WASHING.

The Scaife Trough Washer.[21]—This machine has been successfully used for a good many years in washing coal. It consists of a cast-iron trough, 24 ft. long by 2 ft. in diameter, hinged along one side and supported by a cast-iron frame that can be fixed to timbers at any height (Fig. 8). The

[20] THE ENGINEERING AND MINING JOURNAL, Vol. LXXVIII, 1904, p. 904.
[21] *Mines and Minerals*, Vol. XXV, 1904, p. 223.

adjustable slope is usually set at 2 ft. in the 24 for small lump, nut and slack. Coal and water enter at the upper end. The combined action of the flowing water, the side-moving forks, *c*, operated by *d*, and the dams at the bottom of the trough, causes impurities to settle at the bottom, while clean coal discharges at the lower end. When the impurities have filled the last dam, the coal feed is turned into another trough while the water washes out the last clean coal. The first trough is then dumped by a simple operation of the hand lever, *g*, which raises and again locks the trough ready for washing. The whole operation can be done in a minute. This washer handles 75 to 100 tons of coal in 10 hours with an efficiency equal to that of the best jigs. Its absence of screens, its simplicity, durability and cheapness make it preferable to jigs where dirt and clay are abundant and water scarce.

Stewart System.[22]—The Stewart washer was designed for large capacity

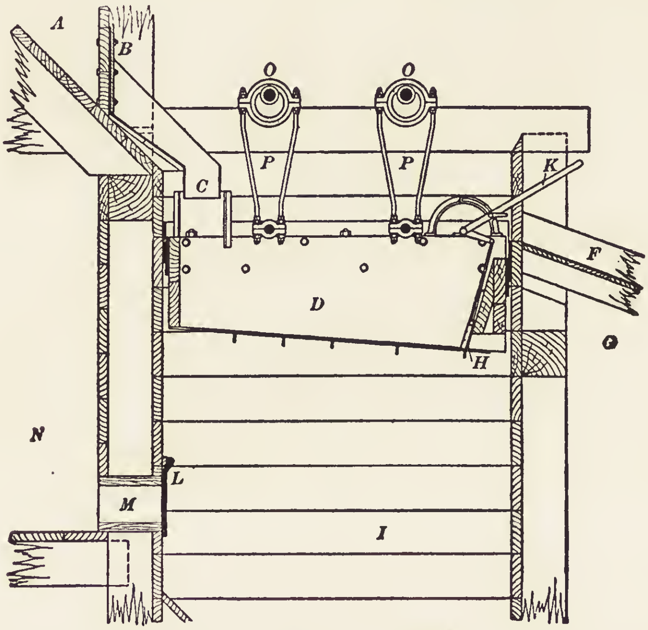

FIG. 9. STEWART COAL WASHER.

and high efficiency with small ground-space; it is of the reciprocating jig type. The coal is crushed to ½-in. cubes and under, to get the best preparation for coking, and is then stored in bin, *A*, Fig. 9. The jig-box is placed to the side and below the storage bin so as to receive the coal by gravity. The coal goes into the jig-box, *D*, through the housing, *C*, which extends down into *D*, so as to force all the coal to pass under water, thus preventing fine dust from floating over the washed coal. *D* is hung from the two parallel overhead shafts with eccentrics to give it a smooth reciprocating motion.

[22] *Mines and Minerals*, Vol. XXIV, 1903-4, p. 212.

It has a horizontal section 5 ft. by 7 ft. and is fitted, with nearly water-tight joints, into the tank, *I,* which is 12 or 14 ft. deep. The box, *D,* is bushed in on four sides by cast-iron plates planed off to make a smooth, snug fit and a practically water-tight joint. *I* is connected to a supply tank, *N,* by an opening, *M,* closed by a check-valve, L. On the up-stroke of *D,* there is an inflow from *N* to *I.* On the down-stroke, the check closes and water rises through the perforated plate forming the jig-screen. This perforated bottom slopes downward and to the front, where a sliding gate operated by *K* allows the impurities to pass out below the jig and settle in tank, *I,* whence a bucket elevator carries them to waste. The washed coal pours over the front of the jig through a chute, *F,* into a settling tank, *G,* 16 or 18 ft. square at the top and hoppered to 5 or 6 ft. square at the bottom. The water from the settling tank is pumped back into the supply tank. This continuous circulation enables the system to be used where water is scarce, additional water being needed only to replace that absorbed by the washed coal and the refuse.

The capacity of a jig is 30 to 40 tons per hour; by placing them in a row, an indefinite number may be driven from the same shafting. One man can attend to 5 or 6 jigs. For a larger plant, one man can watch the jigs, and another the rest of the machinery. For a plant at New Castle, Ala., to wash 1,800 tons of very dirty coal in 10 hours, the Stewart company guarantee less than 5% of free coal in the refuse and less than 1% of refuse in the washed coal. The cost is $2.75 for a washer man, $2.50 for an engineer, and 0.4c. per ton for oil and general repairs. The advantageous features claimed for the Stewart washer are: (1) Low first cost; (2) low cost of labor; (3) comparatively small ground-space; (4) little water required; (5) screenings washed without previous sizing; (6) loss of coal only 1.5 to 2 per cent; (7) impurities in washed coal less than 1 per cent; (8) good facilities for reducing sulphur. The following table gives an analysis of run of mine coal, treated at Sayerton, Ala., and of the washed product and tailing:

	Run of Mine Coal.		Washed Coal.	Tailing.
	Per cent.	Spec. grav.	Per cent.	Per cent.
Coal	82.6	1.33	87.9	3.8
Bone Coal	11.4	1.45	10.3	18.2
Shale	4.5	1.60	1.8	78.9
Slate from partings	1.5	1.95	0.0	

The essential difference between the Stewart jig and the Lührig jig is that the former moves its screen up and down to obtain pulsations of the water, while the Lührig and most other jigs have a stationary screen, with a piston in a separate compartment.

The following table gives analyses of coke made from unwashed and from washed coal:

	Per cent.	
	Unwashed.	Washed.
Volatile	3.85	2.75
Fixed Carbon	76.71	82.55
Ash	18.85	14.10
Sulphur	0.79	0.65

Robinson Washer.[23]—This is a cone-shaped iron tub 11 ft. high, 11½ ft. diameter at the top, and 22 in. at the bottom, the shell being of ⅜-in. plate. (Fig. 10.) At the bottom is an annular compartment, *L*, admitting water in

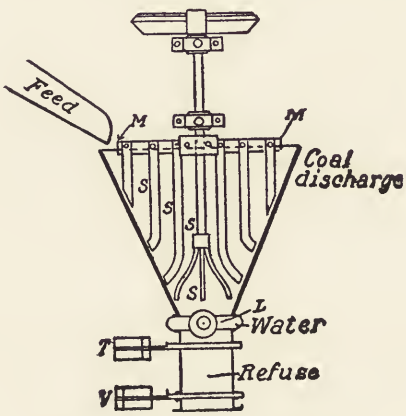

FIG. 10. ROBINSON COAL WASHER.

upward jets. In the axis of the cone is a vertical shaft with four arms, *M*, to which are attached iron stirrers, *S*. Short stirrers are also fastened at the lower end of the shaft, and the whole is revolved 10 or 15 times per minute by gearing at the top of the shaft. The motion of the stirring arms and the upward movement of the water are so regulated that the refuse settles at the bottom of the tub, while the clean coal overflows with the water through an opening at the top. The refuse is drawn off at the bottom through two gates, *T* and *V*, operated by steam. During washing, *T* is open and *V* is closed; to discharge, close *T* and open *V*. The clean coal overflows upon upward-inclined screens which drain out fine particles and the excess of water, delivering them to a Ramsay sludge-tank, while the clean drained coal goes to washed-coal bins.

Ramsay Sludge-tank.[24]—This tank, generally used in connection with the Robinson washer, is shown in Fig. 11. It consists of an iron tank, cylindrical at the top and conical at the bottom. The fine coal, with its impurities, is delivered in a stream of water on the top and at the center of the deflect-

[23] *Mines and Minerals,* Vol. XXV, 1904, p. 230.
[24] *Ibid,* Vol. XXV, 1904, p. 230.

ing plate, *a*, to give an even distribution over the entire plate. The water in the tank is quiet, so that the fine slate and sulphur fall to the bottom and are drawn off by the valve, *c*, while the pure coal overflows with the current of water into pipe, *b*, which, branching to *e*, *e*, leads to the return pumps. The loss of water is only 35 gal. per ton of washed coal. A water inlet at the top, with a ball-cock, *g*, keeps the water-level constant.

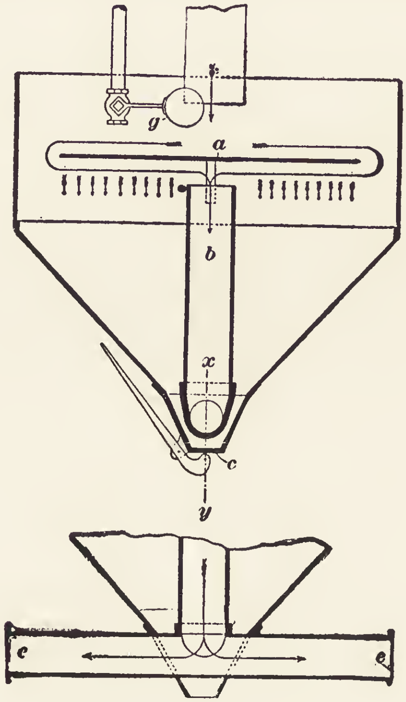

FIG. 11. RAMSAY SLUDGE-TANK.

Robinson Washery at No. 10 Slope, Pratt Mines, Alabama.[25]—A sketch of this plant in side and end elevations is shown in Fig. 12. It was designed to wash slack coal from the mine, and from other sources. The coal, of whatever origin, is dumped on shaking screens to separate lump from fine. The fine coal falls into a bin, from which a spiral conveyor takes it to the boot of an elevator, *E*, which discharges through a chute into the top of a Robinson washer, *F*, previously described. The clean coal is discharged with the overflow water upon double screens, *G*, inclined at 20 degrees, by which the excess water is drained into a Ramsay sludge-tank, *H*, while the coal is discharged by drainage conveyors into the washed-coal bin, *K*. The refuse is drawn off at the bottom into bins, whence it is carried away in cars. The capacity of this plant is easily a ton of washed coal per minute; the

[25] *Mines and Minerals*, Vol. XXV, 1904, p. 227.

system is extremely simple, but, of course, not adapted to every condition. For the separation of a pure coal from a heavy slate without other impurities, it will give as good results as any washer on the market, but when bony coal, clay, and shale are present, the separation will be imperfect, just as the promiscuous dumping of such a mixture into a single jig-washer would fail to give the best results.

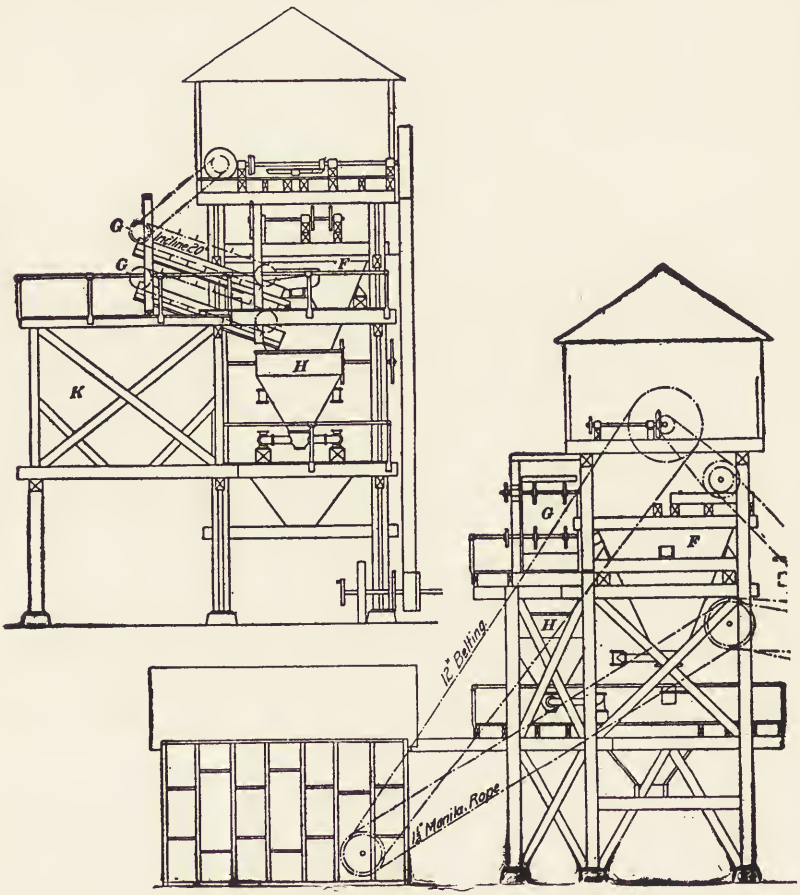

FIG. 12. ROBINSON WASHERY AT NO. 10 SLOPE, PRATT MINES, ALABAMA. (SIDE AND END ELEVATIONS.)

Coal Washing in Alabama.[26]—In December, 1904, there were in Alabama 33 washeries of a total daily (10 hours) capacity of 25,700 tons. Of these plants, 20 were on the Robinson system with a capacity of 11,600 tons, 11 on the Stewart system, capacity 12,300 tons, and two on the American jig (similar to the Stewart) system, capacity 1,800 tons. The following are results of a month's run in each of two Stewart washeries:

[26] *Mines and Minerals,* Vol. XXV, 1904, p. 227.

	Raw Coal in Tons.	Washed Coal.		Refuse.		Loss of coal in Refuse.	
		Tons.	Per ct. of raw.	Tons.	Per ct. of raw.	Tons.	Per ct. of total coal.
A......	14,403	12,929	89.77	1,474	10.23	118	0.9
B......	15,962	14,238	89.20	1,724	10.80	131	0.9

The coke produced from A contained 11.03 per cent ash, and that from B, 14.20 per cent ash.

The following are results from Robinson washeries:

Raw Coal in Tons.	Washed Coal.		Refuse.		
	Tons.	Per cent of raw.	Tons.		Per cent of raw.
			Coarse.	Fine.	
315	302	95.87	11	2	4.13
157	142	90.76	13	1.5	9.24

An average analysis for 11 days at a Robinson washery showed a reduction of ash from 9.98% in the raw to 5.78% in the washed coal. The coarse refuse contained 12.29% coal carrying 23.16% ash, and the fine refuse 16.03% of coal containing 10.06% ash. These and other results showed that the best work is done on large sizes of coal. The loss of coal in refuse was 3.4 tons out of 425 tons of material treated, equivalent to 0.8 per cent.

Campbell Washing Table.[27]—This table, of the bumping type, is shown in Fig. 13. The body is a frame 3 ft. wide by 9 ft. long supporting a curved surface over which the coal passes. The surface is curved so that the materials washed must climb a grade of ½ in. to the foot before escaping from either end of the washer. The table is suspended by four rods, *b*, *b*, giving a slight inclination in the direction of the flow of wash-water; this inclination is adjustable by the arrangement, *h*. On the curved surface are transverse riffles of galvanized iron, 2 in. wide, spaced 2 in. apart, and raised ½ in., with their edges towards the movement end of the table. Movement is imparted by the eccentric, *e*, through the cam-lever, *k*, and connecting-rod, *r*. On the forward stroke, the eccentric, *e*, pulling on the lever, *k*, which bears against the adjustable fulcrum, *o*, gives an even outward movement to the table with a smooth ending and turning. On the back stroke, the lever, *k*, bearing with its other side against the curved rocker, *n*, which gives a constantly increasing leverage, accelerates the movement of the table until it strikes the bumper-block, *p*. Springs take up undue strains on *k*. The material is fed to the middle of the table and the wash-water to the

[27] *Mines and Minerals*, Vol. XXIV, 1904, p. 371.

upper or movement end. The jarring action stirs up the bed of coal, keeps it in motion, and gradually works the heavy refuse up to and over the head end to waste. The coal is washed down to the lower end and discharged.

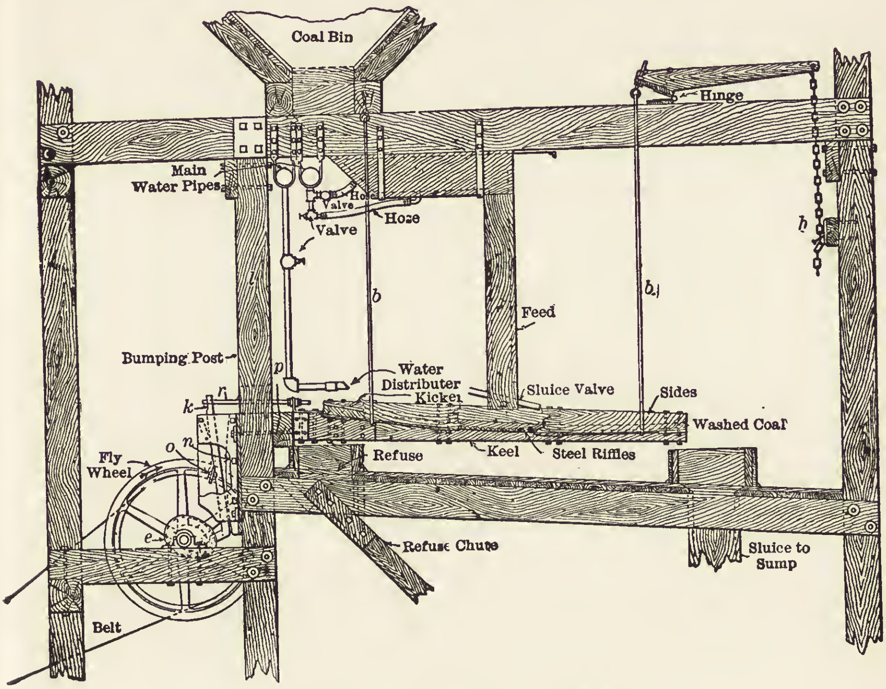

FIG. 13. CAMPBELL COAL WASHER.

Campbell Washery at Howe, Indian Territory.[63]—This coal after washing is reduced to coke in bee-hive ovens. The following is an average analysis of the coal:

	Per Cent.
Moisture	0.48
Volatile and combustible	21.35
Fixed carbon	67.95
Ash	9.25
Sulphur	0.89
Phosphorus	0.08

All the coal goes through a Williams disintegrator, which reduces it to ¼ in. and smaller, after which it goes to a dry-coal bin, *A*, at the top of the building, Fig. 14. It is thoroughly mixed with water by a hydraulic feeder and sluiced to the middle of the Campbell washers, *B*. Each washer has a capacity of 5 tons of washed coal per hour. The length of stroke varies, according to the size of coal treated, between 4 and 6 in.; the number of strokes is 60 or 70 per minute. The washed coal is discharged into launders, *N*, which conduct it to the boot of an elevator, *E*, placed at one end of

[63] *Mines and Minerals*, Vol. XXIV, 1904, p. 371.

a sludge-tank, *G*, whence the coarser sizes of coal are raised while the sludge moves slowly with the water to the other end of the tank. The fine materials settle roughly, according to their size and specific gravity. An agitator, consisting of two parallel sprocket chains connected at intervals by angle irons, moves slowly from the back to the front end close to the bottom of the tank, and gradually works the fine coal and waste to the boot of the sludge elevator, *H*, which raises the fine coal. The waste is dis-

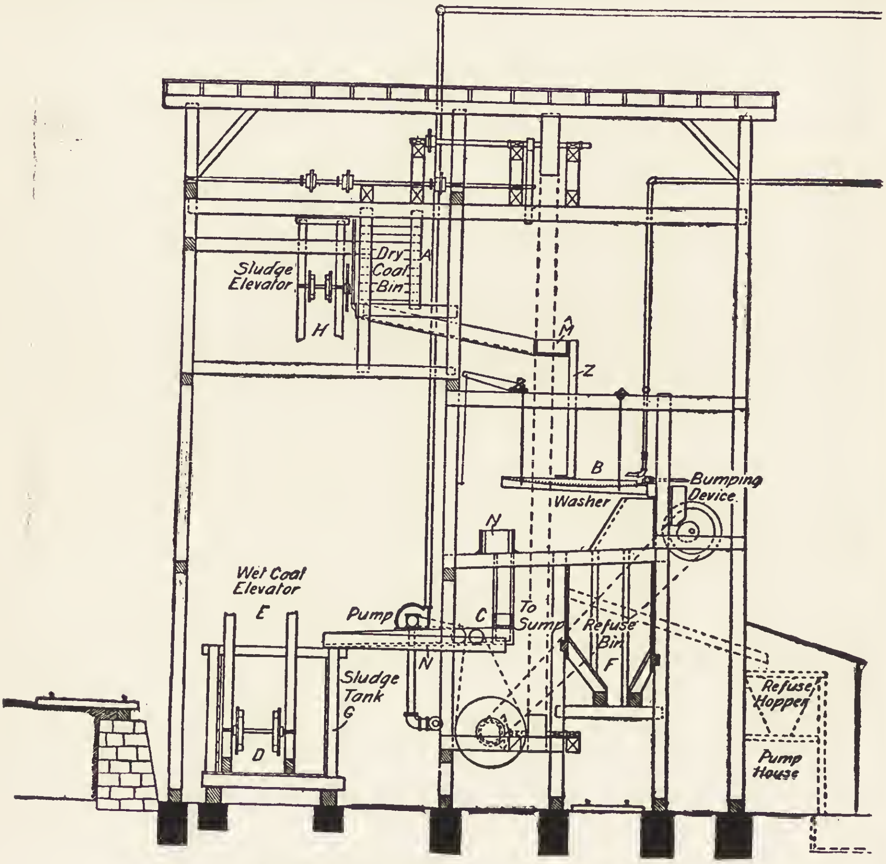

FIG. 14. CAMPBELL COAL WASHERY AT HOWE, INDIAN TERRITORY. (SECTIONAL ELEVATION.)

charged through a pipe at the bottom of the boot. From the settling tank, a large part of the water is raised by a centrifugal pump and is used again. The elevators take the coal to storage bins, whence lorries carry it to the ovens. The waste from the washers goes into the refuse bin, *F*, below which is a track for waste-cars.

Campbell Washery at Sydney, Cape Breton.[29]—The Dominion Iron & Steel Company is using Campbell tables to wash slack for coke-making. The

[29] *Journal* of the Mining Society of Nova Scotia, Vol. VIII, 1903-4, p. 101.

raw coal is received in sizes up to 1 in., and is reduced by grizzlies and rolls to ¼ in. and less. It is then elevated to long bins in the top of the building, whence adjustable chutes take it to the washers. At the head of each of these chutes water is added to sluice the coal. Each table has a capacity of 5 tons of washed coal per hour; the refuse, including the coal carried off with it, amounts to 4%, so that 52 tons of raw coal is the work of one table for a 10-hour day. The raw coal contains 6.5% ash and 2% sulphur. The washed coal carries 3 to 4% ash and 1.2 to 1.4% sulphur. The refuse contains 40 to 45% sulphur and 35 to 40% coal, which means a loss of 0.7 or 0.8 ton of coal per table per day. To utilize this coal, the coal content of the waste is permitted to increase to 6%, thus obtaining a purer coal for coking; the refuse is then roughly re-washed, giving a product carrying 3 or

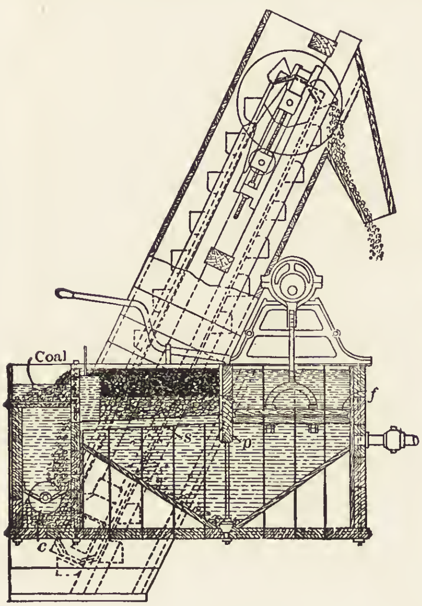

FIG. 15. NUT-COAL JIG.

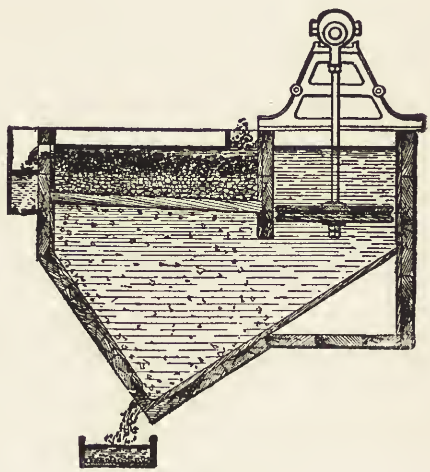

FIG. 16. FINE-COAL JIG.

LUHRIG JIGS.

4% sulphur, much slate, and 60 to 70% of coal, which can be used as fuel at the plant.

The Lührig Jig.[30]—This is a rectangular box, Fig. 15. If the capacity of the plant requires a number of jigs, the box is made long enough to divide into as many jigs as desired. In the center of the front, just above the jig-screen, is an opening, regulated by a slide, through which the refuse works its way to a compartment in which a screw-conveyor, *c*, pushes the refuse to one end and into an elevator. The coal overflows into another compartment at the foot of the jig. For the treatment of fine coal, a jig-bed of uniform-size feldspar is provided, through which the waste descends, being

[30] *Mines and Minerals*, Vol. XXII, 1902, p. 366.

drawn off at the bottom, instead of above the screen. The fine-coal jig is shown in Fig. 16.

The Lührig System of Coal Washing.[31]—The coal is first sized and each size is treated separately on a jig specially adjusted for it. Two classes are made: the nut coals, 1, 2, and 3, and the fine coal, that passing through ¾-in. holes. The nut coals go through their respective jigs, then upon bumping screens, where the excess of water is drained, and finally to shipping bins. The refuse from the nut-coal jigs is disposed of by elevators.

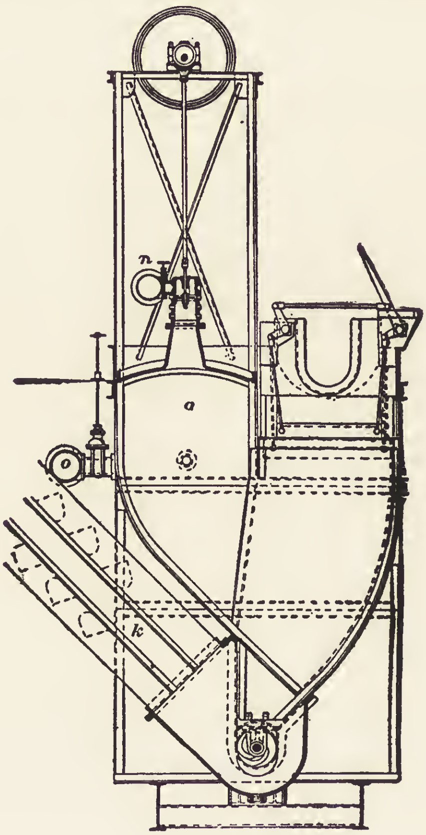

FIG. 17. BAUM JIG.

The fine coal, under ¾-in., is sluiced into a V-shaped grading-box where, with diminishing water-velocity, the coal is classified, and each class treated in a separately adjusted jig. The fine coals are all re-mixed after washing and are sluiced into the boot of the fine-coal elevator. From this the water drains into the sludge-tank, which receives also the hutchwork and the water from the jigs. This tank is 75 ft. long and has a conveyor running its whole length. At one end is a sump serving as the boot of the elevator, and from the other end is withdrawn the clearer water for re-use. The velocity of the

[31] *Mines and Minerals,* Vol. XXII, 1902, p. 366.

water is sufficiently low to allow the fine coal to settle. The only water lost is that carried away by the wet coal.

The Baum System.[32]—In the systems just described, the procedure has been to classify and then to wash, but in the Baum system this is reversed, resulting in a cheap and elastic system suited to almost all kinds of coal. The pulsating motion in the Baum jig (Fig. 17) is obtained by compressed air (4 ft. water gauge) which bears upon the water surface in the main compartment, *a*, giving a movement more elastic and yet more energetic than that obtained from a piston. The result of this pulsating movement of the water through the jig is to classify the coal, fed upon the screen, *s*, into layers according to specific gravity, the heaviest at the bottom. The bottom layer of shale is removed through openings at each end of the screen, the height of the openings being regulated by gates worked by the levers, *g*.

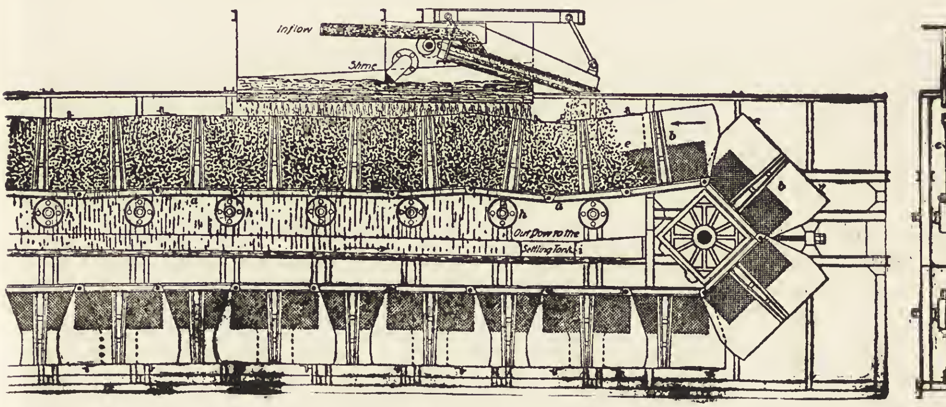

FIG. 18. BAUM DRAINAGE PLANT.

After passing through these openings, the shale has to go over a dam whose height is regulated by other levers; it then falls to the bottom of the jig, whence it is carried by screws, *c*, to an elevator, *k*. The wash-water and the washed coal are discharged, at *f*, into a trough which leads to a large trommel, making as many products as desired. The sized coal is then conveyed to the separate bins.

An important adjunct of the Baum system is the *draining plant*, Fig. 18, which is designed to reduce to a minimum the water in the washed coal, and to clarify it at the same time. The plant is essentially a strong conveyor composed of perforated bottom and side plates, hinged together; each bottom plate carries at its middle a vertical hollow partition, *b*, formed by two perforated plates, the whole thus resembling a string of perforated boxes hinged together. The feed goes over fine sieves, which allow the water and the fine coal to pass through while the coarser coal slides at once to the conveyor at *e*. The fine coal follows at *f*, covering the coarse coal and affording

[32] *Mines and Minerals*, Vol. XXV, 1904, p. 213.

the best conditions for draining. As the conveyor moves forward, it sags between the rollers, *h,* and the partitions, *b,* squeeze the water from the coal. The water is led to a settling tank.

Washery at Aldridge, Park County, Montana.[33]—Owing to the steep dip of the coal measures and to the method of mining, the coal contains a large proportion of foreign matter, mainly fireclay, slate and bony coal, which it is impracticable to pick out by hand. The clean run of mine coal is very friable; 74% passes through an 8-mesh sieve and contains 15.7% ash; 16% is between ½-in. and ⅛-in., with 25.6% ash; and the remaining 10% is coarser than ½-in. and has 40.8% ash. The mines and washery are at the top of a mountain and the washed coal is flumed down to coke ovens below. The run of mine coal is received at a bin from which a link-belt conveyor feeds it to a breaker, which reduces it to ½-in. or under. It is then flumed into two hydraulic classifying boxes, from which the grades pass to two batteries of feldspar jigs, where they are washed and cleaned. The clean coal from the front of the jigs goes to a draining screen of 8-mesh copper-wire cloth. The coal is rinsed with clear water and what passes over the screen is flumed down the mountain. What passes through the screen drops into a settling tank, whence the coal is recovered by regular sludge methods, and is delivered by elevator to the flume down the mountain. The refuse from the feldspar jigs goes to four re-washing jigs, which give a middling product that is used in the boiler room. On occount of the fireclay the wash-water is run into a lake, every other day, to settle, and the tanks are filled with fresh water. From the run of mine coal, carrying originally 28% ash, are obtained 61% of coking coal carrying 10 to 11% ash; 3% of middling used for plant fuel, with 18 to 20% ash, and 36% of refuse carrying 60 to 68% ash. The plant supplies 150 ovens. Although the coke is high in ash, it is of good quality and finds a ready market on account of prohibitive freights on outside cokes.

Coal Washing at Segundo, Colorado.[34]—The Colorado Fuel & Iron Company has installed at Segundo a washing plant similar to the one at Sopris, described in THE MINERAL INDUSTRY, Vol. VI. (1897), p. 717, with Stedman disintegrator and Forrester jigs. The two washeries, one right- and the other left-handed, have a total capacity of 2,000 tons per day. The boiler plant consists of 10 return-tubular boilers of 100 h. p. each, with forced draft. The power for each washery is furnished by a 22 by 42-in. Corliss engine at 85 r. p. m. The raw coal, after crushing to 1 in., consists of 20% nut carrying 19.12% ash, 30% pea with 12.33%, and 50% slack with 11%, an average total of 12.97% ash. The average of the washed coal is 9.05%, so that it scarcely pays to clean the slack, and it is often run past the jigs without washing. About 1½ tons of washed coal produce 1 ton of coke, averaging 16% ash and having a crushing strength of 1,820 pounds.

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[34] *Mines and Minerals,* Vol. XXIII, 1904, p. 4.

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KAOLIN, OR CHINA CLAY.

BY J. H. COLLINS.

Kaolin, the purest and whitest varieties of which are commercially known as 'china clay,' is a decomposition product of various alkaline-earthy silicates, and particularly of orthoclase or albite feldspar. For commercial uses china clay is usually obtained by washing a variety of decomposed (and often disintegrated) granite, which is sometimes called *carclazite,* from its occurrence at the old Carclaze pit in Cornwall. In this the feldspar crystals, though often retaining their original form, have been more or less completely converted into kaolin. When the kaolinization is complete, or nearly so, the rock itself is locally termed 'clay'; when it is less complete, if there is an absence of objectionable elements in the other components of the rock, the mass is wrought and sold for use in the potteries as so-called china-stone (or petuntzite).* Carclazite occurs in many parts of the world, but is so abundant and so conveniently situated in the west of England that, excluding China and Japan, the greater part of the world's supply is at present drawn from that locality.

It is found that this kaolinization extends over very considerable areas, particularly around Hensbarrow Beacon in Cornwall and at Lee Moor in Devon; its persistence in depth, though certainly great, is as yet unknown. At the Beam mine, china clay was found in the neighborhood of the lodes at a depth considerably exceeding 90 fathoms from surface, and at Balleswidden more than 150 fathoms. All the more important clay 'deposits' are traversed by, and closely associated with, veins of quartz and black tourmaline or schorl, the greatest horizontal extension of the kaolinization coinciding with the course of the veins. These veins are often found to contain small quantities of cassiterite, which occasionally becomes an important by-product.

Except locally, in gullies and ravines where denudation has been rapid, the clay-ground, in common with the hard ground in the immediate neighborhood, is usually covered with an overburden consisting of stony fragments of the neighboring rocks embedded in sand and clay and passing by imperceptible gradations into the workable clay itself. The thickness of this overburden is an important consideration in fixing upon a site for work, as it has to be entirely removed before clay can be won; in general, its thickness varies from two to four fathoms, but in a few cases clay has been wrought, after the removal of overburden, to a depth exceeding seven

* These are the rocks which were formerly known as protogine, and supposed to be talcose, i. e., magnesian. See the author's 'Nature and Origin of Clay,' *Mining Mag.,* 1888.

fathoms. The considerable thickness of the overburden does not altogether obscure the position of the kaolinized rock beneath; the situation of the 'clay' is usually indicated, to the practiced eye, by a slight depression of the surface, which is quite distinct from its larger sculpturings. To these depressions, and to the masses of clay ground beneath, the local term 'slads' is applied, a word which, not being open to the objections which apply to the terms 'deposits' and 'beds,' might be generally and conveniently used in this connection. Sometimes china clay has been traced for distances of a quarter of a mile or more in the direction of the quartzose and schorlaceous veins already mentioned, while the breadth may be only a few feet, or even a few inches, but occasionally may reach several fathoms. Where wide masses of china clay are wrought, these are found to be associated with many more or less parallel veins of the kind mentioned. The breadth of the decomposition does not, however, seem to bear any precise relation to the size of the vein, a mere thread being occasionally bordered by a considerable band of kaolinization; but the direction of the decomposed band is distinctly governed by that of the vein. Occasionally carclazite passes into petuntzite in depth, more frequently in lateral extension. In a few instances petuntzite has been found which passes into carclazite in depth. Seen at a short distance, there is little difference in the appearance of these two rocks.

The methods generally adopted for the working of china clay were pretty fully described by the present writer nearly 30 years ago in a work now out of print.[1] Except as regards the much greater extent of the operations as seen at present in the principal works, there is little modification required in the description. In brief outline, the most approved plan may be given as follows: The depth of the overburden and the extent of the workable clay-ground having been sufficiently ascertained by pitting or boring (often by a combination of both methods), a shaft is sunk in the firm rock, near the clay which is to be worked, and to a depth of 15 or 20 fathoms. A crosscut is put out from the bottom of the shaft into the clay ground. This must be securely timbered where it approaches the clay ground. The overburden having been removed and deposited at a convenient spot, a raise is put up vertically through the clay to the surface. In this is placed (vertically) a wooden launder, which reaches within a fathom or two of the surface, and is provided with lateral openings a foot or two apart, each of which is closed by a temporary wooden cover. This is called a 'button-hole' launder. The shaft having been equipped with a suitable pump, work may be begun at once. The clay ground, to a depth of a fathom or so around the button-hole launder, is removed and a stream of water, pumped from the shaft or brought along from some other source, is made to flow over the broken ground, which is at the same time stirred up as may be necessary. The fine clay particles, held in suspension in the milky stream, pass down the launder and along the crosscut to the shaft, whence they are pumped up for

[1] 'The Hensbarrow Granite District,' a geological description anda trade history. Truro, 1878.

further treatment. The quartz grains ('sand') and the coarser particles of mica, schorl, etc., are shoveled up from around the launder and trammed away to the waste-dump. As the depth of the workings increases, other 'button-holes' are opened, the inclination of the clay 'stopes' being at the same time maintained by removing more overburden and by cutting away the margin of the pit, as indicated by the dotted lines in Fig. 1.

The clay raised in suspension from the shaft by the pump is made to flow through a long series of shallow troughs called 'micas'; these are set nearly level, and the stream is divided again and again so as to lessen the rate of flow and to allow the fine sandy and micaceous particles to settle. Finally the refined clay stream is led into circular stone-lined pits, preferably from 12 to 18 ft. deep, where the clay settles to a creamy consistency,

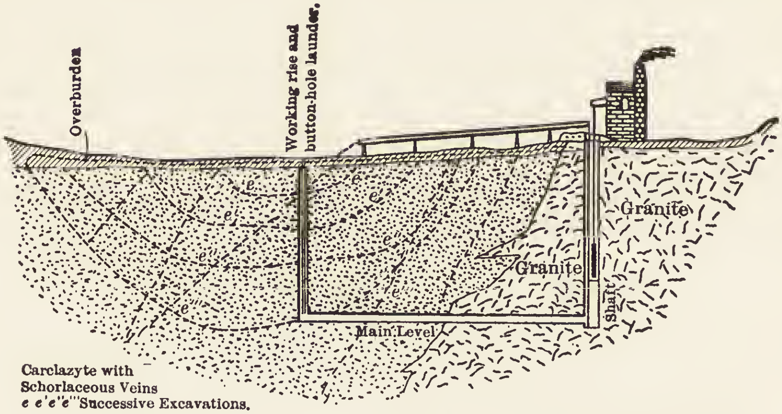

FIG. 1. SECTION SHOWING NORMAL METHOD OF OPENING UP A CHINA-CLAY PIT.

while the overflow of nearly clear water is conducted back to the clay stopes, where it again serves for the washing process. The deposit in the 'micas' is swept out from time to time, an operation which occupies only a few minutes, after which they are again ready to receive the clay stream. The thickened clay from the pits passes to large stone-built or stone-lined tanks, which are from 5 to 8 ft. deep. In many cases they consist merely of two dry-built rubble walls placed as far apart as the depth of the tank and puddled between with waste sand, containing a little clay from some previous working. From the tanks, after further settlement, it is trammed into the kiln or 'dry.' The deposit in the micas is sometimes re-washed, so as to yield an inferior product, which is commercially sold as 'mica' or 'mica-clay.'

Carclazite varies much in productiveness; in obtaining one ton of fine clay the following by-products have to be dealt with: From 3 to 7 tons of sand, average 4 tons; 2 to 5 cwt. of coarse mica, average 3 cwt.; 1 to 3 cwt. of fine mica (mica clay), average 2 cwt.; 1/4 to 1 cwt. of stones, mostly quartz, with, generally, much 'schorl' from the stony veins or branches. A cubic fathom of carclazite of good quality will yield about three tons of fine clay; on an average nearly half a cubic fathom of overburden must be removed in order to get it.

The drying kiln or 'dry' usually employed affords some features of interest. As built at present, the length varies from 120 to 200 ft.; the drying-floor or 'bed' is from 12 to 15 ft. wide; there is a linhay or store-shed along its whole length and under the same roof as the bed. The fireplaces at one end widen from the door inward toward the flues; these are constructed of firebrick, which is locally made from the refuse sand and clay. The flues are placed side by side, separated only by walls of firebrick 4½ in. thick. They are covered with fire-tiles so as to form the 'pan' of the 'dry.' A common size for the tiles is 20 in. by 12 in. At the fire end a thickness of 4 in. or more is often employed; at the stack end 2½ in. is usually found sufficient. The general arrangement is shown in cross-section in Fig. 2. All

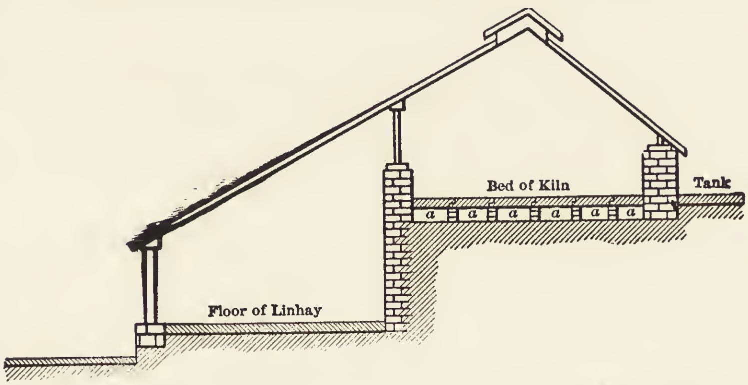

FIG. 2. CROSS-SECTION OF KILN, LINHAY, ETC. *a, a, a*, FLUES. SCALE ABOUT 14 FT. TO 1 IN.

the flues open into a stack of stone or brick, which is commonly from 30 to 40 ft. high, but in some cases more. Sometimes the creamy mass of clay from the tanks is simply run in upon the dry pan and spread with shovels or rakes; but usually the 'loading' of the dry is effected as follows: The tanks being paved with stone, there is no difficulty in running tram-wagons wherever they may be required without using rails, though sometimes an easily moved track is employed. The stiff, pasty mass of clay is shoveled into the wagons, which are then run on to a traveling 'bridge,' which moves along rails fixed on each side of the dry pan. At suitable intervals the clay is tipped out on to the 'pan' and spread with shovels. A good fire being maintained in the fireplaces, in 24 hours at the fire end, and somewhat longer at the stack end, the clay is found to be sufficiently dried. A little before this the attendant scores the drying mass across into squares with the edge of a shovel. This facilitates its breaking into rectangular blocks of convenient size, which can be readily lifted and thrown into the linhay when the drying is completed. In a few works air-drying is still in operation, the stiffened clay being taken from the tanks and laid in lumps on the ground in the open, or upon shelves in sheds which are open at the sides. This method requires more space and involves more hand-labor. There is, furthermore, a great degree of uncertainty in an operation which depends so much upon the weather, and this would generally be fatal to the regular filling of large contracts; however, the total cost per ton of finished clay is said to be less for air-drying in a good season than with kiln-drying.

The sale value of the dried clay at the works varies from $1.75 up to about $5.50 per ton, according to quality. Freights to the shipping ports will add to these figures. The greater number of works are situated several miles from a shipping port and some distance from a railway siding, while they are also at a considerable elevation above the railway. In such cases it has become common practice to acquire sufficient space for tanks and drys at some convenient point, close either to a railway or to a shipping port, and to convey the thick clay-water from the pits to the tanks and dry by means of a pipe-line, which may be either of earthenware, steel or light cast iron; and may vary from 6 in. to 12 in. in diameter, according to the head and capacity desired.

The cost of producing china clay may vary as follows: Removing overburden and sand, $0.12 to $0.50 per ton of clay; clay-getting, $0.75 to $1.25; drying, $0.50 to $0.75; pumping and maintenance, $0.12 to $0.50; royalty, $0.12 to $0.87; rents, rates and taxes, $0.06 to $0.25 per ton of clay.

There must, of course, be a combination of favorable conditions before such a low-priced product can be made to pay, among which the following are obviously of vital importance: Overburden not too thick; workable area not too small; clay not too sandy; rents, royalties and taxes moderate; cheap and effective labor; a sufficient water supply to compensate for evaporation and other losses; fuel at moderate rates; convenient ground for débris; shipping port not too distant. These combined conditions obtain over a considerable part of the west of England, better perhaps than in any other known region—at any rate, outside the Chinese Empire.

The working of petuntzite is a very simple matter; in some cases the stone is merely broken down in the quarry, the lumps scabbled over with a stone-axe, to remove the discolorations which are often found in the joints, and so sent to market. In this condition it realizes about $4 per ton f. o. b. Frequently, however, the lumps are broken to road-metal size, and ground with water in mills consisting of chert 'runners' working on a chert bed, a sort of arrastre arrangement. The fine white mud thus produced is settled in pits and dried, like the clay. In this condition it is worth from $5 to $7 per ton f. o. b.

The Cornish china clay and china stone were first brought into use by William Cookworthy about the year 1760; they had been previously reported upon and condemned by an 'expert' employed by Dr. Borlase, the historian-naturalist. The quantities used even fifty years after Cookworthy's time were very small, but the industry has now become one of the most important in the west of England, the steady growth of which is well shown by the following figures, which are partly estimated for the first half of the nineteenth century, but taken from fairly complete official reports since about the year 1860:

Period.	Tons.	Value.
1801—1810	30,000	60,000
1811—1820	40,000	70,000
1821—1830	115,000	90,000
1831—1840	180,000	110,000
1841—1850	580,000	400,000
1851—1860	860,000	580,000
1861—1870	1,038,114	690,000
1871—1880	2,093,012	1,400,000
1881—1890	3,574,000	2,507,000
1891—1900	4,988,026	3,147,931
Total	13,498,152	9,054,931

Of this large quantity, probably a little over 1,250,000 tons were china stone, the remainder china clay. For the completed years of the present century the figures can be given with somewhat more of detail:

	Tons.	Value.
1901 China Clay	517,568	£332,310
" Mica Clay	3,165	1,266
" China Stone	59,923	25,074
Total	580,656	£358,650
1902 China Clay	546,014	£380,772
" Mica Clay	8,542	3,047
" China Stone	57,882	26,451
Total	612,438	£410,280
1903 China Clay	546,392	£362,278
" Mica Clay	13,197	5,578
" China Stone	53,680	21,635
Total	613,269	£389,491
1904 China Clay	583,984	£390,200
" Mica Clay	7,140	4,500
" China Stone	66,994	28,000
Total	658,118	£422,700

The figures of value for 1904 are approximations only.

As regards the uses of china clay, it was at first employed only in the manufacture of fine pottery; it is now extensively used by 'bleachers' for 'dressing' cotton cloth, by paper makers, chemical manufacturers and others (mica clay being similarly employed), as also for mixing with fire-resisting compositions.

ALASKA.*

BY ALFRED H. BROOKS.

Those who have expected a rapid increase in Alaska's mineral output will be disappointed. It must be remembered that exploitation is much slower than in more accessible regions; and, unless another Klondike be found on the Alaskan side of the boundary—an unlikely event—the mineral production will increase but slowly.

The value of the gold output for 1904 will probably be about $9,000,000, showing an increase of $500,000 over 1903. Of this amount a little over one-third is produced by lode mines, chiefly by the Treadwell group. The placers of the Seward peninsula contributed between four and four and a half millions, the Yukon about a million, while the balance comes from the smaller placer camps.

The mines of Southeastern Alaska produced a small quantity of silver, about $30,000. One copper mine on Prince William sound has continued regular shipments of ore to Puget sound smelters, and a few tons have been shipped from other mines. Some stream tin has been exported from the York district. Beside the metals, a few thousand tons of coal are annually mined for local use. Among mineral resources hitherto unproductive are petroleum, for which the prospects are still good; also marble and gypsum, in Southeastern Alaska.

Lode mining, except for the Treadwell group, is still unimportant, but it is undergoing steady development. At the Treadwell, a depth of 1,000 ft. has been reached, while the width and value of the ore are maintained. The half dozen properties tributary to Juneau on the mainland have continued at work, but the extensive developments anticipated have not been pushed. There has been active prospecting at Windham bay, 40 miles south of Juneau; the mine at Snettisham has maintained a small production; but at Sumdum operations have ceased. Between Juneau and Berners bay, auriferous lodes at several localities are promising, and their development is progressing favorably. Probably the most important event in the Juneau district is the crosscutting of the gold-bearing vein of the Kensington mine, at a depth of 800 ft., on Berners bay; current reports indicate that this will become an important gold producer. The Jualin and neighboring mines have continued productive, without developments of moment.

On the islands west of Juneau prospecting continues. The apparent collapse of a large, ill-advised enterprise on Rodman bay is a noteworthy event; it appears to have been the result of large investment in equipment

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before a workable orebody was opened up. In the Wrangell district, south of Juneau, the single producing gold mine closed down. There are a number of prospects; some of these yield chalcopyrite and pyrrhotite in commercial quantities; others contain gold and silver ore. To the south is the Ketchikan district. Though this region first attracted attention some years ago as a prospect for gold and silver lodes, more attention is being given to its copper, which deposits are yet unproductive. Several gold veins were worked in a small way during 1904. Of more import, however, is the systematic development of a copper property at Niblack Anchorage, on the east side of Prince of Wales island. Kasaan peninsula, 20 miles north, is also the scene of active development of copper properties, and on its north side a 400-ton smelter has been erected. Another smelter, with a capacity of 250 tons, has been erected on the west side of Prince of Wales island, to treat the ore of the Copper Mountain property. In the latter a tunnel is being driven, destined to cut the orebody 1,100 ft. below its outcrop.

Lode mining is practically confined to Southeastern Alaska. The Gladhaugh mine, on Prince William, is the only copper mine in Alaska that has reached the productive stage. The ore is chalcopyrite and the mine, being on a good harbor open throughout the year, has the same low freight rates that are enjoyed by the tidewater mines of Southeastern Alaska. The same district contains other bodies of copper ore, many of which were prospected. The Apollo mine is on Unga island; it has been a large producer in the past, and after several years of small production is reported to have taken a new lease of life. The ore is free milling. The Big Hurrah quartz mine, about 40 miles east of Nome, has attracted attention, because it is the only lode deposit in this placer district that has reached the productive stage. It appears to be an example of the success possible to careful management, even under adverse conditions. The capacity of the mill has been increased to twenty stamps, while the mine workings have reached a depth of nearly 150 ft. The attention of mining men at Nome has been given mainly to the placers, with their promise of sure and quick returns, and but few attempts at lode prospecting have been undertaken by experienced men. Many abortive attempts at lode exploitation have resulted; these are rather on the increase.

Tin-bearing gravel is being exploited on Buck creek, in the York region, and small shipments have been made. No deposits seem large enough to warrant extensive operations, though, with the wide distribution of stream tin, it is possible that such may be found. For lode deposits the outlook appears more hopeful. Prospecting in the Lost River region has developed good surface showing, which, if maintained in depth, will become profitable. At Cape mountain, some drifting has been done along the periphery of a granite mass. Ore of low grade has been found, besides some richer material. Tin bodies are also reported at Ear mountain. All this goes to show that there is a legitimate field for the tin prospector, though the outcome cannot yet be predicted.

The placers of Alaska produced between $5,500,000 and $6,000,000. Of this, about $4,500,000 came from the Seward peninsula, $1,000,000 from the Yukon district, and the balance from the Cook Inlet, Copper river and Juneau regions. Placer mining in the Seward peninsula was hampered by a dry season; work by small operators was, in many instances, entirely interrupted, while none of the ditches could furnish the expected supply of water. Throughout the peninsula there has been feverish activity in ditch construction; as a consequence, a number of ill-conceived enterprises have been inaugurated. Many appear to believe that it is impossible to mine placers without ditches and hydraulic elevators. Miles of ditches have been constructed for the purpose of hydraulicking shallow gravel-beds which could be more economically mined by other methods. The companies suffer from bad management; there are relatively few experienced mining engineers in the entire district, fully 50 per cent of the enterprises being in charge of men who are utterly unfit. Some have come from the placer fields of California, and these, when they have adapted themselves to the new conditions, are usually successful, but large sums of money are being squandered by men of no experience.

As the Seward peninsula opens up, the transportation problem becomes more serious. All freight must be landed on the beach with lighters, at a cost of $5 per ton, while in the late summer and fall, storms often interrupt traffic. During dry seasons it is possible to haul good loads with horses to almost any point in the peninsula, but a rainy season makes the country almost impassable for wagons. The Nome Arctic Railway gives adequate service to the creeks that it touches in its nine miles. The Council City and Solomon River Railway is steadily pushing its construction inland and, at the close of the season, had about 16 miles of track completed; this railway, when finished to Council, will open up a region well nigh inaccessible under present conditions.

The practice of mining deeply buried pay streaks by drifting is increasing. Most of this work is done in winter when there is no surface water to contend with, and when wages are 50 per cent less than in summer. The dumps, accumulated by winter mining, are sluiced in the spring, when the thawing of the snow assures a water supply; by this means probably over $1,000,000 was taken out during the winter of 1903-1904. A significant feature of recent development is the successful operation of a steam shovel on Anvil creek, by the Pioneer Mining Company. It appears that the steam shovel will find more extensive use in the future, though it is not applicable to frozen ground. Several companies have been formed to exploit the gravel plain, or 'tundra' placers, lying within a few miles of Nome. These placers are rich, but up to the present they have been worked only in a small way, either by rockers and hand shoveling in summer, or by shafting and drifting in winter. The problem of extracting gold from these deposits, which lie at or below sea level and frequently in frozen ground, is not an easy one; steam shovels have to be preceded by stripping and thawing, while hydraulic methods involve a large outlay for ditches, and the use of elevators for the disposal of tailing. Late in the fall some phenomenally rich placers were found on Little creek, a stream which flows across the tundra near the base of the highlands. This occurrence has been interpreted by some to mark the former course of Anvil creek, but the coarseness of the material would indicate a local source of the gold; its importance lies in the fact that the possibilities for new discoveries have not been exhausted, even in the region close to Nome.

Beside the operations immediately in the vicinity of Nome, there has been activity on Osborn creek, east of Nome river, and in the Penny river region, west of Snake river. Hydraulicking was also done on Dorothy near the head of Nome river. Deep mining during winter was pushed in the high-bench gravel of the Anvil-Dexter divide; eventually this whole mass, in places over 100 ft. deep, will be removed by hydraulic methods, but in the meantime the rich pay streaks are being followed by drifting. This method is made expensive by the fact that the pay streaks are exceedingly irregular in their course, and much labor is lost in attempting to trace them.

In the Solomon river region developments have been rapid, stimulated by the construction of the Council City and Solomon River Railway. Three or four long ditches have been built, and several smaller ones are in operation on Shovel creek. Two dredges have been operated throughout the season on the main river and hydraulicking was done on a number of claims. Winter work was more extensive than during any previous season. The completion of the railway, as planned, will make accessible the extensive gravel deposits of the Casa de Paga. These were abandoned by the pick-and-shovel men over three years ago for want of transportation facilities. Some large enterprises have been planned for this district, which promises to become an important producer.

Across the divide to the northwest are the Iron creek placers, which continue to be productive, despite difficulty of access. The Topkok Company has extended its ditch to obtain more water. This enterprise is successful by reason of cheap hydraulicking.

The Council region is progressing. Ophir creek has been the steadiest gold producer, and still contains a large reserve of gravel. The company operating the dredge on the Niukluk river went to pieces before the profitable exploitation of these fluvial placers had been demonstrated.

The Bluestone and Grantley Harbor regions, northwest of Nome, continue to make a fair output.

In the Kugruk region more activity was displayed, two ditches having been completed and several more started.

The Fairhaven district, including the northeastern portion of the Seward peninsula, is isolated, and consequently progress is very slow. Miners are here at work under the most adverse conditions, and yet exploitation of some of the placers has been profitable. Despite scarcity of fuel, winter work was carried on. Among other ditch projects, surveys have been made which contemplate the tapping of Imuruk lake and hydraulicking the bench gravels along the Inmachuk river.

A broad belt of mineralized rock stretches westward from the international boundary near Dawson to the Yukon below the Arctic Circle. Gold has been found widely distributed in the stream gravels, and scores of creek placers are productive. With the development of the region the rapid journey and careless search of the pioneer is succeeded by the systematic prospecting of the trained miner, and often with ample reward. It is no uncommon occurrence for placer gold to be found in stream gravel which was prospected and abandoned a decade ago. There is always the hope that another Klondike will be discovered. Nor is this hope altogether vain, for the same conditions repeat themselves on the Alaskan side of the boundary which are found in the famous Canadian district.

Meanwhile, well established districts, such as Fortymile, Birch creek and Rampart, continue to produce from $150,000 to $200,000 each year. The Fortymile district supported a mining population of over 500 men, and produced about $175,000. This has been chiefly taken from Chicken, Wade and American creeks and from Discovery and Walker forks. Unfortunately, the one attempt at large scale operation, which had for its purpose the exploitation of the river gravel at the 'Kink,' was ill advised, and work has ceased. Plans have been formulated for bringing water, under heavy head, to hydraulic the benches on Chicken creek.

The Birch creek district proper has made little progress and the output is about the same as that of Fortymile. Scarcity of water and low stream gradients hinder hydraulicking, nor has the presence of rich bench gravel been established.

Placer gold has been found in the Beaver creek basin, about 50 miles northwest of Birch creek and about 20 miles from the Yukon. This discovery was made by a small party of prospectors late last August, but there was not time to reach bed-rock before the season closed. A number of men are wintering in this district, and more definite evidence will be available in the spring.

The Fairbanks placer district, because of the increase of its output from $40,000 in 1903 to about $400,000 in 1904, has become the focal point of popular interest. This gold has practically all been taken from three creeks—Pedro, Cleary and Fairbanks—and their tributaries, but pay gravel has been reported from a dozen other streams. Roughly outlined, the present known gold-bearing area embraces at least 500 square miles, and is about equal to that of the Klondike. The producing creeks all lie within 25 miles of steamboat navigation on the Tanana, and the topography is such that railway and road construction will not be expensive.

Fairbanks, a town of several thousand inhabitants, situated on a slough navigable for large steamers only at high water, is the chief supply point, while Chena, a smaller settlement, is on the main Tanana river. These places are about equally distant from the gold-producing creeks. At the close of the season freight rates ranged from 10 to 20c. per pound, the winter rates being about one-quarter of this.

The district is connected by military telegraph with Seattle, and telephone lines are being installed which will afford direct communication with the creeks. Railway supplies were shipped into the country in the late fall, and the promoters contemplate the connection of the settlements on the river with the creeks by a narrow-gauge line. Fairbanks can be conveniently reached via Dawson by steamer during the open season from about the middle of June until the middle of September. Freight and passengers can also be carried to Fairbanks by way of St. Michael, though this route will take a little longer. A winter dog trail has been established from Valdes to Fairbanks by a route about 275 miles long.

Pedro, Cleary and Fairbanks creeks are all less than 10 miles in length and carry 100 to 200 inches of water, with gradients not over 100 ft. per mile. The gravel is usually frozen to bed-rock. All development has been confined to the creek beds, or to low benches; as, in adjacent regions, gold has been found in high gravel, it would appear that the prospector might well search for high benches in this district also. On Pedro creek the gravels are 8 to 30 ft. deep, the pay streak is 1 to 4 ft. thick and 40 to 200 ft. wide. The bed-rock, chiefly mica schist, is deeply decomposed, and from 1 to 5 ft. is frequently mined. The yield of pay streak is estimated at 5 to 25c. per pan.

On Cleary creek the depth to bed-rock has been found to vary from 14 to 80 ft., with an average of over 50 ft. Of this, 20 ft. is gravel, covered by a heavy overburden of muck. The pay is found in 1 to 7 ft. of gravel and at a depth of 1 to 4 ft. in bed-rock.

Mining extended about 4 miles along Fairbanks creek during the summer of 1904. The depth to bed-rock varies from 15 to 60 ft., and the pay streak from 1.5 to 7 ft., with a width of 45 to 250 ft. The average was about 5 to 10c. to the pan.

The larger valleys of the district are heavily timbered, affording fuel and lumber. In 1904, in spite of the local supply from several sawmills, lumber brought as high as $200 per thousand. Wages are usually not over $5 per day, with board.

The extent and yield of the gravel deposit is such as to assure a good future for the district. The depth of gravel and scarcity of water have prevented rapid development. Drifting with steam points has been the favorite method of mining. But few mechanical contrivances have been used. Hydraulic methods have not been introduced, and probably will not be, because of low stream gradients and lack of water. The expense of mining has probably consumed from one-third to one-half the output.

The large influx of miners to Fairbanks has led to prospecting in the adacent country, especially south of the Tanana valley. Along the northern base of the Alaskan range there are extensive deposits of overwash glacial gravel, and these are known to be auriferous. In my explorations no workable placers were found, but it appears not improbable that there are localities where the gold may be sufficiently concentrated to be workable. Certain it is that there exist heavy gravel deposits, aggregating in some instances hundreds of feet, which from their topographic position may be regarded as worthy of the attention of the hydraulic miner, who must, however, first satisfy himself of their gold content. The streams which rise in the high mountains to the south will furnish ample water, and under sufficient head.

The Rampart district, the most westerly in the Yukon-Tanana region, lies in the elbow between the Lower Tanana and a part of the Yukon rivers. For over a decade the gold placers in the basin of Minook creek have made a small but steady output. During the past season half a dozen tributaries of this stream have been worked. On Hunter creek a hydraulic plant has been installed, fed by a ditch a mile long, which carries 300 inches at a head of 75 ft. On Hoosier, Ruby and Big Minook, similar plants are being installed. The southern part of the Rampart district embraces a number of streams tributary to the Lower Tanana, which are yielding placer gold. Among these is Glenn creek, which has produced over $250,000 in the past three years. No extensive mining plant is being installed in this southern area, but many creek placers are being worked in a small way. The working expenses range from one-third to one-half of the output.

The Koyukuk district, north of the Arctic Circle, is also in the Yukon region. Current reports indicate an unfavorable season. No new discoveries are reported; inaccessibility has been a hindrance to large operations. There is no question both of the wide distribution of gold and its occurrence in commercial quantity.

In the Cook Inlet district several hydraulic plants are in operation. A railway, the Alaska Central, is under construction; this will give communication with Resurrection bay, on the Pacific side of the Kenai peninsula, where there is an excellent harbor, open throughout the year, with ample wharf facilities. The railway project is planned to tap the Yukon placer field, near the mouth of the Tanana, which will require about 300 miles of track.

The Chistochina district is the only one in the Copper river basin which made any considerable output of gold. The Nizina and other districts are, however, not abandoned, and await exploitation.

The settlement of the boundary controversy has attracted capital to the Porcupine placers, near Lynn canal. Though a beginning has been made on the Lower Porcupine, where one company controls a large group of claims, the output has been comparatively small.

Alaska's extensive coal deposits are almost entirely undeveloped. This is partly due to the lack of intercommunication between different parts of the territory, making it cheaper to supply fuel from Puget sound than from a local source. The most important advances are in the Bering coal fields, lying within 25 miles of Controller bay, on the Pacific coast. Here the extensive seams of bituminous and semi-anthracite coals have attracted some strong companies, who are engaged in surveying, trail building and prospecting, preliminary to systematic exploitation. During 1904 many miles of trail were constructed in this region, and probably 100 new prospects were opened up.

In the Cook Inlet region to the westward, there is an abundance of good lignite coal, easily accessible from tidewater, but no attempt has been made at systematic mining. It would appear that the coal miner might find it profitable to supply the local market offered by the many canneries and small steamers of Southwestern Alaska.

On the Yukon, all coal-mining operations have been practically suspended since the introduction of oil engines on the river steamers. The use of petroleum is a commercial success, though its transportation 4,000 miles (to the neglect of a local supply) does not appear sound economy.

The Lisburne fields, on the Arctic coast, furnish a little coal to the occasional vessel in those waters; but the attempt to introduce to the Nome market this fuel in competition with the outside coal has not been repeated since the failure of two years ago. Probably the most successful coal mining venture is that on Chicago creek, on the Seward peninsula, where upward of 1,000 tons were produced and sold in the local market at $40 per ton, in competition with Washington coal at $82 per ton.

The petroleum industry in Alaska shows but little progress. Though some borings were made, the most authentic reports indicate that an oil pool has not yet been located, in spite of the favorable geologic structure, and the certainty of the presence of petroleum as indicated by seepages. Final decision as to the value of the field must await more extensive and systematic drilling.

THE KLONDIKE.

BY J. P. HUTCHINS.

The gold production of the Klondike district was between $10,000,000 and $11,000,000, or a million less than that of 1903, although this last season has been exceptionally favorable. It was possible to begin sluicing the dumps of material mined during the winter of 1903-1904, and ready to be washed with the water from the melting snow, about two weeks earlier than usual. Another favorable condition was slow melting of snow. There was no loss, as sometimes occurs, when rapidly melting snow causes high water in the creeks and washes away material dumped in the creek bottoms. This slow melting of a more than normal snowfall rendered unnecessary the overloading of sluices, which occurs in seasons when there is a lack of water for a time sufficient to wash all the dumps.

A deal of stripping of muck and other overburden from creek, hillside and bench claims was possible by ground-sluicing with this large amount of spring water, and a great volume of material was prepared for working during the later months. There was a heavy rainfall in spring and summer, with unusually cool weather. The creeks at their lowest contained from four to five times as much as the minimum flow of the previous year. A cold fall caused a cessation of operation slightly earlier than usual. With this exception, the season was remarkably favorable.

The development of valuable claims in the Tanana district induced some operators and laborers to leave the Klondike for the new diggings. In some instances this resulted in claims remaining unworked; however, the output was not seriously affected. One cause for the smaller production was the fact that on account of success with the hydraulic method, a number of claims which ordinarily would have been 'drifted' were reserved for 'hydraulicking' whenever a supply of water should be available.

There were no important discoveries of rich placer ground, nor was any unusually rich ground worked, as during the previous year, when five 'laymen' (or 'tributers'), by winter drilling on Bonanza creek, cleaned up over $200,000, an average of about $1 per pan. Several deposits of pay gravel have been developed under material which has slid into the creek bottom off the adjacent hillside. It is probable that there will be other developments of this sort, but it is not likely that any extensive deposits will be found, nor will such discoveries be numerous. A 'second bed-rock' was suspected at a considerable depth. The finding of much shattered bed-rock, with large slabs not in place, led to this belief, which is not warranted.

Some work has been done on several veins, with hope of developing gold-bearing quartz. There has also been a disposition to hunt for the 'mother lode,' as has been done before in other regions. The fact that the placer gold has been concentrated from an enormous volume of presumably low grade material is not sufficiently recognized. There are no paying quartz mines in the Klondike district.

During the past year more than ever before the value of the so called 'worked out' ground has been demonstrated. These claims were worked in the early days, five and six years ago, and such mining was carelessly done, but recent operations in many cases have shown them to possess value. Secondary terraces, or benches, on the rim of the 'white channel' have not been found, though this deposit has been thoroughly drifted. There is the possibility of such 'peneplains' with valuable content. The 'white channel' is what is left of the ancient creek-bed; it has a course approximately parallel to and at an elevation of 150 to 300 ft. above the present creek. Where it has not been eroded it usually appears as a bench deposit with one rim completely removed.

It has been demonstrated that the Klondike district is one of unusual concentration; that is, there is a very slight dissemination of gold in the upper gravel. A heavy seasonal rainfall permitted hydraulicking and ground sluicing. Most of this work was done on deposits which had been quite thoroughly drifted, and the result was poor. It has been well shown during the past year that there is much lateral concentration; pay-streaks are, in general, narrow and irregular.

Mining methods have not been greatly modified. Hydraulicking was more general during the past year. Much ground, such as has been drifted, has been reserved for exploitation by the hydraulic method, and installations of hydraulic machinery have been made. Water grants (some of them, unfortunately, conflicting) have been issued, and numerous ditches have been excavated.

The topography of the Klondike is such that it is not possible to bring in sufficient water throughout the summer season without building long ditches over unfavorable ground, with long flumes and inverted siphons. Water is now obtained from watersheds of limited area. Many of the larger gulches have a minimum flow of less than 1 cu. ft. per second, with a maximum flow, for a short period during the spring thaw and after heavy rains, of about 20 cu. ft. per second. These gulches have been denuded of timber, and there is little undergrowth to conserve water. The wet season, at best, is short and unreliable, and hydraulic mining will be conducted on a small scale until long and expensive ditches shall be built. Not more than 1,000,000 cu. yd. were washed by the hydraulic process during the year. Attempts have been made to conserve water from the melting snow, but there are no good reservoir sites. During the summer the highest dam yet constructed in the Klondike was built. It was made of earth and rock and is 40 ft. high, forming a pond estimated to contain 26,000,000 gal. Another will be 70 ft. high and will hold 160,000,000 gal. These figures will indicate how unfavorable are the best reservoir sites available. Hydraulicking with pumped water has been conducted on a larger scale than before. A pump weighing 114 tons and throwing about 5 cu. ft. per second to an elevation of 350 ft. was in operation. Water lifted by this pump had already been used many times for sluicing, and carried 1.75 oz. solid matter, largely quartz, per gallon. This method is too expensive to be profitable. A high duty, more than 5 cu. yd. per miner's inch per twenty-four hours, was attained in several cases. It was possible to use a grade of 8 per cent, and the gravel washed rapidly when thawed. The comparative absence of large boulders, without excess of fine sand, contributed to this result. Large thawing surfaces are essential; a face covering of 50,000 sq. ft. should be allowed, on the shady side of hills, for 200 to 250 miner's inches; much less will suffice on a sunny slope.

About 15 miles of ditch, carrying 750 miner's inches, and many more systems with a capacity ranging from 50 to 200 in. have been built. Construction costs have been high and not much water is available. These conditions will make the cost of hydraulicking (including amortization, etc.) high, namely, about $0.20 per cubic yard.

In mining the creek-beds there is little new to note. Winter drifting is still largely done by 'laymen,' on 'lays' varying from 50 to 80 per cent of the output. The larger number of these men are miners who work for wages during the summer and take 'lays' during the winter, for want of something better to do. There is little summer drifting done in the creek-beds, except where the depth of overburden renders the open-cut method unsuitable. No drifting is done on the benches, except where hydraulicking is impossible.

Most of the creek-bottoms are worked by open-cutting. The overburden is stripped, either by ground-sluicing, steam- or horse-scraping, or by steam-shoveling, though some hand-shoveling is still done. The more common method is by steam-scraping; larger scrapers, with much more powerful engines, were used during the past year. For getting the pay-gravel and the bed-rock to the sluices, numerous different arrangements were used. Shoveling to platforms, then to sluices; shoveling to wheelbarrows, wheeling to bucket, raising on inclined cableway to sluices; shoveling into skips, hoisting by derricks to sluices; shoveling into cars, hauling on inclined track to sluices; steam-shoveling into cars, hauling on inclined track to sluices; steam-shoveling direct into sluices, were some of the various methods employed. Shoveling into wheelbarrows, wheeling to bucket and hoisting on inclined cableway was the most generally practiced method of getting 'pay dirt' to the sluices. Electricity is generated by a steam plant at Dawson, using coal and wood. Power at $1 per h. p. for ten hours was supplied to miners on Bonanza creek, and is more generally used to pump sluicing water. In open-cutting, except where mechanical excavators, such as steam-shovels and dredges are employed, little steam-thawing is required, the overburden being scraped and the 'pay' gravel shoveled as it thaws by exposure to sun and air. Steam-shovels and dredges do good work in thawed material. A dredge of the New Zealand type, with buckets of 3 cu. ft. capacity, has been in operation most of the last two seasons in ground much of which had been worked by drifting and open cutting. A prospecting dredge of the 'single lift' type, with sluice sustained on the dredge hull, and having buckets of 2 cu. ft. capacity, has been at work during the latter part of the season on the Klondike river, near its confluence with Bonanza creek. Two steam-shovels have been employed, one for stripping, on ground little of which has been drifted; two others have been digging in ground which had already been mined by other methods. The lowest cost for working the creek-bed, if only the actual operation be included, was that for dredging.

A good class of labor is available, and no strikes have taken place. Wages are still high—40c. per hour and board for common labor was the ruling rate. Fuel is costly. During the past season wood cost from $10 to $16 per cord, in 16-ft. lengths, the price varying with the amount of hauling. Coal from several mines, two of which are more than 200 miles up the Yukon river from Dawson, was tried. It was found to have low calorific value, and its use was discontinued, wood proving the cheaper fuel. Excellent roads have been built and maintained by the Territorial Government on all the more important creeks. This policy has been of great benefit to the Klondike. Large loads, often 20 cwt. per animal, are hauled.

The law still requires $200 worth of work per annum on each placer claim or fractional claim; this is called 'representation.' Title cannot be obtained, but claims are leased by the Crown to licensed 'free miners' from year to year, as long as regulations are followed. A new regulation allows the holder of a water grant to sell surplus water; this has benefited operators unable heretofore to get water. The former regulations made it compulsory to use water on claims named as appurtenant to it in the water grant. The penalty for infraction was forfeiture of the water right. A large area in the Klondike is included in concessions. There has not been much work done on these during the past year.

ARIZONA.

BY WILLIAM P. BLAKE.

The progress of mining, except for copper, in the Territory of Arizona during the year 1904 has not been characterized by brilliant advances or discoveries. It has been a year of patient preparation rather than a period of large production. The great properties which maintained their normal activity during the year 1903 have continued their output and give satisfactory promise of maintaining it for years to come.

Much activity has been shown during the year through the gold region of Central Arizona in Congress, Martinez and Wickenburg districts, and at Quartzite. The Octave mine is reported to be running a 60-stamp mill and to be paying $30,000 a month in dividends. Among the numerous properties under development, the following receive prominent mention: Oro Grande, Gold Road, Black Rock and O'Brien. The Leviathian ledge is being prospected. The old Vulture mine has been idle owing to litigation.

In the Congress mine the main incline shaft has reached a depth of 3,900 ft., and there are two other shafts 1,800 ft. deep, measured on the incline. Mining and milling have been continuous as usual during the year. No. 3 shaft, on the Congress vein, has been sunk to the 3,900-ft. level, and considerable drifting has been done at that depth. The vein is found to carry sulphurets of the same grade and character as above, but the question of quantity has not been settled. On the parallel Niagara vein, two shafts, No. 5 and 6, have been sunk to the 1,800-ft. level. The work of opening that level is now in progress, with very encouraging indications. The production from both veins of the property during 1904 was 21,606 oz. gold and 19,407 oz. silver.

The King of Arizona gold mine in Yuma county has been worked with but few temporary intermissions. Explorations upon the vein have reached a depth by shaft of 600 ft., with a further depth, by winze, of 280 ft., showing a satisfactory continuance and richness of the mineralization at that depth. The average gross value of the production was $27,500 per month.

The Commonwealth, at Pearce, Cochise county, has been closed down for the present, and work has been confined to the treatment of the tailing by the cyanide process.

In the Arivaca and Oro Blanco districts but little progress has been made, and the promise of 1903 has not been realized. The Pride of the West has not resumed operations, and aside from prospecting and the acquisition of more claims, little has been accomplished at Washington camp.

The World's Fair mine, near Patagonia, made some shipments under the new ownership, but has been closed by litigation for a large part of the year. At the Saléro, 10 miles north of Patagonia, work has been prosecuted upon the Eureka claim, and two or three shipments of good ore have been made to El Paso smelter. The lowest, or adit, level has been extended along the vein for nearly 300 ft., necessitating an air-shaft, which is now 200 ft. deep, following the vein on its dip, and in ore for the entire distance. The ore above the adit level is now being stoped. The Arizona Gold and Copper Company's concentrating plant, near Saléro, has remained idle, as also the smelter and sampling works at Patagonia.

In Santa Cruz county the Mowry mine, which produces argentiferous lead and is well known in the history of mining in Arizona, has changed ownership, and is now being actively reopened and worked. The large volume of water encountered in sinking is being removed by newly installed, powerful pumps. Bodies of ore, richer than former ones, are reported, and the erection of smelting furnaces at the mine is promised, as is also railway connection with the Sonora road at Patagonia.

At Twin Buttes, Pima county, the bodies of high-grade copper ore discovered in depth have proved extensive, and as a result railway connection with the Southern Pacific at Tucson will soon be made.

The gold-bearing placers on the east side of the Santa Rita mountains, at Greaterville and vicinity, have been under investigation, and a pipe-line several miles long has been laid to convey water from projected reservoirs to the placer ground.

In the extreme southwestern portion of Arizona, in the Quijotoa mining district, the Weldon Gold and Copper Company has continued development work. This company is now the owner of 24 claims and two mill sites on the North Quijotoa mountain, 80 miles from Tucson and about 20 from the border. The discovery of a gold-bearing vein of large size has recently engaged the attention of this company in preference to the development of its copper deposits. At a depth of 260 ft., a large body of sulphide ore was found, and a flow of water was tapped which rose 60 ft. in the shaft, giving a much needed supply. Powerful pumps have been erected and a 20-stamp mill will soon be erected, a mill test at the Arizona School of Mines having shown that the oxidized ore can be readily worked by stamp-mill and plate amalgamation.

At Tombstone, in Cochise county, at the mines of the Tombstone Consolidated Mines Company, great activity has been maintained throughout the year. Work has been greatly retarded by the unexpectedly large amount of water found in sinking, so that the company is only now able to begin work on the 800-ft. level. The 700-ft. level is practically dry, and crosscutting for the veins and orebodies on that level is progressing. Shipments of ore have been constant during 1904 from the ground above the water, and the ore so shipped has contained metals as follows, the amounts for November and December being estimated on account of the absence of complete returns: Silver, 557,617 oz.; gold, 9,299 oz.; lead, 715-720 lb. The following table shows the quantity of water in gallons raised per month since December, 1902, and the depth of the shaft at corresponding months:

	Gallons per month.	Depth of Shaft.
December, 1902	....	570
January, 1903	27,000,000	653
February	41,304,427	677
March	40,326,180	697
April	53,317,156	709
May	66,814,996	"
June	51,176,981	"
July	65,704,088	"
August	65,479,039	"
September	70,178,500	"
October	71,198,185	"
November	67,451,440	"
December	68,184,865	"
Year	688,135,857	
January, 1904	71,103,853	709
February	70,555,954	"
March	74,659,565	722
April	99,345,858	744
May	105,030,940	762
June	112,223,373	781
July	121,475,126	"
August	111,263,251	"
September	102,174,274	"
October	102,598,248	803
November	100,022,588	808
December	95,000,000	808
Year	1,165,453,030	

The drainage extends over a wide area and the progress of unwatering is necessarily slow. Distant mines are being drained, permitting work at much lower levels than at any time before.

At the West Side mine of the same company a new level is being driven 120 ft. below the old water level, and the vein is found to be much stronger and better than at the water level. New levels are also being opened in the Silver Thread and Emerald mines below water level, with very encouraging results. In the Lucky Cuss mine, 4,000 ft. from the pump shaft, the water has receded 130 ft.

The Poland tunnel, in Yavapai county, has been completed and several mineral-bearing veins have been cut; one especially, carrying good value in gold, has great promise and has been drifted on for 1,000 ft. or more. The burning of the Val Verde smelter destroyed the nearest and best market for the concentrates of the Poland mill, so that shipments have been suspended.

At the Sierra de Oro (gold) mine, on the San Francisco river, north of Clifton, Graham county, the work of crosscutting has continuel without interruption, penetrating the granite mountain for about 1,100 ft. Four different gold-bearing veins have been cut which did not show on the surface. The first of the two large lodes, for which the tunnel was projected, will be cut in about 200 ft. The surface indications and the assays justify the expectation of high-grade pyrite ore in quartz.

The revival of an active demand for ores of tungsten has stimulated mining for them at the Dragon mountain locality and a few tons have been shipped, chiefly from placer washings, for the details of which reference may be made to the article by Forbes Rickard.[1] A few tons of scheelite have been mined by Captain Burgess at the Maudena mine in the Catalina mountains north of Tucson. The mines at the Gigas, southwest of Tucson, remain unworked, so also others in that region, it being more profitable to sell properties at a high figure than to work them. Several other occurrences of wolframite have been discovered in Arizona and are now being developed. In general, these ores consist of the manganiferous variety of the mineral.

Bismuth ore is found in the eastern part of Maricopa county. Cobalt has been discovered in ores sent to the Arizona School of Mines from Pima county. The rare mineral, iodobromite, has been identified in silver ore from the Globe district.

[1] The Engineering and Mining Journal, Aug. 18, 1904.

CALIFORNIA.

BY CHARLES G. YALE.

While there were no features of startling interest in the mining industry of California during 1904, steady progress is being made in most branches. Less than half the total value of the mineral output is derived from gold-mining operations, whereas, at one period a generation or more ago, hardly anything but gold was thought of.

Of the gold yield, about 76 per cent now comes from quartz mines, 8 per cent from dredging, 6 per cent from hydraulic operations, and the rest from drift and placer mining. In quartz mining there is no apparent extension of the productive area, though a number of old districts, more particularly in the Southwest, are being re-opened. In most of these cases the mines were at one time active producers, but high cost of transport, supplies and labor led to their abandonment. These deserted camps are being searched and the old mines prospected, retimbered and explored. The greatest development has been in established districts; this is especially true of the Mother Lode region. It is now possible, with improved appliances, to handle with profit ore which 25 years ago could not be touched. Capitalists evince a preference for old mines over those recently found; the older ones have sufficient development to show that, properly equipped and managed, they may be made profitable.

The annual yield of gold continues to be between $17,000,000 and $19,000,000, but a material increase is likely within the next two years. This will be due to the opening of new mines, to the larger quantity of ore crushed by mills recently erected, and to the success of dredging.

The preliminary estimate of the Director of the United States Mint for 1904 credits California with a gold output of $19,000,000 and a silver yield of 1,380,000 fine ounces. This is the largest precious metal production the State has made in many years. Not since 1883 has the gold yield reached nineteen millions. In fact, in 1889 it had run down to $11,212,000, but has been gradually increasing since that year. In 1903 the gold yield, according to the Director, was $16,104,500, so that the increase for 1904 is practically $3,000,000. This marked increase of gold product in one year is doubtless almost entirely due to the operations of gold-dredging machines, which are rapidly increasing in number and capacity. In fact, it may possibly be seen, when the complete figures of the year 1904 have been compiled in the usual way, that the output will exceed this preliminary estimate of the Director. The receipts of California gold at the United States Mint in San Francisco and at the Selby smelting works were, in 1904, nearly 20 per cent greater than those of the previous year.

These are the principal depositories for the gold from California mines, and their combined receipts are the best indications of the total gold yield. California is still six millions behind Colorado in gold production, but is nine millions ahead of the next in rank of the States and Territories. With the big dredgers which will come into operation early this year, the 1905 yield in California will show a much larger total.

It is in dredging that the most marked advances are noticeable. The gold obtained from this source has doubled, the total output of the dredges being now equal to the combined yield of both hydraulic and drift mines. The application of these machines is being so extended and their size so materially increased that it is not difficult to foresee the time when their combined output will equal that of the quartz mines of the State. Dredging operations, at first confined to the river-bottom near Oroville, in Butte county, are now being carried on in Yuba, Trinity, Sacramento and Shasta counties; in El Dorado, Amador, Calaveras, Sutter, Plumas and other counties, active prospecting of possible dredging land is under way. Large tracts have been placed under bond for this purpose at many distant points. Not only are the river-bottoms and valley-lands suitable for dredging, but even in the more mountainous districts there are numerous small valleys and wide cañons where this method is practicable. All such available land brings good prices. The latest machines have twice the capacity of those formerly used, and some of the companies have three or four of them in operation. In addition to those already at work, a dozen or more of the largest size are being built. This method of gold mining possesses one special advantage which makes it attractive to investors, namely, the ground may be pretty thoroughly prospected in advance of any permanent investment.

While gold continues to be the most important of the mineral products of the State, there are some 44 other substances now being mined or commercially utilized. The relative order of the principal products, in point of value, is now: First, gold; second, petroleum; third, copper; fourth, clays and their products; fifth, quicksilver. In 1903 the petroleum output of the State was 24,340,839 barrels, valued at $7,313,271. The yield for 1904, as estimated by the secretary of the California Petroleum Miners' Association, was 28,425,860 barrels. Prices have been low, and consumption has not increased in proportion to the output; in fact, the disposal of stocks at a profit is a pressing question. It is true that railroads and manufacturing enterprises on the Coast are using large quantities for fuel, and that many thousand barrels are shipped to other States and abroad for the same purpose; much also is being refined, and the number of refineries in California is on the increase; nevertheless, the output is difficult to market. Kern and Fresno counties, in the north, and Los Angeles, Ventura and Orange, in the south, are still being exploited for new wells, and the older wells keep up their yield. Owing to low prices and the difficulty of sale at a fair profit, many of the smaller companies have reduced their production. Several pipe-lines have been constructed, or are being built, to bring the oil of the interior counties to tidewater; this means of transport is expected to relieve the situation in time. Kern county continues to be the largest producer, yielding over 18,000,000 barrels, as against about 6,000,000 barrels by all the other counties combined.

The most marked feature in the petroleum industry is the rapid development of the Santa Maria and other fields in Santa Barbara county. A number of new wells of large productive capacity have 'come in' during the latter part of 1904; many more are being bored. Heretofore the production of oil in this county has been practically confined to the Summerland district on the ocean beach near Santa Barbara. None of the projects in any of the counties north of Fresno has come to fruition, notwithstanding large sums spent in prospecting. There is a small output from Santa Clara county, but none has yet come from Santa Cruz, San Benito, Contra Costa, Marin, Colusa, Shasta or Mendocino, where many wells have been sunk without result.

The copper mines were not expected to show an increase in yield. Over 16,000,000 lb. out of the total of 19,000,000 came from Shasta county, the next in rank being Calaveras, with over 2,000,000 lb. to her credit, In the latter county, the old mines at Copperopolis, worked with profit 40 years ago, are being systematically re-opened and equipped on an extensive scale. In Shasta county, the Mountain Copper and Bully Hill continue to be the principal mines and the largest in the State, but none of the other much advertised enterprises has as yet completed smelters or commenced active production.

The importance of California clays and their products, namely, brick, pottery, sewer pipe, terra cotta, etc., is constantly increasing with the building of cities and towns on a more substantial basis. More granite, sandstone and marble are being quarried than ever before. The product of lime and limestone is increasing rapidly, and there is a steady demand for new quarries near transportation facilities. Much larger quantities of macadam and rubble are quarried. The State Mining Bureau is about to publish a bulletin on the 'Structural and Industrial Products of California,' which will give details of all these substances.

There is no marked change in the production of quicksilver or in the number of mines yielding that metal. A few more enterprises have reached a productive stage, and a number of others are prospecting and installing equipment. This increase in number of mines, however, is not likely to continue, as there has been an overproduction for some time; as a result, prices have been low and unsatisfactory, and continue so. This country will take only so much quicksilver yearly; the surplus must be shipped abroad to be sold in competition with the European product at a much lower price than it brings here. In the home market the metal has brought an average of $44 to $45, but quotations are now only $39 and $40 per flask of 75 pounds. A further drop will close some of the smaller properties, and even the larger ones that exploit low-grade ore. If the producers obtained, on an average, the price of the local market, they could do well, but they do not receive it. As is generally understood, the total output is pooled, and when much has to be sold abroad at low prices this reduces the general average received by the miners, as compared with the price quoted in American papers.

There is a large increase in the output of cement, three large concerns being engaged in its manufacture. One of the large quarries is in San Bernardino, one in Napa, and one in Solano county. The asphalt output is also on the increase, large quantities now being made by the oil refineries handling the California petroleum, which has an asphalt base. Some of the oils carry as high as 20 per cent asphalt. The yield of borax is not more than in 1903, no new properties of any size having been opened. The demand for California coal is not as great as formerly, and the two largest mines are briquetting their product with the idea of popularizing this class of fuel, so as to increase the consumption of local coal.

The yield of magnesite has not been enlarged, as the Coast will take only 4,000 to 5,000 tons a year; one mine alone, in the San Joaquin valley, produces this amount, and could quadruple the output should a demand arise. Freights are too high to ship this substance East in competition with the Grecian magnesite coming in by sea. More slate is being quarried than formerly, there being a stronger demand for it. The output of natural soda remains about the same. In gem mining there is increase of interest in tourmaline, turquoise, chrysoprase and kunzite, and closer search is being made for these substances. The mines are confined to San Diego and San Bernardino. Some opals have recently been found in the latter county.

The total value of all mineral substances produced in California has been increasing about $2,000,000 per annum since 1893; then the sum was $18,811,261, while in 1903 the aggregate was $37,759,040. This shows that from 1893 to 1903, inclusive, the total mineral output of the State has been $307,702,667. This includes gold, silver, copper, quicksilver, oil and all mineral substances mined or quarried.

From these official figures it will be noted that the mining industry of California is in a progressive condition. As this is the oldest of the mining States west of the Missouri river, and one having a record for gold alone of a total output of $1,395,746,672, it is pleasant to note that after all these years it is not retrograding. On the contrary, as more and more mineral substances are utilized, and larger operations are conducted, the annual output continues to increase. The mineral output for 1904 will show an aggregate value of about $40,000,000.

NEVADA.

BY C. C. BURGER.

The most important developments in 1904 have been in the Tonopah and Goldfields districts. At Tonopah, the chief event has been the completion of the railroad connecting the mines, through the Carson and Colorado branch, with the main line of the Southern Pacific. Apart from the assurance of cheaper supplies, ore can now be shipped which formerly it would not pay to haul. The branch line is 60 miles long and narrow-gauge; the Carson and Colorado railroad, by reason of the greatly increased traffic, has been compelled to broad-gauge its track, and the Tonopah line is doing likewise.

Development of the mines has been held back pending the completion of the railroad. Since then shipments of ore have been lively. The Tonopah Mining Company is prepared for the extraction of ore on a large scale, and is now making a large output. The Tonopah Extension and the Montana-Tonopah companies have made good progress. Exploratory work in the Tonopah-Belmont property, adjoining the Tonopah Mining Company on the east, has disclosed good ore. This company also has been shipping since the advent of the railroad.

The early days of Tonopah were beset with difficulties. The camp was in an isolated situation, without water, fuel or transportation, and much of the ore was unsuited to ordinary milling. The transport problem has been solved, likewise the question of water, which is obtainable in the town and by the mines from an organized water company. Experimental wells, 14 miles from the town, in the valley traversed by the railroad, have demonstrated the existence of a sufficient quantity of water for milling purposes on a large scale. The ore output is treated by the smelting companies at fair rates, and, when the broad-gauging of the Carson and Colorado railroad is completed, there remains but one thing to facilitate the turning into money of the ore-reserves in the mines, and that is the erection and satisfactory operation of a local milling plant of a size commensurate with the amount of low-grade ore available. This should be the chief event of 1905. The Midway Company's 10-stamp mill has been helpful, but this plant is merely a forerunner of custom work on a large scale.

The most important developments in Nevada have been at Goldfields. This new district is about 23 miles southeast of Tonopah, and was discovered in the late spring of 1903; it was first named Grandpa. During 1904 exploratory work has been highly successful.

According to J. E. Spurr, the predominating rocks at Goldfields are rhyolites and andesites, and the orebodies consist simply of silicified portions of these volcanic rocks. These bodies of quartz are extremely irregular, and often disappear suddenly; the outcrops are sometimes nearly circular or crescentic, often lenticular and generally irregular. Exploration has shown that some of these quartz bodies contain pay shoots, often of very considerable value; the shoots present the general form of channels, indicating that they were the courses of the hot waters that made these deposits. The latest of an extensive series of fractures has given the irregular form to the orebodies, and outside of the channels the values in the reefs are low. The pay orebodies often run very high in value; the average of the camp's production in 1904 has been from $200 to $300 per ton, while occasional small lots run into the thousands per ton. Most of this ore is oxidized, though sometimes mixed with sulphides. Several of the mines have reached water-level at comparatively shallow depths, 100 to 250 ft. As to the continuity and value of the sulphide zones encountered at water-level, sufficient work was not done in 1904 to afford complete data. Some of the orebodies encountered at this level are high-grade and somewhat complicated in composition. Iron sulphide is found, together with some copper, a little tetrahedrite, and indications of tellurium and bismuth. The exploitation of the orebodies below water-level during 1905 will have the greatest importance to the district, and with the extension of the Tonopah railroad, which is expected to be completed in the summer of 1905, Goldfields should be the scene of active operations.

Among the principal mines is that of the Jumbo Mining Company, recently involved in litigation over the division of ownership. A receiver was applied for and obtained, but the receivership has been vacated and the lessees are again at work. The property has three shafts upon it, the deepest of which is 250 ft. Water has been encountered, and it is said that the sulphide ore is high grade. The width of the vein is given as 6 ft., a considerable portion of it being shipping ore. The production of this property during 1904 is given at about $1,500,000. Another prominent enterprise is the Combination Mining Company. Their mine is opened to a depth of 320 ft., and the shaft is about 50 ft. below water-level. The unoxidized ore is said to be of good grade. The total production is estimated at $400,000. It is a noteworthly fact that very little waste has been extracted in the course of development work, most of the ore on the surface showing gold by panning. This company is erecting a 10-stamp mill, which is expected to be in operation shortly. The Goldfields Mining Company, owning the celebrated January claim, is also prominent. This mine is opened to a depth of 280 ft., and has just reached water-level. The total production is estimated at $1,000,000. The lease under which the mine has been worked expires on January 5. This mine is also notable for its high-grade ore. The Sandstorm mine is opened to a depth of only 80 ft., but the ore is the richest in the district. The lessees have shipped ore running as high as $5,000 per ton. The property of the Kendall Mining Company is also looking well, and the lessees of this property have also shipped some high-grade ore. There are a number of other prospects undergoing development; among these the Diamondfield Mining Company owns a prospect three miles from Goldfields, which contains some high-grade ore and a considerable width of milling ore. It is opened up to a depth of 100 feet.

Attention has been attracted to another district, known as Bullfrog, about 70 miles from Goldfields. The Bullfrog Mining Company is at present prosecuting surface work on a vein which is said to outcrop distinctly for a long distance. This new Bullfrog section will no doubt be the scene of active work in 1905, as the discoveries there are said to be remarkable. Other important finds have been made at Lida and in the Kawich range. The extension of the discoveries in this section of Nevada in 1904 is very noteworthy. In the extreme south of the State, in Lincoln county, the Searchlight district has continued to be prominent. The Quartette mine is the principal property, and developments are said to be favorable. Other properties are also undergoing development in the same vicinity, and, in general, it seems to be a district worthy of attention. The construction of the San Pedro, Salt Lake & Los Angeles Railroad is stimulating exploration in southern Nevada, and vigorous prospecting may be looked for in the country adjacent to this railroad. With regard to the Comstock, there has been a flurry in the stocks of some of the companies, but conditions in general remain about the same as heretofore, though the treating of the dumps by the cyanide process is assuming prominence.

EASTERN STATES OF AUSTRALIA.

BY F. S. MANCE.

It is anticipated that complete returns will show that the total mineral production of the Eastern States of Australia varied but little from that for 1903, which was:

State.	Value.
New South Wales	$28,380,537
Victoria	16,231,296
Queensland	17,693,261
Tasmania	6,254,021
South Australia	2,802,845
Total	$71,361,960

Gold falls short, as does coal, but these decreases are compensated somewhat by the greater value of the silver and lead; in both copper and tin a slight advance is exhibited; while the augmented production of other minerals, more particularly wolfram, goes far toward making good any deficiency in the total output.

Gold.—The position of this industry in the several States and in New Zealand may be gathered from the following table:

State.	1903. oz. fine.	1904. oz. fine.
Western Australia	$2,064,801	$1,983,231
Eastern States:		
Victoria	767,351	765,596
Queensland	668,546	639,151
New South Wales	254,260	269,817
Tasmania	59,891	65,921
South Australia	21,195	23,250
Commonwealth	$3,836,044	$3,746,966
New Zealand	479,748	467,898
Total for Australasia	$4,315,792	$4,214,864

Victoria maintains the lead among the Eastern States as a gold producer, this branch of the industry being followed more closely than in the neighboring States. Bendigo has been the chief center of activity, and its output, which has not been exceeded during the past thirty years, amounts to 248,000 oz. The line of workings extends for 10 miles, and payable returns have been obtained at depths varying from 500 to 2,815 ft. The most noteworthy results have been secured by the South New Moon Company; its yield for the twelve months ending with November was 37,024 oz. from 27,942 tons, the cost being $3.78 per ton. Prospecting on this field is being pushed with encouraging results at a vertical depth of over

4,020 ft. At Walhalla and Berringa the mines have been energetically worked, the Long Tunnel, Extended and Birthday companies standing out prominently as regular dividend payers. The Long Tunnel, at Walhalla, has produced more gold than any other mine in Victoria, but work has been suspended for two years past to enable the necessary development (including the sinking of a new shaft to a depth of 2,880 ft.) to be carried out. The reef was intersected in November, and this mine has again become productive. The general results from Ballarat approximate those of the previous year. The average yield for the September quarter fell to 5.21 dwt. per ton; and it speaks well for the management that the principal companies were able to declare substantial dividends. The majority of the companies working the Berry, Duke, Chiltern and Rutherglen deep alluvial leads have obtained satisfactory returns, and this fact, coupled with extensive explorations on other leads, has given a decided stimulus to this class of mining. The dredges working at Castlemaine, Bright and Creswick have also had a profitable year.

In Queensland the mines have been unable to maintain the large yield recorded for 1903. Charters Towers retains its position as the premier goldfield; its average output during each month of the past year has approximated 22,000 oz. fine, while dividends averaged $156,000 per month. The ore raised during 1904 was of lower grade, and the yield consequently less, but the financial results were better. The Queen Cross Reef Company has maintained a monthly dividend of $96,000; other consistent dividend payers were the Brilliant St. George, the United and the Brilliant Central. The next field in importance is Gympie, which at the end of October had been worked for 37 years and had produced 2,509,075 oz. fine. Here, also, the quality of the ore declined, and, notwithstanding an increased tonnage, the yield fell off. Returns from the Mount Morgan mine show decided improvement, the yield for the twelve months ending June amounting to 109,902 oz. fine. This company is erecting a complete plant to deal with the extensive deposits of copper-gold ore occurring in the lower levels. Boring operations have proved the existence of 1,046,000 tons, averaging 3.5 per cent copper and 8 dwt. gold, and other further large bodies of less value. A feature of the industry in this State was the alluvial gold rush at Dee river, Rockhampton, where numerous nuggets were found, ranging from several ounces to 182 oz. in weight. Encouraging results were obtained from Croydon, and the output was larger.

New South Wales holds the first place among the Eastern States for its production of minerals, but, as the returns indicate, gold mining is a minor industry. The scene of the largest operations is at Cobar, the chief producers being the Mount Boppy Company and the Cobar Gold Mines Limited. The Great Cobar Company also contributed, the gold being refined from the copper. The total production from this district suffered because the Cobar Gold Mines Limited has been compelled lately to limit productive work, pending arrangements to treat the ore; although the gold average is the same, the increase in copper necessitates treatment other than by cyanide. The Wyalong district made a satisfactory output. As in Victoria, the numerous dredges operating on the alluvial deposits have done well, and the gold obtained from this source forms no inconsiderable proportion of the total yield.

In Tasmania the gold is obtained chiefly from the refining of blister copper and silver-lead bullion, but there are several productive gold mines, notably the Tasmania, at Beaconsfield, and the New Golden Gate, at Mathinna. The record of the Tasmania mine to the end of June, 1904, shows that 516,998 tons of quartz were treated for a yield of 588,789 oz.

South Australia comes last as a gold-producing State. Good progress is being made in opening up several fields, notably at Tarcoola, Arltunga and the MacDonnell ranges; the output from these has increased. As a stimulus to the industry, the State Government has established crushing and cyanide plants in the principal districts.

Silver and Lead.—Broken Hill is the greatest mining center in Eastern Australia. The improvements effected in ore treatment, the economies in mining, and the increase in the price of lead and silver, have all had the effect of placing the mines in a most satisfactory position. Those companies which had suspended operations for several years past resumed productive work, and the number of men employed along the line of lode was greater than any year since 1900. The success achieved and the good work done by the processes designed for the separation of the zinc from the tailing afford ground for congratulation, and a large source of revenue has now been opened up to the several companies. From the Yerranderie mines (also in New South Wales), improved returns were obtained; the general prospects of this field are encouraging. The mines at Zeehan and Dundas, on the west coast of Tasmania, also register an output well in advance of 1903. The value of the products from the silver-lead mines in the eastern States, including the silver refined from copper, produced by the Mount Lyell and Chillagoe companies, is estimated for the year at $15,300,000.

Copper.—Satisfactory results were obtained in copper mining. The largest output is credited to Mount Lyell, in Tasmania. The production of the Mount Lyell Company amounted to 8,371 tons, and the profits show a gratifying increase. The ore reserves are sufficient to enable operations of the present magnitude to be continued for several years. In South Australia the Yorke peninsula contributed 6,278 tons of copper, the bulk of which was supplied by the Wallaroo and Moonta mines. Operations were greatly impeded by the fire at the Wallaroo, which entailed the direct expenditure of $264,000. In New South Wales the Cobar mine has fully maintained its position, and the extensive additions and improvements made to the plant enabled an increased output to be handled successfully. In this district several mines of considerable promise are being developed.

The Burraga mine, wihch has been one of the most consistent producers in New South Wales, shut down in July, because the ore was not rich enough to cover working expenses, the miners refusing to submit to any reduction. Development work was carried on meanwhile with a limited staff, and with such a measure of success that operations were resumed lately. At one time the closing down of the smelting works and mines of the New Chillagoe Railway & Mines Company, in Queensland, also seemed inevitable, earnings being insufficient to meet interest on the debenture debt. The position, however, was tided over, and work proceeded on the usual scale. The Cloncurry field is attracting much attention, and proposals are in hand for extensive development on orebodies which are said to give a return of 25 per cent of metal.

Tin.—Good progress can be recorded in this branch, while the principal mines are in the satisfactory position of being able to augment their output still further. In Queensland the mines on the Walsh and Tinaroo field have developed well, and have supplied regular quantities of ore, the principal contributors being the Stannary Hills, Lancelot, Vulcan and Smith's Creek companies. In Tasmania the Mount Bischoff Company has carried on operations uninterruptedly, and the year's work shows much better financial results. At the Briseis and New Brothers Home mines the removal of the greater portion of the massive rock and overburden, which had a thickness of as much as 136 ft., has been completed; and the companies are now able to attack the enormous bed of tin-drift, which is about 145 ft. thick, with a width of from 250 to 300 ft. In New South Wales a satisfactory yield continues to be obtained from the stanniferous drifts in the New England district. The dredges, particularly those working on the Queensland border, are an important feature. Dredging for tin is also followed with payable results in Tasmania. An exceedingly rich deposit of stream tin was discovered and worked by some Chinese at Port Darwin, in the Northern Territory; the area of the deposit, however, appears to be limited.

Coal.—The production of New South Wales, as already mentioned, is less. The output for 1904 was 6,019,809 long tons, which is a decrease of 335,037 from 1903. The principal falling off occurs in the export trade, and is particularly marked in respect of shipments to the west coast of America. This industry has been greatly hampered by labor troubles, and owners contend that, owing to the excessive hewing rates they have been compelled to pay to the miners, they have been unable to compete successfully for trade. The opening up of the large and easily worked seams in the Maitland district has led to the diminished trade being more widely distributed, and this has also militated against the prosecution of profitable operations. In Queensland a number of mines have been worked profitably, and the prospecting and opening up of other seams have also engaged attention, but the outlay of considerable capital will be necessary before these mines can successfully enter the lists against the collieries more favorably situated on the seaboard. The long-standing labor difficulty at the Outtrim mines, in Victoria, has been settled, but in this case also the fact that these seams are situated some distance from the industrial centers is a serious handicap in the competition for trade.

Other Minerals.—Mining for wolfram in Queensland reached large proportions, and the value of the output amounted to $775,848. The extent of the deposits and the activity of the miners resulted in overproduction. The mining for precious opal at White Cliffs, in New South Wales, is still a lucrative industry and supports a large population.

WESTERN AUSTRALIA.

BY H. C. HOOVER.

The production for the year, month by month, as compared to 1903, is as follows:

	1903.	1904.
	oz.	oz.
January	210,451	211,373
February	192,397	194,321
March	194,723	163,728
April	208,627	216,574
May	207,501	191,782
June	208,060	200,357
July	212,501	192,306
August	206,617	201,537
September	201,405	198,449
October	190,785	208,926
November	201,173	196,153
December	202,070	197,515
Total bullion	2,436,310	2,373 021
Equivalent fine gold	2,064,801	1,983,231

It will be seen that the total production shows a decrease of 81,570 oz. fine gold. This decrease was pretty evenly distributed over the entire State, and does not apply to any particular district. It is probable that a further reduction will take place, barring new discoveries; during the past two or three years a large percentage of the production has come from ore extracted from above water-level by prospectors, and milled at Government batteries and customs mills. This is, of course, a transitory production, as a great number of the mines which are thus worked do not warrant equipment for further operation in depth. The backbone of the industry is the yield derived from about 16 large mines. These mines treated roughly 1,300,000 tons of ore in 1903, and 1,600,000 tons of ore in 1904, in both years furnishing close to 60% of the total production. There is not likely to be further increase from this group, as the mines are pretty well equipped to their limit. I estimate the total dividends paid, and to be paid, on account of 1904, at £2,050,000, as against £2,024,152 in 1903. In addition to this, amounts aggregating probably £300,000 will be added to reserve funds during the year. There should be an increase in dividends during 1905, as in 1904 very large sums have been expended in extension of equipment.

There has been no great change in working methods during the year. The re-grinding of sand by tube-mills, or otherwise, as a means of increasing the stamp-duty, and as an aid to extraction, has made steady progress. In the practical development of this feature of gold metallurgy, this State can fairly claim to have been the pioneer, and the method is now finding rapid favor in South Africa, Mexico, and elsewhere. Practically every large stamp-mill in Western Australia is now partially or wholly equipped for the re-grinding of sand, and the stamp-duty now averages well over 6 tons per diem, and 7 tons is not considered by colonial metallurgists as being beyond attainment. It is, of course, possible to increase the stamp-duty even further by the re-grinding of coarser screen products, but there is an economic limit, not very well defined yet, as to what proportion of sand and of what coarseness it is profitable to re-grind. The problem of fine grinding is considerably complicated by the slime question. In the case of some ores, it is highly desirable from an extraction point of view that the sand should be ground to slime, and in some mills in this State the whole of the product is thus reduced. In other mills, a practically equally efficient extraction is secured by percolation, when the question of expense of re-grinding slimes is considered. It is not always easy to determine to what extent it pays to grind to slime, in order to secure an increased extraction, and the problem has been approached in most cases by gradually re-grinding an increased proportion of the sand to slime, until the economic point is reached.

In underground methods, there has been but little change, except for the tendency to put levels at a greater distance, now from 150 ft. to 250 ft. apart, instead of the old arbitrary interval of 100 ft. A number of mines whose reefs are adaptable to the purpose are initiating shrinking stoping, in order to do away with the costly filling hitherto rendered necessary by the scarcity of timber.

More careful and economical practice throughout all the leading mines has resulted in the reduction of expenses, and an increase in the percentage of extraction, until Western Australia can be considered from a working standpoint to have reached a very satisfactory footing. Accurate comparative statements are difficult to prepare, because of the wide variety in the character of the ore-deposits, in the metallurgical character of the ore itself, the size of the mines, and in their situation. The minimum necessary expense on simple ores is exemplified by the Great Fingall and the Cosmopolitan mines, which are working quartz reefs of fairly large and regular size, the ore from which presents no special metallurgical difficulties. The process employed at these mines is wet milling, concentration, treatment of concentrate by roasting, fine-grinding and cyanidation, separating the coarse sand and re-grinding portions of it, the treatment of sand by percolation, the treatment of slime by agitation and filter-pressing. Exploitation under more complex conditions is best represented by the Oroya Brownhill, Associated and Lake View mines, where the ore occurs in disconnected bodies, difficult of access and costly of development, the ore itself containing quantities of tellurides which necessitate special treatment. In the case of the Oroya Brownhill, treating telluride ore, the ore is milled wet, concentrated, the concentrate is treated by roasting, fine-grinding and cyanidation, the coarse sand is ground in pans, and the entire product passed through tube-mills, where it is ground to an absolute slime. The slime is agitated with bromo-cyanide and the solution separated in the filter-presses.

The following tables of expenditure on the Great Fingall and the Oroya Brownhill, for the last quarter, include the total expenditure, except taxes on profits and London office:

<table>
<tr><th></th><th>Oroya Brownhill. 50 stamps.</th><th>Great Fingall. 100 stamps.</th></tr>
<tr><td>Development</td><td>$1.5600</td><td>$0.6000</td></tr>
<tr><td>Breaking ore</td><td>0.8720</td><td>1.1592</td></tr>
<tr><td>Supporting stopes</td><td>0.1594</td><td>0.0330</td></tr>
<tr><td>Trucking and haulage</td><td>0.6516</td><td>0.3994</td></tr>
<tr><td>Rock-breaking</td><td>0.1572</td><td>0.0922</td></tr>
<tr><td>Ore transport</td><td>0.0876</td><td>0.1102</td></tr>
<tr><td>Milling</td><td>0.5442</td><td>0.8276</td></tr>
<tr><td>Concentrating</td><td>0.1412</td><td>0.1050</td></tr>
<tr><td>Roasting concentrate</td><td>0.1628</td><td rowspan="3">0.0856</td></tr>
<tr><td>Fine grinding</td><td>0.1144</td></tr>
<tr><td>Cyaniding</td><td>0.1044</td></tr>
<tr><td>Fine grinding sand</td><td>0.3216</td><td></td></tr>
<tr><td>Cyaniding by percolation</td><td>......</td><td>0.2560</td></tr>
<tr><td>Cyaniding by agitation</td><td>1.6172</td><td rowspan="2">0.2240</td></tr>
<tr><td>Filter-pressing</td><td>0.3992</td></tr>
<tr><td>Precipitation and smelting</td><td>0.2526</td><td>0.0732</td></tr>
<tr><td>Disposal of residue</td><td>0.0578</td><td>0.2920</td></tr>
<tr><td>Realization of bullion</td><td>0.1734</td><td>0.1808</td></tr>
<tr><td>Total</td><td>$7.3766</td><td>$4.4382</td></tr>
</table>

These figures indicate in a general way the costs of working in the State at the present time; they include distributed management, superintendence and royalties.

THE TRANSVAAL.

BY W. FISCHER WILKINSON.

The value of the gold produced in the Transvaal during 1904 was £16,054,809, an amount which is about on a level with the gold of the record year, 1898. Below will be found a table showing the gold production since the beginning of the industry.

Year.	Witwatersrand District.			Outside Mines Value.	Transvaal Total.
	Tons Milled.	Value.	Value per Ton Milled.		
		£	s.	£	£
1884-9..........	1,000,000	2,440,000	48.8	238,231	2,678,231
1890...........	730,350	1,735,491	47.4	134,154	1,869,645
1891...........	1,154,144	2,556,328	44.2	367,977	2,924,305
1892...........	1,979,354	4,297,610	43.4	243,461	4,541,071
1893...........	2,203,704	5,187,206	47.0	293,292	5,480,498
1894...........	2,830,885	6,963,100	49.2	704,052	7,667,152
1895...........	3,456,575	7,840,770	45.2	728,776	8,569,555
1896...........	4,071,697	7,864,341	39.2	739,480	8,603,821
1897...........	5,325,355	10,583,616	39.74	1,070,109	11,653,725
1898...........	7,331,446	15,141,376	41.3	1,099,254	16,240,630
1899a..........	6,639,355	14,046,686	41.14 }	661,220	15,728,693
1899b..........	233,395	1,020,787	..... }		
1900...........	459,018	1,510,131	65.82	....	1,510,131
1901...........	412,006	1,014,687	49.25	81,364	1,096,051
1902...........	3,416,813	7,179,074	42.00	74,591	7,253,665
1903...........	6,105,016	12,146,307	39.79	442,941	12,589,248
1904...........	8,058,295	15,539,219	38.56	515,590	16,054,809

(a) January to October. (b) November to December, supplementary (incomplete).

During 1904 the monthly yield of the Witwatersrand rose from £1,184,552 in January to £1,486,234 in December, and is now not far behind the record established in August, 1899, shortly before the outbreak of the war. The following table gives the figures for the two periods:

	Aug. 1899	Dec. 1904	Per Ct.
Number of stamps........	5,970	5,555	93.0
Tons milled...............	812,469	788,916	97.1
Value of yield............	£1,642,025	£1,486,234	90.5

Many stamps are still idle owing to the shortage of unskilled labor, but as this difficulty is now being surmounted, a constant increase in the output may be expected.

The number of mines that make returns is small, compared with the number of mining companies that have been formed. A recent report of the State Mining Engineer gives a total of 224 gold mines, of which 56 were producing, 38 developing and 130 not working on June 30, 1903, the date to which the returns were made up. The same report gives some statistics of the amounts expended on development and equipment, the figures of which, however, do not agree with those presented to Mr. Chamberlain by the Chamber of Mines, on the occasion of his visit to South Africa in 1902. That statement gave an expenditure of nearly £37,000,000 for 111 companies. The following is a summary of the report of the State Mining Engineer:

	Number of mines making returns.	Share capital issued.	Amount expended on shafts and development.	Amount expended on equipment.
GOLD MINES.				
Witwatersrand.				
Producing, dividend-paying	25	£11,833,750	£2 593,713	£5,371,193
Producing, non-dividend paying	23	10,916,108	2,927,727	5,197,963
Developing	29	13,148,592	2,825,696	3,985,635
Mines not working	96	29,513,040	1,421,076	2,555,495
	173	£65,411,490	£9,768,212	£17,110,286
Outside Districts.				
Total	51	10,738,780	670,960	1,405,460
Totals for gold mines	224	£76,150,270	£10,439,172	£18,515,746
COAL MINES.				
Producing	12	£3,609,880	£140,163	£573,980
Non-producing	5	625,250	25,980	25,935
Total for coal mines	17	£4,235,130	£166,143	£599,915
DIAMOND MINES. Total	6	856,375	14,547	46,041
Grand Totals	247	£81,241,775	£10,619,862	£19,161,702

The year 1904 opened with 52 companies on the active list, and up to December, 9 other mines had commenced milling, the number of stamps being increased from 4,367 in January to 5,555 in December. The accompanying table gives full particulars of the monthly returns:

	Witwatersrand Mines.					Outside Mines, £	All Transvaal, £
Month, 1904.	No. of Cos.	Tons Milled.	No. of Stamps.	Fine gold Oz.	Value, £		
January	53	606,389	4,367	278,867	1,184,552	42,294	1,226,846
February	55	607,703	4,565	282,436	1,199,712	30,014	1,229,726
March	56	653,675	4,688	299,625	1,272,726	36,603	1,309,329
April	56	640,294	4,710	297,470	1,263,572	36,004	1,299,576
May	57	672,974	4,810	306,586	1,302,294	33,532	1,335,826
June	58	652,050	4,790	299,913	1,273,949	35,282	1,309,231
July	57	661,069	4,705	298,825	1,269,328	38,293	1,307,621
August	57	678,684	4,760	301,113	1,279,047	47,421	1,326,468
September	57	666,026	4,785	301,131	1,279,123	47,383	1,326,506
October	58	701,729	4,905	313,928	1,333,481	49,686	1,383,167
November	59	728,786	5,185	324,011	1,376,311	51,636	1,427 947
December	61	788,916	5,555	349,889	1,486,234	52,566	1,538,800
Gold won in 1904, but not previously declared				4,447	18,890	14,876	33,766
		8,058,295		3,658,241	15,539,219	515,590	16,054,809

It will be noticed that the value of the yield per ton (38.56s.) for the year 1904 shows a decrease, but this falling off does not necessarily mean that the mines are getting poorer. It is due largely to the reduced expense of working; with lower cost it becomes profitable to mine a grade of ore which would otherwise be left in the mine and probably lost for all time.

The grade most profitable to maintain, having regard for the life of a mine, is a nice point involving elaborate actuarial calculations. In general, it may be said that the managers strive to approach the economic limits as closely as possible, so that a lowering of costs has the effect of preventing a waste of mineral wealth.

A study of the returns shows a marked decrease in working costs since the war, partly due to the lower price of dynamite and coal and partly to the attention that is paid to economy in every department. It is difficult to make comparisons at any mine for different periods, and still more so to compare one mine with another, because so many factors have to be taken into consideration, such as the scale of operations, cost of labor and material, width of stope, etc. The data supplied by the Rand Mines, Ltd., are invaluable in this connection;

Company.	1899.		1903		Reduction.	
	s.	d.	s.	d.	s.	d
Glen Deep	26	7	24	6	2	1
Rose Deep	22	9	17	8	5	1
Geldenhuis Deep	21	4	19	5	1	11
Jumpers Deep	28	10	22	11	5	11
Nourse Deep	30	6	27	10	2	8
Crown Deep	23	7	18	10	4	9
Langlaagte Deep	28		23	10	4	2
Durban Roodepoort Deep	36	6	27	10	8	8

These figures are a healthy sign, because, as has been pointed out so often, the future of the Rand is bound up with the possibility of working the low-grade ore, which is widely distributed over the Transvaal.

The most important event of the year has been the arrival of the Chinese miner. It was not without a great deal of opposition that the importation of indentured labor was allowed. The question whether it was either necessary or wise to introduce a foreign element was hotly debated in England and South Africa. The most violent opponents of the scheme looked upon it as a return of the slave trade, while the majority regarded it as necessary to the very life of the mining industry, the industrial backbone of the country, which was not expanding owing to the lack of unskilled labor. The ordinance to regulate the introduction into the Transvaal of unskilled, non-European laborers was passed in the Legislative Council at Pretoria on February 10, 1904, by an overwhelming majority.

The Chinese commenced to figure in the returns during June, when 1,004 were employed, a number which was increased in November to 19,316. This welcome addition to the labor supply caused a corresponding increase in the gold production, and had the effect of stimulating business in every direction, for, as more stamps were dropped, so additional employment was found for the white population. On this point some instructive figures may be quoted from a letter written by Lord Milner to a correspondent at home, and published in the English newspapers. He calculated that the introduction of 7,000 Chinese, which was about the number employed during August and September, had led to the increase of 1,000 white workmen, and assuming that half of those were married and had families of four children on an average, the direct result of the employment of these Chinese was an increase of 3,000 in the whites employed, not to mention the livelihood given to a larger number dependent on the activity of the mines.

The number of whites employed on the mines in October, 1904, was 14,525. The ratio of white to colored labor was 1 to 5.82. In July, 1899, the ratio was 1 to 8.578. The statistics of colored labor for the year are as follows:

1904.	Natives.	Chinese.	Total Colored Labor.
January	68,767	.....	68,767
February	69,966	......	69,966
March	72,340	......	72,340
April	72,577	......	72,577
May	70,778	......	70,778
June	68,857	1,004	69,861
July	67,294	1,384	68,678
August	65,848	4,947	70,795
September	68,545	9,039	77,584
October	71,661	12,968	84,629
November	74,233	17,476	91,709
December	76,611	20,918	97,529

The Chinaman has proved himself to be a good workman; he makes rapid progress in learning to drill, so that in a short time he can do as much as the best Kaffir. He has given very little trouble since his arrival, and is settling down to his new life with contentment. Great pains have been taken to make his life comfortable and to give him the food to which he is accustomed in his own country. As to the expense of procuring this labor no exact statistics have yet been published, but estimates have been made ranging from £12 to £25 per head. The contract is for three years, so that the expense per annum may be taken at about £7 or £8, without allowing for the expense of repatriation.

Turning now to the subject of white labor, I may draw attention to the fact that the conditions of living are now far more favorable than they were before the war. At that time there were comparatively few married men living with their families in South Africa. The conditions have so far changed that many men have their families on the spot, and intend making the Rand their home. The mining companies are encouraging their employees to do this, and are erecting comfortable cottages with small gardens attached. In connection with this point, some instructive figures were recently given by Mr. Samuel Evans at a meeting of the Langlaagte Deep Gold Mining Company: "In 1899 there were on the property only two families (including the manager's), and no children. To-day the figures as regards our white employees are:

Number married and housed on property (number of children 66)	39
Number of married employees who live with their families off the property	12
Number of married employees whose families are in England	37
Number of single men living at the mine	124

"We recognize that we have everything to gain by doing all we can to make the lives of our white employees happy and cheerful. The houses we have built for them are very comfortable four-roomed cottages, with bathroom, pantry, and from 3,000 to 3,400 square feet of garden and yard space. We propose erecting more of these cottages, as we want the forty-nine married men whose families are living elsewhere to be housed on the mine. It is a wise policy on our part to do all we can to induce our white employees to bring their families out and make this country their home, as the married man who is comfortably settled with his family is by far the best and most reliable workman."

On the same occasion Mr. Evans gave an interesting estimate as to the annual expenditure required for an importation of 50,000 Chinese.

Wages of white skilled laborers	£2,000,000
Wages of Chinese unskilled laborers	1,500,000
Cost of procuring Chinese (spread over three years)	200,000
Explosives	575,000
Fuel	670,000
Stores and supplies purchased through local dealers	1,795,000
Taxes paid to the Government	255,000
Sundry expenses and stores purchased outside of South Africa	290,000
Total	£7,285,000

This works out at £146 per annum per unskilled laborer. It will be seen that the estimated cost of importing a Chinaman is £12 per head per annum.

Turning now to the progress of the industry in technical matters, mention must be made of the introduction of tube-mills for fine grinding. This machine has been used for some time past on the gold mines of Western Australia, where the ores have been ground finer than has been the practice on the Rand. Experiments have shown that finer grinding than has been customary will pay, and it is claimed that the finest grinding can be done better by the tube-mill or some other form of grinding machine than by the stamp. On several mines tube-mills have been installed and many more have been ordered. To what extent machines supplementary to stamps will be introduced, or what is the best machine, has not yet been determined. It may, however, be said that changes in the ordinary practice are taking place and that the standard plant of the future will probably be a combination of stamps and fine grinders. Experiments are also being made in the use of filter-presses, and, provided a rapidly discharging press is found, this method, for which quicker treatment and higher extraction are claimed, may take the place of the decantation process in the treatment of slime.

As regards the effect of these changes on the economical results, it has been calculated that on an average 10 dwt. ore an additional extraction of 50c. (2s.) per ton may be made, giving a net profit of 25c. (1s.) per ton. On last year's tonnage of 8,000,000 tons this would mean a saving of $2,000,000 (£400,000).

The total dividends for the year amounted to £3,911,093, and show a considerable increase on the previous year. The following table shows the dividends declared since 1896:

DIVIDEND LIST. RAND GOLD MINING COMPANIES.

Year.	No. of Companies.	Amount paid.
1896	21	£1,530,381
1897	25	2,707,180
1898	41	4,847,505
1899	36	2,933,251
1900	..	....
1901	5	415,813
1902	23	2,148,715
1903	29	3,345,499
1904	33	3,911,093

There has been great activity in boring, especially at the eastern end of the Rand, with the result that much information has been obtained regarding the extension of the mining area. While the Witwatersrand district is responsible for the great bulk of the gold produced, outside districts have also made a considerable contribution, to the extent of half a million sterling.

Besides gold, the Transvaal promises to be an important producer of diamonds, one mine, the Premier, having yielded during the period of July 1, 1903, to March 31, 1904, 195,739½ karats, valued at £264,649. The output for the Transvaal has been:

	Carats.	Value.
Year ending June 30, 1903	33,572.57	£46,358
Year ending June 30,1904	497,917.14	685,720
July, Aug. Sept. Oct, 1904	366,310.94	491,064

Mining for base metals has not yet reached large proportions, but with the influx of population and a reduction in the cost of living, there is reason to hope that before long mining for copper, iron and other ores may be carried on. Speaking generally, the mining industry is in a healthy condition, with promise of a considerable expansion in the coming year.

THE MINING STOCK EXCHANGES IN 1904.

In the following pages are summarized the fluctuations and the transactions in the mining and industrial shares listed on the more important exchanges in the United States and in London. In the United States speculation during the year has been most active in the steel and copper shares, while in London the event of greatest importance has been the introduction of Chinese labor on the Rand:

FLUCTUATIONS OF MINING STOCKS AT NEW YORK IN 1904.

Name of Company.	Par Val.	January.		December.		Year, 1904.		Sales.
		High.	Low.	High.	Low.	High.	Low.	
Amalgamated, Mont.	$100	$52.00	$47.50	$82.75	$61.50	$82.75	$43.12½	$10,662,073
Anaconda, Mont.	25	19.62½	18.00	29.62½	23.75	30.22	15.25	180,203
Belcher, Nev.	1	.70	.33	....	....	.70	.18	8,200
Best & Belcher, Nev.	3	3.50	2.10	1.22	1.10	3.50	.60	4,900
Brunswick Con., Cal.	1	.06½	.05	.16	.10	.20	.03	65,420
Caledonia, Nev.	1	1.50	.80	.49	.42	1.50	.35	10,860
Chollar, Nev.	2½	.38	.21	.26	.20	.38	.08	21,722
Confidence, Nev.	3	1.10	1.00	.85	.75	1.15	.65	5,850
Consolidated California and Virginia, Nev.	2½	3.20	1.15	2.10	1.50	3.20	1.00	35,998
Crown Point, Nev.	1	.40	.23	.21	.15	.40	.11	12,500
Daly, Utah	20	2.00	1.80	2.00	2.00	2.25	1.80	595
Elkton Con., Col.	1	.63	.45	.74	.63	.72	.45	40,563
El Paso, Col.	1	.60	.60	1.15	1.15	.95	.60	18,500
Federal, com., Idaho	100	....	....	68.00	60.12½	68.00	43.50	8,345
Federal, pf., Idaho	100	....	....	85.00	75.50	85.00	72.00	2,920
Gould & Curry, Nev	1	.75	.35	.25	.25	.75	.13	13,500
Green Con. Copper, Mex.	10	14.50	11.50	34.75	18.50	34.75	9.87½	1,404,347
Hale & Norcross, Nev.	3	1.00	.60	1.20	.95	1.20	.55	19,400
Homestake, S. Dak.	100	50.25	50.25	73.00	72.00	73.00	49.50	1,831
Horn Silver, Utah	25	1.25	1.15	1.55	1.50	1.65	1.15	8,610
Iron Silver, Colo.	20	....	....	1.55	1.55	2.10	1.85	2,013
Isabella, Colo.	1	.14	.09½	.30	.25	.37	.09½	70,409
Justice, Nev.	1	.22	.10	.10	.10	.23	.07	23,200
Little Chief, Colo.	50	.08	.07	.06	.05	.09	.05	10,950
Mexican, Nev.	3	4.00	1.50	1.35	1.00	4.00	.78	22,850
Mollie Gibson, Colo.	5	.06½	.06	.04	.04	.08	.04	29,300
Moon Anchor, Colo.	5	.10	.10	.08	.07	.11	.07	32,300
Moulton, Mont	25	.24	.20	.15	.14	.24	.14	2,800
Occidental Con., Nev.	3	.55	.50	.82	.81	1.80	.50	3,500
Ontaria, Utah	100	4.50	4.50	4.37½	3.50	4.75	3.50	3,260
Ophir, Nev.	3	7.50	3.60	3.70	2.50	7.50	2.20	23,385
Overman, Nev.	2	.39	.34	....	....	.39	.12	10,130
Phoenix, Ariz.	1	.15	.09	.15	.10	.30	.04½	420,720
Portland, Colo.	1	1.60	1.20	1.75	1.70	2.10	1.20	15,985
Potosi, Nev.	1	.46	.21	.17	.12	.46	.08	29,720
Quicksilver, com., Cal.	100	....	....	2.50	2.00	2.50	.75	15,339
Quicksilver, pf., Cal.	100	6.00	5.25	6.00	4.00	7.00	3.62½	4,200
Savage, Nev.	3	.80	.47	.28	.17	.80	.17	237,500
Sierra Nevada, Nev.	3	1.20	.65	.52	.42	1.20	.22	18,700
Silver Hill, Nev.	1	.83	.68	.65	.57	.83	.54	9,406
Small Hopes, Colo.	20	.30	.30	.26	.26	.30	.20	3,400
Standard Con., Cal.	10	2.00	2.00	1.90	1.70	2.75	1.70	9,821
Tennessee Copper	25	32.00	28.00	43.75	34.00	43.75	26.50	127,520
Union Con., Nev.	1	1.80	.75	.60	.48	1.80	.32	15,900
United Copper com., Mont.	100	8.00	5.87½	12.50	5.00	12.50	5.00	27,095
White Knob, Idaho	10	9.00	6.50	.62½	.43½	9.00	.43½	808,990
Work, Colo.	1	.08	.04½	.13	.09	.13	.03	79,200
Yellow Jacket, Nev.	1	.53	.44	.23	.15	.53	.15	11,326
Total sales, 14,600 856 shares								

FLUCTUATIONS OF COAL AND INDUSTRIAL STOCKS IN 1904.

Name of Company.	Par Val.	January.		December.		Year, 1904.		Sales.
		High.	Low.	High.	Low.	High.	Low.	
Allis-Chalmers, com	$100	$ 8.75	$ 7.00	$19.87½	$16.00	$21.37½	$ 6.00	82,006
Allis-Chalmers, pf	100	66.00	55.00	71.00	59.00	71.00	39.50	22,223
Am. Agric. Chem., com	100	14.75	14.50	24.62½	21.00	24.62½	13.00	9,846
Am. Agric. Chem., pf	100	75.87½	72.75	87.00	80.00	87.00	72.75	1,718
Am. Sm. & Ref., com	100	51.50	47.50	82.50	75.75	82.50	46.00	1,723,056
Am. Sm. & Ref., pf	100	94.50	88.75	113.50	111.62½	115.00	88.75	235,579
Col. Fuel & Iron, com	100	34.50	27.62½	58.00	40.62½	58.37½	25.50	1,451,685
Col. Fuel & Iron, pf	100	65.00	50.00	95.00	90.00	95.00	95.00	8,610
General Chemical, com	100	58.50	55.00	65.00	60.00	65.00	43.00	2,066
General Chemical, pf	100	....	....	102.00	100.00	102.00	94.00	2,741
Mong. River Coal, com	100	....	....	11.00	10.12½	11.00	8.00	5,785
Mong. River Coal, pf	100	29.00	25.00	32.00	28.87½	32.00	19.00	21,507
National Lead, com	100	16.50	14.50	25.50	22.00	26.25	14.12½	455,700
National Lead, pf	100	85.25	79.75	98.00	96.37½	98.00	79.75	23,307
Pittsburg Coal, com	100	15.25	10.00	26.12½	22.00	26.12½	10.00	93,780
Pittsburg Coal, pf	100	59.00	47.87½	85.00	82.00	85.00	47.87½	135,742
Republic Iron & Steel, com.	100	8.75	6.50	18.00	14.50	18.25	6.00	393,732
Republic Iron & Steel, pf.	100	49.50	40.50	72.00	65.37½	73.50	37.00	366,912
Sloss-Sheffield St. & I., com.	100	39.00	31.25	63.50	58.50	65.37½	31.25	116,292
Sloss-Sheffield St. & I., pf.	100	79.25	77.00	105.00	102.00	105.00	77.00	10,682
Standard Oil	100	674.00	649.00	639.00	624.50	674.00	590.00	7,018
Tenn. Coal & Iron	100	40.00	35.00	77.12½	63.00	77.50	31.62½	1,294,327
U. S. Steel, com	100	12.62½	9.62½	33.12½	25.00	33.12½	8.37½	12,086,262
U. S. Steel, pf	100	60.00	54.62½	95.62½	84.75	95.62½	51.25	16,650,013
Va.-Car Chem., com	100	34.37½	27.00	44.12½	39.50	44.12½	22.75	326,907
Va.-Car. Chem., pf	100	106.25	98.00	114.00	110.00	114.50	96.00	109,976

Total sales, 35,077,472 shares.

FLUCTUATIONS OF MINING STOCKS AT BOSTON IN 1904.

Name of Company.	Par Val.	January.		December.		Year, 1904.		Sales.
		High.	Low.	High.	Low.	High.	Low.	
Adventure, Mich.	$25	$ 3.50	$ 2.25	$ 6.75	$ 5.50	$ 7.75	$ 1.75	55,094
Allouez, Mich.	25	5.00	4.37½	19.87½	17.00	21.00	3.37½	258,301
American Zinc & Lead, Mo.	25	10.50	10.00	13.12½	11.75	14.00	8.00	22,616
Arcadian, Mich.	25	1.00	.75	2.00	1.12½	3.00	.25	30,208
Atlantic, Mich.	25	8.75	7.75	18.00	15.00	22.25	7.00	126,120
Bingham, Utah	50	24.00	22.00	37.75	33.00	38.75	19.00	257.516
Boston Con., Cal.	5	....	....	7.75	6.12½	7.87½	6.12½	126,859
Calumet & Hecla, Mich.	25	455.00	435.00	680.00	645.00	700.00	435.00	4,395
Centennial, Mich.	25	17.75	15.00	29.25	24.00	33.00	14.62½	202,483
Con. Mercur, Utah	5	.75	.60	.40	.33	.75	..33	119,023
Copper Range, Mich.	100	47.75	44.50	71.87½	64.00	74.50	38.00	684,467
Daly-West, Utah	20	36.50	34.00	13.50	12.00	36.50	11.62½	106,904
Franklin, Mich.	25	9.25	8.00	13.00	11.00	15.00	7.87½	37,315
Granby, B. C.	10	4.00	3.25	5.50	4.75	5.87½	3.00	436,287
Guanajuato, Mex.	5	.97½	.75	4.25	3.12½	4.25	.62½	86,496
Isle Royale, Mich.	25	9.50	7.00	26.75	20.00	35.50	7.00	206,101
Mass. Con., Mich.	25	4.87½	4.00	10.00	8.00	10.00	3.00	59,746
Michigan, Mich.	25	6.50	4.75	10.00	8.25	11.00	4.25	48,159
Mohawk, Mich.	25	39.50	35.62½	56.00	49.87½	57.75	34.12½	111,480
Old Colony, Mich.	25	1.25	1.00	1.50	1.25	2.50	.87½	15,723
Old Dominion, Ariz.	25	12.00	9.50	27.50	23.50	29.00	9.00	136,134
Osceola, Mich.	25	62.87½	58.50	97.00	89.00	98.00	53.00	77,537
Parrot, Mont.	10	23.50	21.00	32.00	25.50	23.50	21.00	72,217
Quincy, Mich.	25	103.00	94.75	117.00	99.00	125.00	80.00	10,023
Rhode Island, Mich.	25	1.12½	1.00	2.37½	1.50	3.00	1.00	11,594
Shannon, Ariz.	10	9.25	7.25	9.75	6.87½	10.50	6.50	555,011
Tamarack, Mich.	25	120.00	100.00	128.00	115.00	140.00	94.00	10,236
Trinity, Cal.	25	5.25	4.87½	14.50	9.00	18.50	4.62½	337,510
United States, Utah	25	22.00	18.00	28.75	23.50	28.75	19.75	633,140
Utah, Utah	5	35.50	30.00	46.12½	40.00	47.00	30.00	1,553,158
Winona, Mich.	25	7.50	6.50	12.50	10.00	13.50	5.00	93,029
Wolverine, Mich.	25	73.50	68.00	108.00	104.00	110.00	68.00	20,899

Total sales, 6,305,771 shares.

FLUCTUATIONS OF MINING SHARES AT LONDON IN 1904.

Company.	Shares Issued.	Par value.	Latest Dividend.		January 12.		April 15.		July 15.		October 20.		December 15.	
			Amt.	Date.	Buyers.	Sellers.	Buyers.	Sellers.	Buyers.	Sellers.	Buyers.	Sellers.	Buyers.	Sellers.
American:		£ s. d.	s. d.		L s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Alaska-Treadwell.....	200,000	5 0 0	4 0	Oct., 1904	4 10 0	4 15 0	4 11 3	4 13 9	4 10 0	4 15 0	4 12 6	4 17 6	4 17 6	5 2 6
Anaconda............	1,200,000	5 0 0	2 0	Nov., 1904	3 16 3	3 18 9	3 13 9	3 16 3	3 16 3	3 18 9	4 15 0	4 17 6	5 0 0	5 2 6
Camp Bird..........	820,000	1 0 0	9	Nov., 1904	1 5 0	1 6 3	1 5 0	1 6 3	1 6 3	1 8 9	1 8 3	1 8 9	1 8 3	1 8 9
Copiapo.............	112,500	2 0 0	5 0	Oct., 1904	17 6	1 2 6	1 0 0	1 5 0	1 0 0	1 5 0	1 0 0	1 5 0	1 0 0	1 5 0
De Lamar............	80,000	1 0 0	2 0	Nov., 1904	10 0	12 6	12 6	15 0	13 9	16 3	16 3	18 9	15 0	1 0 0
El Oro...............	1,080,000	1 0 0	9	July, 1904	1 5 0	1 7 6	1 1 3	1 3 9	1 2 6	1 5 0	18 9	1 1 3	1 1 9	1 2 11
Frontino & Bolivia....	140,000	1 0 0	rts.	Mar., 1904	6 3	8 9	7 6	10 0	6 3	8 9	8 6	9 3	10 6	11 6
Le Roi...............	200,000	5 0 0	5 0	Nov., 1899	12 6	15 0	1 10 0	1 12 6	13 9	16 3	13 9	16 3	16 3	18 9
Le Roi, No.2.........	120,000	5 0 0	1 0	June, 1904	16 3	18 9	17 6	1 0 0	13 9	16 3	11 3	13 9	18 9	1 1 3
Stratton's Independ...	1,000,007	1 0 0	6	Dec., 1904	4 9	5 3	4 3	4 9	2 3	2 9	3 6	4 0	5 6	6 0
St. John del Rey......	546,265	1 0 0	6	Dec., 1904	14 0	15 0	13 6	14 6	*9 6	10 6	12 6	13 9	13 0	14 0
Tomboy.............	300,000	1 0 0	1 0	Dec., 1904	1 12 6	1 17 6	1 5 0	1 10 0	1 5 0	1 10 0	17 6	1 2 6	1 5 0	1 7 6
Ymir................	200,000	1 0 0	1 0	Mar., 1902	3 9	6 3	2 6	5 0	2 6	5 0	2 6	5 0	3 9	6 3
European:														
Linares..............	15,000	3 0 0	5 0	Sept., 1904	2 10 0	3 0 0	3 15 0	4 5 0	3 0 0	3 10 0	3 5 0	3 15 0	4 0 0	4 5 0
Mason & Barry	185,172	1 0 0	7 0	May, 1904	3 10 0	3 15 6	3 17 6	4 2 6	2 17 6	3 2 6	2 17 6	3 2 6	3 2 6	3 7 6
Rio Tinto............	325,000	5 0 0	32 6	Nov., 1904	49 17 6	50 2 6	53 2 6	53 7 6	53 10 0	53 15 0	58 2 6	58 7 6	60 7 6	60 12 6
Rio Tinto, pref.......	325,000	5 0 0	2 6	Nov., 1904	5 17 6	6 2 6	6 0 0	6 5 0	6 0 0	6 5 0	6 2 6	6 7 6	6 2 6	6 7 6
Tharsis..............	625,000	2 0 0	7 0	May, 1904	4 12 6	4 17 6	4 12 6	4 17 6	4 2 6	4 7 6	4 17 6	5 2 6	5 5 0	5 10 0
West Australian:														
Associated..........	495,388	1 0 0	2 6	July, 1904	2 12 6	2 15 0	2 17 6	3 0 0	2 6 3	2 8 9	2 2 6	2 3 9	1 17 6	2 0 0
Cosmopolitan.........	400,000	1 0 0	1 0	April, 1904	15 3	15 9	12 6	13 6	9 3	9 9	6 9	7 3	6 3	6 9
Golden Horseshoe.....	300,000	5 0 0	6 0	Nov., 1904	8 16 3	8 18 9	8 6 3	8 8 9	7 6 3	7 8 9	6 18 9	7 1 3	7 0 0	7 2 6
Great Boulder........	1,750,000	2 0	9	Dec., 1904	1 6 9	1 7 3	1 7 3	1 7 9	*1 3 6	1 3 9	19 9	1 0 3	1 2 0	1 2 6
Gt. Boulder Persever..	1,400,007	1 0 0	1 0	Sept., 1904	....	....	1 4 0	1 4 6	11 0	11 6	12 9	13 9	10 6	11 0
Great Fingall.........	250,000	1 0 0	7 0	Oct., 1904	8 1 3	8 3 9	*8 6 3	8 8 9	*7 18 9	8 1 3	7 18 9	8 1 3	8 1 3	8 3 9
Ivanhoe.............	200,000	5 0 0	5 0	Oct., 1904	8 16 3	8 18 9	8 11 3	8 13 9	7 10 0	7 12 6	7 11 3	7 13 9	7 15 0	7 17 6
Kalgurli.............	120,000	1 0 0	2 6	Jan., 1905	5 10 0	5 15 0	*5 12 6	5 15 0	*5 5 0	5 7 6	*5 12 6	5 15 0	6 3 9	6 6 3
Lake View...........	250,000	1 0 0	1 6	Oct., 1904	1 8 9	1 11 3	1 5 0	1 7 6	1 3 9	1 5 0	1 3 9	1 6 3	1 3 9	1 5 0
Oroyo-Brownhill.....	450,000	1 0 0	4 0	Dec., 1904	3 13 9	3 16 3	3 7 6	3 8 9	*3 3 9	3 6 3	3 10 0	3 12 6	3 12 6	3 13 9
Miscellaneous:														
Brilliant Central......	100,000	1 0 0	1 0	Dec., 1904	*2 17 6	3 2 6	2 17 6	3 2 6	*2 15 0	3 0 0	2 0 0	2 5 0	1 0 0	1 5 0
Briseis.	600,000	1 0 0	......	....	6 0	6 6	9 0	10 0	8 0	8 6	11 9	12 3	8 6	9 6
Broken Hill..........	960,000	8 0	1 0	Nov., 1904	1 8 6	1 9 6	1 14 0	1 15 0	1 17 6	1 18 9	2 1 6	2 2 6	2 3 6	2 4 6
Mt. Lyell............	1,200.000	3 0 0	1 3	June, 1904	19 0	1 0 0	19 6	1 0 6	*13 0	14 0	10 0	11 0	15 0	16 0
Mt. Morgan..........	1,000,000	1 0 0	3	Dec., 1904	2 2 6	2 7 6	*2 5 0	2 10 0	2 5 0	2 7 6	*2 12 6	2 15 0	2 16 3	2 18 9
Waihi...............	497,412	1 0 0	2 6	Dec., 1904	4 17 6	5 0 0	5 12 6	5 15 0	5 8 9	5 11 3	5 15 0	5 17 6	5 18 9	6 1 3

* Ex-dividend.

Company.	Shares Issued.	Par value.	Latest Dividend. Amt.	Latest Dividend. Date.	January 12. Buyers.	January 12. Sellers.	April 15. Buyers.	April 15. Sellers.	July 15. Buyers.	July 15. Sellers.	October 20. Buyers.	October 20. Sellers.	December 15. Buyers.	December 15. Sellers.
Indian:														
Champion Reef	2,000,000	10 0	1 5	Jan., 1905	8 1 3	8 3 9	1 15 6	1 16 6	1 12 6	1 13 9	1 11 6	1 12 6	1 13 0	1 14 0
Mysore	580,000	10 0	4 6	Nov., 1904	6 11 3	6 13 9	6 7 6	6 10 0	*6 8 9	6 11 3	6 10 0	6 12 6	6 8 9	6 10 0
Nundydroog	484,000	10 0	1 6	Nov., 1904	2 3 9	2 6 3	1 16 3	1 18 9	1 12 6	1 13 9	1 15 0	1 16 3	1 12 6	1 13 9
Ooregum	683,000	10 0	9	Dec., 1904	1 1 3	1 3 9	1 0 0	1 2 6	17 6	18 9	17 6	18 9	18 0	19 0
Ooregum, preferred	240,000	10 0	9	Dec., 1904	1 11 3	1 13 9	1 8 9	1 11 3	1 8 9	1 11 3	1 6 3	1 8 9	1 6 3	1 8 9
South African:														
Angelo	600,000	1 0 0	7 0	Aug., 1904	6 10 0	6 15 0	6 12 6	6 17 6	7 0 0	7 2 6	6 1 6	7 0 0	7 1 3	7 3 9
Bonanza	200,000	1 0 0	7 0	Feb., 1905	2 3 9	2 6 3	1 11 3	1 13 9	1 5 0	1 7 6	1 2 6	1 5 0	1 5 0	1 7 6
British So. Africa	4,568,392	1 0 0	rts.	May, 1899	2 2 4	2 3 6	2 2 6	2 3 9	1 8 9	1 11 3	1 7 6	1 8 9	2 5 3	2 6 5
Cape Copper	300,000	2 0 0	6	Jan., 1905	3 2 6	3 7 6	3 0 0	3 5 0	*3 2 6	3 7 6	4 2 6	4 5 0	4 15 0	4 17 6
Cape Copper, pref.	45,000	2 0 0	6	Jan., 1905	3 0 0	3 5 0	2 15 0	3 0 0	*3 0 0	3 5 0	4 0 0	4 5 0	4 2 6	4 7 6
City & Suburban	340,000	4 0 0	6 0	Feb., 1905	6 11 3	6 13 9	6 15 0	6 17 6	6 2 6	6 7 6	5 2 6	5 5 0	6 0 0	6 5 0
Consol. Goldfields	2,000,000	1 0 0	2 6	Nov., 1904	6 3 9	6 6 3	6 13 9	6 15 0	6 5 0	6 7 6	6 10 0	6 12 6	8 3 9	8 5 0
Crown Reef	120,000	1 0 0	18 0	Nov., 1904	17 0 0	17 10 0	16 15 0	17 5 0	14 5 0	14 15 0	15 15 0	16 5 0	15 15 0	16 5 0
De Beers, preferred	800,000	2 10 0	10 0	Feb., 1905	19 3 9	19 6 3	18 13 9	18 18 9	18 11 3	18 13 9	18 1 3	18 3 9	17 18 9	18 1 3
De Beers, deferred	1,000,000	2 10 0	2 0	Feb., 1905	19 17 6	20 0 0	19 12 6	19 15 0	18 16 3	19 1 3	18 0 0	18 2 6	17 18 9	18 1 3
East Rand	990,000	1 0 0	5 0	July. 1903	6 13 9	6 15 9	7 12 6	7 13 9	7 11 3	7 13 9	8 7 6	8 10 0	9 2 11	9 4 1
Ferreira	95,000	1 0 0	22 6	Aug., 1904	19 10 0	20 0 0	20 15 0	21 5 0	20 10 0	21 0 0	20 15 0	21 5 0	23 0 0	23 10 0
Geldenhuis Estate	200,000	1 0 0	5 0	Feb., 1905	6 2 6	6 5 0	5 12 6	5 15 0	5 6 3	5 8 9	5 10 0	5 12 6	5 12 6	5 15 0
Geduld	400,000	1 0 0	rts.	Mar., 1902	6 3 9	6 5 0	6 12 6	6 15 0	6 2 6	6 5 0	6 13 9	6 16 3	7 11 3	7 13 9
Henry Nourse	125,000	1 0 0	8 0	Feb., 1905	8 12 6	8 17 6	8 17 6	9 2 6	8 5 0	8 10 0	8 5 0	8 10 0	8 5 0	8 10 0
Jubilee	50,000	1 0 0	5 0	Feb., 1905	4 12 6	4 17 6	4 15 0	5 0 0	4 5 0	4 15 0	4 10 0	4 15 0	3 15 0	4 5 0
Jumpers	100,000	1 0 0	2 6	May., 1904	3 0 0	3 5 5	3 5 0	3 10 0	2 15 0	3 0 0	2 17 6	3 2 6	2 12 6	2 15 0
Langlaagte	470,000	1 0 0	2 0	Feb., 1905	3 11 3	3 13 9	3 15 0	3 17 0	3 11 3	3 13 9	3 16 3	3 18 9	3 18 9	4 1 3
May	288,750	1 0 0	4 0	Feb., 1905	4 0 0	4 2 6	4 3 9	4 6 3	3 17 6	4 0 0	4 0 0	4 2 6	4 3 9	4 6 3
Meyer & Charlton	100,000	1 0 0	5 0	Jan.,., 1905	5 12 6	5 17 6	5 7 6	5 12 6	5 7 6	5 12 6	5 5 0	5 10 0	5 7 6	5 12 6
Modderfontein	290,000	1 0 0	rts.	April, 1902	8 8 9	8 11 3	9 6 3	9 8 9	8 7 6	8 10 0	9 13 9	9 16 3	10 17 6	11 0 0
Namaqua	94,331	2 0 0	2 6	June, 1904	3 0 0	3 5 0	3 5 0	3 10 0	2 15 0	3 0 0	3 0 0	3 5 0	3 10 0	3 12 6
New Jagersfontein	200,000	5 0 0	15 0	Dec., 1904	28 2 6	28 7 6	28 5 0	28 15 0	*27 5 0	27 15 0	27 5 0	27 15 0	28 15 0	29 5 0
New Primrose	325,000	1 0 0	3 0	Aug., 1904	3 13 9	3 16 3	3 18 9	4 0 0	3 12 6	3 15 0	3 11 3	3 13 9	3 8 9	3 11 3
Rand	1,795,956	5 0	5 0	Aug., 1904	9 11 3	9 12 6	10 7 6	10 8 9	10 2 6	10 3 9	10 13 9	10 16 3	11 11 3	11 13 9
Robinson	550,000	5 0 0	8 0	Feb., 1905	9 12 6	9 17 6	9 17 6	10 2 6	9 5 0	9 10 6	9 12 6	9 17 6	10 5 0	10 10 0
Robinson Deep	950,000	1 0 0	3 0	Aug., 1904	5 5 0	5 10 0	5 11 3	5 13 9	5 7 6	5 10 0	5 5 0	5 7 6	6 0 0	6 2 6
Rose Deep	425,000	1 0 0	3 0	Feb., 1905	7 15 0	8 0 0	8 10 0	8 15 0	8 12 6	8 17 6	8 12 6	8 17 6	8 17 6	9 2 6
Salisbury	100,000	1 0 0	2 0	Jan., 1905	1 12 6	1 17 6	2 2 6	2 5 0	*1 12 6	1 15 0	1 15 0	2 0 0	1 12 6	1 15 0
Village Main Reef	400,000	1 0 0	4 0	July, 1904	7 7 6	7 12 6	7 3 9	7 6 3	6 10 0	6 15 0	6 10 0	6 15 0	7 2 6	7 7 6
Wemmer	80,000	1 0 0	12 6	Dec., 1904	11 0 0	11 10 0	10 17 6	11 2 6	*10 10 0	11 0 0	10 10 0	11 0 0	10 15 0	11 5 0

DIVIDEND AND ASSESSMENT TABLES.

In the following pages are given in tabular form the amount of the dividends paid and the assessments (not installments on capital stock) levied by American mining and industrial companies, for a period of years ending with 1904. The names of many new companies appear this year, for the first time. The figures are necessarily incomplete, since numerous companies do not make reports, and the facts cannot be obtained by inquiry. Many mines are worked by individuals, and by private firms, and if their profits could be included the total dividends shown would be materially increased.

DIVIDENDS PAID BY AMERICAN MINES AND INDUSTRIAL COMPANIES.
$1=$1,000; Total, full amount.

Name of Company.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total Paid.
Aberdeen, c., N. M.					$32				$32,175
Acacia, g., Colo				$43			$14	$29	86,349
Adams, s.l., Colo				88	15	$23			733,500
Ætna Con., q., Cal	$40	$40	$60	15					225,000
Ala. Con. Coal & I., pf.A			44	130	172	172	172	172	862,148
Ala. & Ga. Iron, pf							7		6,500
Alamo, g., Utah			3						2,500
Alaska Goldfields, Alas.			125		135		135		395,000
Alaska Mexican, g., Alas	90	72	72	72			108	189	762,381
Alaska Tr'dwell, g., Alas	300	300	300	30	300	300	450	525	5,800,000
Allis-Chalmers, pf					569	1,138	1,138	350	3,213,750
Alma Oil, Cal							46	12	57,600
Alpha Oil, Cal					1				1,250
Altoona Coal & Coke, Pa.					75				75,000
Amalgamated, c., Mont.			1,500	6,000	8,304	3,847	3,078	3,078	25,812,127
Amanda, g., Colo				10					10,000
American, g.s.l., Colo,	36	54	60						446,000
American Agri. Chem, pf			510	1,020	1,025	1,028	1,088	1,072	5,742,740
American Cement, Pa.			60	80	160	160	160	160	700,000
American Coal, Md	120	135	150	255	150	150	150	125	1,557,500
American Fuel Oil, Cal.			3	12	1				16,000
American Mexican, Mex								103	102,845
Am. Sm. & Ref., pf			1,13	1,545	2,709	3,500	3,500	3,500	15,891,553
Am. Sm. & Ref., com								2,500	2,500,000
Am. Zinc-Lead Sm., Mo			120	60					180,000
Amistad y Concordia, Mex					17	63	86	76	241,648
Anaconda, c., Mont.		3,000	3,900	4,800	3,900	1,200	1,200	1,200	24,450,000
Anchoria-Leland, g., Col.	72	72	36						198,000
Anderson, g., Colo				15					15,000
Anglo-Mex. g., Mexico	90	180	180						1,825,048
Annie Laurie, g.s., Utah						140	150	100	390,061
Apollo Con., g., Alaska	100		40	70					110,000
April Fool, g., Nev			16						16,000
Argentum-Juniata,s.,Col			42						198,000
Argonaut, g., Cal		180	240	70					490,000
Arizona, c.s., Ariz		405	484	576	1,634	896	673	821	5.489,503
Associated, g., Colo.		50	12						62,000
Atlantic, c., Mich.	40	40		80	80				940,000
Aztec Oil, Cal					12	16	14		43,950
Bald Butte, g., Mont.	83	98	150	38	180	160	15	25	1,337,148
Bartolome de Medina, M						20	17	19	98,621
Barreno, g.s., Mex.							14	6	73,990
Big Four, g., Colo				15					15,000
Big Six, g.s.l., Colo							3		17,500
Blue Bird Extension, U.					1				834
Bon Air, c.& i., Tenn., pf.						24	133	113	249,757
Bonanza Dev.,g.,N.Mex			1,050						1,050,000
Bonanza King, g., Colo.								3	5,000
Boston, q., Cal			20						20,000
Boston & Colo.,Sm.,Colo			56	34	45	95			402,350

DIVIDENDS PAID BY AMERICAN MINES AND INDUSTRIAL COMPANIES.—*Continued.*

Name of Company.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total Paid.
Boston & Mont.,c.s.,M't.	$1,800	$1,950	$5,375	$6,450	$5,250	$400	$1,200	$10,200	$38,525,000
Boston-Calif. g., Cal			72						72,000
Boston Gold-Cop.Sm.Col.				50	100				150,000
Boston & Oroville, g., Cal								125	125,000
Boston-S. Dak.,g., S. Dk				10					10,000
Bosun, s.l., B. C.					13				12,500
Breece, i.s., Colo		10	40	30	70	20	10		200,000
Buckhorn Oil, Cal				4	4				7,200
Buena Vista, g.s., Mex.							5		5,000
Buffalo Hump, g., Idaho				275	25				300,000
Bull Hill Con.,g., Colo.				15	38				52,500
Bull'n-Beck & Ch.g.s.,U	170	90	120	60					1,498,400
Bunker Hill & Sull.,s.l.,I	102	228	201	252	252	138	96	738	2,264,000
Burlington Oil, Cal				3					3,600
Butler-Liberal, g.s., U.							3		2,500
Butters' Sal'dor,g.,C.A.						75	263	188	525,000
Butte & Boston c.s.l.,Mt.				1,000	600			200	1,800,000
Butterfly-Terrible,g.,Col.					31				31,250
California, g., Cal					43				43,200
Calumet & Arizona,c.,Ar							400	1,300	1,700,000
Calumet & Hecla,c.,Mich	5,000	5,000	10,000	7,000	4,500	2,500	3,500	4,000	87,350,000
Cambria Iron, Pa			339	339	339	339	339	339	2,032,265
Cambria Steel, Pa			660	940	2,150	1,350	1,350	1,350	7,800,000
Camp Bird, g., Colo						125	843	787	1,754,904
Cariboo-McKin'y,g.,B.C	48	67	72	86		19		50	546,837
Carisa, g.s.c., Utah					30				30,000
Carmen (Hidalgo) Mex.							9	13	91,302
Carmen-Guana'to, Mex.							18		17,750
Cashier, g.s., Colo							18	8	26,160
Center Creek, l.z., Mo.			10	30	30	20	40	40	170,000
Center Star, g., B. C.				35	175				210,000
Central, l., Mo	28	54	60	65	60	60	60	50	435,000
Central C.& C. com.,Mo.						86	308	308	858,750
Central C. & C., pf., Mo.						84	94	94	890,620
Central Eureka, Cal.					16	8	96	211	447,159
Cen'ial-Eureka, s.g.l., U	98	15	120	268	200	50		100	2,767,700
Central Oil, W. Va.				73	25	25	30	30	182,500
Central Pt. Con.,Oil, Cal.				4	38				45,600
Century, g.s.l., Utah							9	21	30,000
Champion, g., Cal	51	26	35						321,700
Champion, c., Mich							300	300	600,000
C. K. & N., g.s., Colo						14	57	10	171,848
Cherry Hill, g., Cal					23	30			62,500
Chicago Oil, Cal						10			10,000
Chippewa Con.,g.s.l.,Col						3			2,500
Cinco Sonores, Mex.					9	57	57		711,935
Claremont Oil, Cal								32	31,500
Clinton, g.s., Colo							36		60,000
Colo. City Mg.& Leas.,Co.						65			65,000
Colo. Fuel & Iron,Co.com					682	805			1,642,500
Colo.Fuel & Iron,Colo.,p	80			800	160	160	80		1 560,000
Columbia, l., Mo				12					12,125
Colum.& Hocking C.&I.O							52	69	155,775
Combination, g., Nev.								64	64,000
Consolidated Coal, Ill.		50	50	50	50	50	50	50	350,000
Commodore, g., Colo.	20	20	48						432,000
Con. Mercur, g., Utah.	250	355	100	225					1,591,000
Con. Mer, g.,(new), Utah				110	375	395	150		1 030,000
Consolidated, g., Colo.			10	110	182	76			378,000
Consolidation Coal, Md.	205	205	205	205	205	205	205	410	6,946,650
Continental, z., Mo						18	35	35	88,000
Continental Oil, Cal.					10				10,400
Copiapo, c., Chile					168		40	135	3 000,900
Creede United, g., Colo							10	65	120,000
Cripple Ck.,g.,pf.,Colo.						5			45,000
Cripple Ck, Con., g., Col				160				170	330,000
Crœsus, g., Cal		29	19	103	76				227,300
Crowned King,g.s.l.,Ariz		96	121						242,760
Crow's Nest Pass C.,B.C					245	250	304	348	1,144,850
Crucible Steel, pf., U.S.				427	1,740	2,187	1,312		5,250,000
Commings Cement, N.Y	27	27	27	27	27	27	27	27	243,000
Dabney Oil, Cal.					10	120	16	38	182,500
Dalton & Lark.,g.s.l.,U					263				350,000
Daly West,s.l.,g.c., Utah			120	487	600	1,004	1,332	1,044	4,535,000
D'dw'd-Stand.g.pf.,S.D.							6		6,000
De Lamar,s.g. Idaho		48	48	48	192	122	32	56	2,796,770
Denver & Crip. Ck.g.,Col.				11					10,625
Dewey Con., Utah.				2	3				5,850
Dillon, g., Colo								9	9,375

DIVIDENDS PAID BY AMERICAN MINES AND INDUSTRIAL COMPANIES.—*Continued.*

Name of Company.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total Paid.
Dixie, g., Nev				$10	$158				167,500
Doctor Jack-Pot,g.,Colo					232				$232,000
Doe Run, l., Mo.	$30	$30	$60	60	60	$90	$60	$90	717,072
Dolores, s.g., Mex.							25		25,000
Dominion Coal, N.S.					240	120	1,290	120	3,210,000
Dominion I.& St.pf.N.S.					175	350			525,000
Dos Estrellas,g.s., Mex.							359	191	773,925
Dutchess, g., Colo.								10	20,419
East Notaway, g.s., Colo							20		20,000
Eldorado, g., Cal.			10						10,000
Elkton Con.. g., Colo.	260	220	68	259	325	100		25	1,429,461
El Orol, g.s., Mex.					946	564	1,004	194	2,708,800
El Paso, g., Colo.					24		61	159	323,550
Empire Steel & Iron, pf.			71	107	71	75	75	89	462,450
Esmeralda, g.s., Mex								5	5,286
Esperanza, s.g., Mex.					171	159	84	223	1,377,149
Esperanza Oil, Cal.								3	2,500
Eureka, g., Cal.					10				10,000
Fairmont Coal, W. Va.								240	240,000
Fanny Rawlings, g., Col			20						20,000
Favorite, g., Colo				48					48,000
Feather River Expl.g.Ca					20				20,000
Federal Mg.& Sm., com.								208	207,500
Federal Mg.& Sm. pf							184	639	822,500
Figaro, g., Colo.					10				10,000
Finance Con., g., Colo.						2			2,000
Florence, s., Mont.	54	44	44	20					223,780
Four Metals, Colo.					25				25,000
Four Oil, Cal.					8	19	27	25	81,406
Fraternal, s., Mex.							22	35	86,513
Free Coinage, g., Colo.					140	20	10	20	190,000
Frontino & Bolivia,c.,Co					103				1,211,703
Garfield, Con. g., Colo.			34		125				159,000
Gemini, g , Utah				50		150	200	150	1,200,000
General Chem, com.			129	285	287	296	371		1,254,599
General Chem., pref.			396	494	506	565	600	600	3,166,418
George's Ck. Cl &I. pf.M.							132	132	1 188,000
Gold Belt Con.,g.,Colo.				113					112,500
Gold Coin of Victor,Colo.	120	120	210	240	360	260	10		1,230,000
Gold Deposit, g., Colo.				10					112,500
Gold Hill Bonanza, Colo.						15			15,000
Gold King Con.,g., Colo.								58	1,350,000
Golden Cycle g., Colo.	60	60	105	120	30				408,560
Golden Cycle(new)g.,Col						56	247		303,750
Golden Eagle, g., Colo.			10	5	10				98,906
Golden M.& Ext.,g.,Ont			10						10,000
Golden Star, g., Ont.			46						45,500
Goodenough, s.l., B C.						7			13,188
Grafton, g., Colo.			10						10,000
Granby Con., B. C.							134		133,630
Grand Central, g.s.,Mex.				120					840,000
Grand Central, g.,Utah.		219	348	25			225	162	993,750
Grant Oil, Cal.							5		5,000
Grass Valley Expl.,g.,Cal			23	7					30,000
Gray Eagle Oil, Cal.				50	97				217,000
Greater Gold Belt,g.,Col				76					76,000
Great Western Oil, Cal.				10					10,000
Green Mountain Oil, Cal.					5				5,000
Greene Con., c., Mex.					220		432	1,123	1,775,200
Guadalupana, g.s., Mex.							7		69,930
Guadalupe Mill, Mex.					157	123	31		3,515,750
Guggenheim Exp., Mex.							551	735	1,286,250
Gunnel g., Colo.							30		30,000
Gwin, g., Cal.		16	35	35	66	120	165		436,500
Hanford Oil, Cal.					6	7		16	29,000
Hecla, l.s., Idaho.				100			20	100	220,000
Hecla Con., s.l., Mont.	30		15	50	30				2,250,000
Helena, g., Oregon.				45	72				116,500
Helena & L.,S.& R.,Mont				90					90,000
Hercules-Horses'e,g.,S.D.								3	2,500
Heywood Oil, Tex.				32			16		144,000
Hidden Treasure,g.,Cal.				29					457 452
Higgins Oil, Tex.						97			96,850
Holy Terror g.,So.Dak.	36	81	50	5					172,000
Home, g., Colo.				100	137				237,500
Home Oil, Cal.				200	61	90	43	15	507,500
Homestake,g.,So. Dak.	375	636	693	1,260	1,260	1,058	655	655	13,022,950
Homestake Oil, Cal.				23	12	1			33,000
Horn Silver,g.s.l.z.c.,U.		80	20	20	72		20	80	5,422,000

DIVIDENDS PAID BY AMERICAN MINES AND INDUSTRIAL COMPANIES.—*Continued.*

Name of Company	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total Paid.
Houston Oil, pf., Tex.					$224	$448	$224		$896,500
Idaho, g., B. C.			$28						292,000
Illinois Crude Oil, Cal.								$13	12,500
Imperial Oil, Cal.					20	24	240	240	740,000
Independence Con.,g.,Co				$100	181				281,375
Ingham Con.,g.,Colo.					34				33,981
Int'l Ach. Graph.pf.N.Y.					35	35	35	35	140,000
International Nickel,pf.							350		349,660
Iowa, g.s.l., Colo.	$25	$10		39	33				186,833
Iron Silver, s.l., Colo.				50			200	250	3,100,000
Isabella, g., Colo.	68		270	158	23				742,500
Jackson, g., Cal.				6					6,000
Jamison, g., Cal.			12		12		47	47	167,700
Jeff.&Clearf.C.,Pa.,com.				30	30	75	75	75	255,000
Jeff.& Clearf.C.,Pa.,pf.		75	75	75	75	75	75	75	675,500
Kansas-Burr'hs g.,Colo.							60		60,000
Katinka, g., Colo.					10				10,000
Kemp-Calhoun,g.,Colo.							5		5,000
Kend, & Gelder Sm.,Col.					20				20,000
Kendall, g., Mont.							230	400	705,000
Kennedy, g., Cal.					10				1,801,000
Kern Oil, Cal.				375	25	20			370,000
Kern River Oil, Cal.				10				12	22,900
Keystone Oil, Colo.								8	8,000
La Fortuna, g., Ariz.	188	238	238	238	150	100			1,166,000
Lake City, g., Colo.				4					3,875
Last Chance, g., B. C.		20	25						45,000
Last Dollar, g., Colo.			30	90	60		30		210,000
Lawrence, g., Colo.				10					10,000
Lehigh Coal & Nav., Pa.	574	574	574	789	861	717	946	1.104	22,145,715
Le Clair, g., Colo.							18		17,500
Le Roi, g., B.C.			240						1,305,000
Le Roi No. 2, g., B, C.					144	144		58	345,600
Liberty Bell, g.s., Colo.						13	78	78	169,441
Lightner, g., Cal.				15	15	15	15	67	253,656
Lillie, g., Colo.		50	136	45					349,183
Los Angeles O. & T., Cal.					3				2,500
Lucky Budge, z., Mo.							12	30	42,000
Lyon, z., Mo.								1	1,200
Madison, g., Colo.				35					35,000
Magna Charta, g., Colo.								21	21,000
Magnolia, g., Colo.				187		11			198,000
Mammoth, g.s.c., Utah.		200	260	200	100			120	1,980,000
Marion Con., g., Colo.			5						300,000
Mary McKinney, g.,Colo.			30	150	150	120	90	90	650,000
Maryl'd Coal, Md., pf.	75	85	94	94	104	141	160	160	1,216,360
May Day, g.s., Utah.					18	12			30,000
Mesquital, Mex.					36		15		51,458
Mexican Coal & Coke.								300	300,000
Midget, g., Colo.				25	15	30			195,000
Milwaukee,g., Idaho.							20		20 000
Mine La Motte, l., Mo.							240	60	300 000
Mines Co. of Am.							435	360	795,000
Modoc, g., Colo.	10	90	45	60	35	25	20		270,000
Mong'la R.C. & C., Pa.,pf.				694	694	694	694	347	3,124,495
Montana Coal & Coke,M.				120					120,000
Montana, g.s., Mont.		36	99						453,700
Montana Ore Pur., Mont	160	160	560	240	722	324	648	486	3,780,000
Montana-Tonopah,g.s.,N							43		42,750
Monte Cristo Oil, Cal.							35	50	85,000
Monument, g., Colo.		13	6		3				21,124
Morning Star, g., Cal.		82	63	7					854,400
Morse, g., Colo.			15						215,650
Mountain, c., Cal.	31	62	1,080	1,200	720	540	143		3,776,250
Mount Diablo, s., Nev.				5					260,270
Mount Rosa, g., Colo.	10	20	40						75,000
Mount Shasta, g., Cal.			6						6,000
Napa Con., q., Cal.	80	80	110	40	40	40	40		1,220,000
National Carbon, pf.					315	315	315	315	1,890,000
National Lead, com.		149	149	149		298			1,341,486
National Lead, pref.	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043	12,780,280
Natividad, s.g., Mex.					24	48	109	120	392,463
Nevada-Keys'e, g.s., Nev						9	33	19	61,790
New Century, z., Mo.								10	9,750
New Central Coal, Md.		20	40	40			20	20	270,000
New Idria, q., Cal.	10	70	110	60	70	80	120	150	670,000
New Jersey Zinc.	600	600	600	1,000	400	1,600	1,200	1,200	7,200,000
New Leadv'e Home g.,C.				100	137	25			265,520
N. Y.&H'd.Ros'o,s.g.,C.A	165	165	180	255	240	100	15	150	1,935,000

DIVIDENDS PAID BY AMERICAN MINES AND INDUSTRIAL COMPANIES.—*Continued.*

Name of Company.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total Paid.
New Zeal'd Con.,g.,Colo					$46	$32			$76.950
Northern Light, Utah								$200	20,000
North Star, g., B.C.				$39		78		78	351,000
North Star, g., Cal			$50			47	$125	150	856,356
N. S. Steel & Coal, com.						268	217	274	788,600
N. S. Steel & Coal, pf.					42	82	82	62	267,800
Nugget, g., Colo.					30				84,730
Ogden-Goldfield, Nev.								10	10,000
O. & Ind. Nat. Gas, U.S.				760	360	360	360		1,440,000
Oil City Petrol'm, Cal.					15			23	37,500
Old Colony,Z.& Sm.,Mo.				68	70				138,184
Old Gold, g., Colo.								11	10,506
Old Town, g., Colo.								15	15,000
Olive, g., Ont.			12						12,000
Omega, g., Colo.				18					18,188
Ontario, g., Colo.								7	7,500
Ontario, s., Utah	$230		15	90	90	180			14,917,000
Ophir, s.g,. Nev.								222	1.797,400
Original Empire, g.,Cal.			100						530,000
Osceola, c., Mich.	191	$277	558	558	575			192	4,439,600
Otero, Oil, Cal.								5	5,446
Oustomah, g., Cal.								13	12,500
Pacific Coast Borax, Cal.			100	240	228	228	228	400	1,934,500
Parrot, c.s., Mont.		483	1,242	1,034	1,264	115		230	6,002,785
Payne, g., B. C.			50		78				1,438,000
Peerless Oil, Cal.						47	144	142	332,000
Peggy, g., Colo.								65	65,000
Pennsylvania Coal, Pa.	800	800	800	800	2,160				21,860,000
Pennsylvania Con.,g.,Cal		28	68	26			25	57	248,875
Penn. Salt Mfg., Pa.		150	150	300	300	300	300	360	13,810,000
Penn. Steel (of N.J.), Pa.					1,151	1,177	1,177	1,177	4,683,248
Penoles, s.l., Mex.					693	1,128	510	541	3,029,114
Petro, s., Utah.			15						32,000
Petroleum, Dev., Cal.							25		25,000
Phila.Nat.Gas,com.,Pa.					848	905	926	1,596	5,012,383
Phila, Nat. Gas, pref.				200	200	400	200	287	1,439,885
Pinto, g., Colo.							10		10,000
Pioneer, g., Cal.		50	13						62,500
Pioneer of Nome, Alaska.						300			300,000
Pittsburg Coal, Pa.				2,240	2,079	2,240	2,079	2,079	10,395,420
Pittsburg Oil, Cal.							48		48,000
Plumas-Eureka,g.,Cal.	25			84	34				2,831,294
Pocahontas Coal, pf., Pa							90	90	280,000
Pointer, g., Colo.					25				25,000
Portland, g., Colo.	330	570	720	750	720	270	360	720	5,377,080
Potomac Oil, Cal.						3			3,178
Practical, g., Colo.							30		30,000
Pride of the West,g.,Ar.						15			15,000
Producers & Cons. Oil,C				53	4				56,500
Providence, g., B. C.							2	20	22,224
Providence, g., Colo.					5				5,000
Providencia, Mex.					16	60	9		169,740
Queen Bess Pro., g., B.C.			25						25,000
Quicksilver, q., Cal., pf.			22	22	22	21	22		1,931,411
Quilp, g., Wash.								15	15,000
Quincy, c., Mich.	800	650	950	900	900	700	550	500	14,620,000
Ram.-Cariboo Con.,g.,B.C			31	34	25	138			220,000
Raven, g., Colo.		20	50	50	25				130,000
Real del Monte,g.s.,Mex							54	47	2,973,495
Reco, s.l., B.C.				10					287,500
Red Bird, g.s.l.c., Mont.							36	36	72,000
Reed Oil, Cal.					50	50	400	600	1,100,000
Republic Con.,g.,Wash.		120	158	105					382,500
Republic I. & St., pref.			355	1,423	1,423	1,423	1,429		6,053,476
Reward, g., Cal.			20						20,000
Reward, g., Colo.								105	105,000
Richmond, g.s.l., Nev.				13					4,453,797
Rob Roy, z., Mo.						1	2	1	3,375
Rocco-Homestake,s.g.l.N					9	45	22	4	94,000
Rocky Gulch,g., Oregon				25		2			90,000
Sacramento, g.s.l., Utah	15	60	50		15		60	20	213,000
Saint Joseph, l., Mo.	144	150	150	150	150	150	225	225	4,059,500
Salvator, g.s., Utah.								7	6,500
San Carlos, Mex.					212	22			234,329
San Diego de Char.,Mex					32				61,100
San Francisco Mill, Mex					37	61		32	318,780
San Joaquin Oil, Cal.					25	35	25	440	625,000
San Rafael, Mex.					136	54	201	287	2 323,814
Santa Rita, g., Colo.				4					4,000

DIVIDENDS PAID BY AMERICAN MINES AND INDUSTRIAL COMPANIES.—*Continued.*

Name of Company.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total Paid.
Senator Oil, Cal.					$5		$4		$9,045
Shawmut Oil, W. Va.					100	$50	53		203,000
Shelby Iron, Ala.			$130	$120		160	150		840,000
Sierra Buttes, g., Cal.								$29	2,011,450
Silver Hill, g.s., Nev.						5	18	18	46,800
Silver King, g.s.l., Utah.	$450	$450	625	1,000	1,300	1,300	1,300	1,300	8,650,000
Silver Shield, g.s.l., Utah				2	3				4,500
Slocan Star, s.l., B. C.								50	517,000
Sloss-Sheff, S. & I., pref.				332	456	469	469	469	2,205,000
Small Hopes, s., Colo.		25	25						3,325,000
Smuggler, s.l.z., Colo.		120	275	360	360	20			2,175,000
Soledad, Mex.						25	42	85	349,672
Somerset Coal, W. Va.								80	80,000
Sorpressa, Mex					27		14	28	228,202
Southern Boy, g., Colo.				18					17,500
So. Cal. Oil & Fuel, Cal.				3	33				39,000
So. Godiva, g. s., Utah.					2				2,000
So. Swansea, g.s.l., U.	50	38	53		8			3	170,500
So. Winnie, g.s., Colo.					15				15,000
Sovereign Oil, Cal.								20	19,950
Spearfish, pf., So. Dak.						18	80	13	110,250
Specie Payment, Colo.						40	25		65,190
Specimen, g., Colo.				153					153,347
Squaw Mount, g., Colo.			10						10,000
Sta. Gertrudis, Mex					81	88	117	94	2,874,620
Sta. Maria de Guad, Mex					133	85			377,018
Sta. Maria de la Paz. M.						104	130	49	2,011,439
Standard, c., Ariz.						40			40,000
Standard Con., g., Cal.	40	27	60	71	71	71	59		4,160,331
Standard Oil of N. J.			26,325	47,800	46,660	43,650	42 680	34,920	241,635,000
Sterling Oil, Cal.								51	51,000
St. Eugene Con., s., B. C.			2		210			64	274,000
St. John del Rey, g., Bra.					102	142	153	69	14,228,101
Stratton's Ind'ence, g. Cal			976	1,789	788	240	375	125	4,255,861
Strong, g., Colo.	250	300	300	300	300	375	300	50	2,625,000
Sunday Ck, Coal, Ohio.							5		15,750
Sunday Lake Iron, Mich.					40				40,000
Sunset, s.l., B. C.						6		6	12,000
Swansea, s.l., Utah.	50	65	65	75	29				330,500
Syndicate, g., Cal.						2			82,000
Tamarack, c., Mich.	360	440	600	1,200	1,200			90	8,580,000
Temonj, g., Colo.				250					250,000
Temple Iron, Pa.						7	14		21,500
Tenn. C., I. & R.R., com.				451					1,102,144
Tenn. C., I. & R.R., pref.				139	20	20	20	20	326,944
Tennessee, c., Tenn.							219	219	437,500
Tetro, g.s.l., Utah.								18	18,000
Texas & Pac. Coal, Tex.			140	120				30	1,890,000
Thirty-three Oil, Cal.						120	120	120	360,000
Thomas Iron, Pa.							200		200,000
Tomboy, g., Colo.		50	152	144	216	72			1,244,000
Tonopah-Alpine. g., Nev.							70		70,000
Tonopah-Nev. g.s., Nev.							70		70,000
Torreon Met. Co., Mo.							270		269,500
Touraine, g., Colo.				88	9				96,119
Town Topics, g.c., Colo.					15	20	15		50,000
Trimountain, c., Mich.							300		300,000
Trinity County, g., Colo.							35		34,561
Twenty-eight Oil, Cal.								81	81,000
Tyee, c., B. C.								137	136,800
Uncle Sam, Con., g.s., U.					45			10	55,000
Union, g., Colo.	23			313	25	25			445,244
Union, z.l., Kas.				9	7				16,000
Union Mill, Mex.					31	26	35	73	486.886
Union Oil, Cal.					272	215	113	147	963,422
United, c., pf., Mont.						150	300	300	750,000
United, g., Colo.						280	40	20	339,933
United, z.l., Mo.			3	28	30	47	50	32	185,470
United Petroleum, Cal.						34	17		50,638
U. S. Crude Oil, Cal.				3	24				27,220
U. S. Marble, Wash.					20				20,000
U. S. Red. & Ref., com.						177	237		414,078
U. S. Red. & Ref., pf.						236	237		472,821
United States, Utah.								210	210,000
U. S. Steel Corp., com.					15,228	20,333	12,708		48.267,952
U. S. Steel Corp., pf.					26,753	35,720	30,404	25,221	118 097,735
United Verde, c., Ariz.			3,000	4,499			2,025	2,025	17,085,322
Utah, g., Utah.	4		2	2	14	12	14	4	225,000
Utah Con., c. Utah.					732		954	900	2,586,000

DIVIDENDS PAID BY AMERICAN MINES AND INDUSTRIAL COMPANIES.—*Concluded.*

Name of Company.	1897.	1898.	1889.	1900.	1901.	1902.	1903.	1904.	Total Paid.
Ventura Con. Oil, Cal.	......	......	......	......	......	$5	......	......	$5 000
Vic. C. & C., com., W. Va	......	......	......	......	$15	......	......	......	15,000
Vic. C. & C., pf., W. Va.	......	......	......	......	9	6	......	......	15,000
Victoria, g. s.l., Utah	......	......	......	......	......	......	......	$8	7,000
Vindicator, g., Colo.	......	......	$178	$189	170	253	$198	99	1,192,000
Virginia-Car. Chem.,com	$40	$40	270	360	480	1 329	700	700	3,078,829
Virginia-Car. Chm., pref.	......	......	800	800	920	960	960	1,200	8,220,869
War Eagle, g., B. C.	......	177	315	53	......	......	......	......	540,250
Wasp No 2,g.,So. Dak.	......	......	......	......	3	9	......	16	234,679
West Mount'n, g.s., U.	......	......	......	......	......	......	9	2	11,483
West Shore Oil, Cal.	......	......	......	......	20	45	60	50	150,000
Westmoreland Coal.	......	......	750	750	750	750	750	30	8,280,000
White Rock, g., Nev.	......	......	......	......	......	2	......	......	2,000
Wild Goose, Alaska.	......	......	......	......	......	......	......	150	150,000
Wolverine, c., Mich.	......	60	210	240	240	240	330	450	1,770,000
Yankee Con., g.s.l., U.	......	......	......	......	......	75	......	......	75,000
Yellow Aster, g., Cal.	40	131	145	150	......	30	80	30	583,789
Ymir, g., B. C.	......	......	30	......	192	48	......	......	288,000
Yreka, g., Cal.	......	......	......	50	8	......	......	......	58,000
Zoe, g., Colo.	......	......	......	8	......	......	......	......	7,500

c., copper; g., gold; i., iron; l., lead; q., quicksilver; s., silver; z., zinc.

ASSESSMENTS LEVIED BY MINING COMPANIES.

Name of Company.	1897.	1898.	1899.	1900.	1901.	1902.	1903	1904.	Total Levied.
Acacra Oil, Cal					$6,000				$6,000
Acme Oil, Cal					10,000				10,000
Acorn, g. s. l., Utah			$365	$760					1,125
Addie, g. s. l., Utah						$2,500			5,000
Admiral, g., Utah						2,500			2,500
Ætna, g. s. l., Idaho				5,000					5,000
Ætna, g. s. l., Utah		$2,500	500						3,000
Ætna Oil, Cal					50,000				50,000
Ajax, g. s. l., Utah					15,000	30,000	$15,000	$27,000	87,000
Alaska, g., Cal					20,000				20,000
Alaska, g. s. l., Utah			34,000	20,000	12,000	28,000	24,000		118,000
Albion, g., Utah					20,000	24,000	8,000	20,000	72,500
Alexandria, g. s. l., Dak.			500	500					1,000
Alhambra, s., Nev		100,000							100,000
Allah, g., Utah						2,500	2,500		5,000
Alliance Ex. & Mg., g.Cal				5,000	2,000				7 000
Alliance, g., Utah			15,000	10,000					225,000
Allison Ranch-Ford g.,C.			5,000	10,000					15,000
Allouez, c., Mich		80,000			240,000			298,533	2,059,463
Alma, g., Cal						10,000	15,000		25,000
Alpha, s., Nev	$8,400	8,400	3,150	3,150	3,150	6,300	5,250	15,750	352,800
Alta, s., Nev	16,200	16,200	16,200	16,200	10,800	10,800	5,400	10,800	3,735,110
Alta, g., Utah			938						938
Amelia, g., Cal				2,500					2,500
American, g., Cal							50,000	50,000	100,000
Am. Oil & Ref., Cal				5,000	10,000				15,000
American, g. s. l., Utah						2,000		2,500	22,500
American Mines, Utah						5,000	15,000		20,000
Ancient Channel,g., Cal.								25,000	25,000
Andes, s., Nev	20.000	10,000	15,000	15,000	10,000	15,000	20,000		1 270,000
Annandale, g., Utah						5,000	6,333	3,167	14,500
Annie, g. s., Utah				5,000					5,000
Apex, c., Utah						5,000			5,000
Apollo, Alaska					10,000			10,000	20,000
App Con., g., Cal						50,000			50,000
April Fool, g. s. l., Nev.						50,000			50,000
Argentum-Juniata,g;Colo						104,000			104,000
Argonaut Oil, Cal				12,000	12,000				24,000
Arrastraville, g., Cal		20,000	20,000	10,000					50,000
Aurora, g. s. l., Utah						500			500
Bachelor's Oil, Cal					6,000				6,000
Badger, g., Oregon				10,000	10,000		10,000		40,000
BadgerHill&Cher'e,g.,Cal			60,000						60,000
Baker Divide, g., Cal						12,000			12,000
Bald Eagle Oil, Cal							15,000		15,000
Baliol, g., Cal	25,000	30,000							55,000
Baltic, g., Cal								5,000	5,000
Bk of England, g.s.l., U.							2,500		2,500
Bay City Oil, Cal					5,000				5,000
Bear Flag Oil, Cal					6,761				6,761
Beaver Harrison,g.s.l.,U.								30,000	30,000
Belcher's., Nev	57,000	20,800	34 000	52,000	52,000	26,000	10,400	20,800	3,712,400
Belle, g., Cal				2,000					2,000
Bellefontaine, g. s., Cal.		10,000	10,000	10,000	10,000		6,000		46,000
Belmont, g. s. l., Utah								5,000	5,000
Ben Butler, g.s., Utah			11,250	6,250	2,500	10,000	1,250		31,250
Ben Butler, No. 3, Utah							1,000		1,000
Ben Franklin, g., Cal						15,000			15,000
Benton Con., g. s., Nev.				20,000					20,000
Berkeley Crude Oil, Cal.						4,500			4,500
Best & Belcher, s., Nev.	75,600	30,240	40,320	60,480	30,240	50,400	55,440	50,400	2,878,363
Big Casino, g., Cal,								15,000	15,000
Big Chief Oil, Cal					5,000				5,000
Biesinger&Beck, s.l.g.,U				756					756
Bingham Placer,g.,Utah			27,500	27,500		27,500			82,500
Black Bess,g.s.l., Utah							15,000	10,000	25,000
Blaine, g. s. l., Utah								2,500	2,500
Blue Bird, g., Utah			500						500
Blue Eagle, g., Utah					10,000	5,000			15,000
Blue Extension,g., Utah					5,500	2,500			7,500
Blue Goose, Cal					10,000				10,000
Blue Gravel, g., Cal				10,000					10,000
Bonanza Con.,g.s.l.,Utah							2,000	2,250	4,250
Bogan s., Utah					12,500				39,375
Boss Tweed, g., Utah						10,000			18,000
Bos. & Crip. C'k, g., Col.		20 000							20,000
Boulder, g., Cal		10,000	3,000	3,000	3,000				19,000
Bountiful, g. s., Utah				5,000		15,000			20,000
Brown, g., Utah						5,000			5,000
Brunswick Con.,g.s., Cal.	30,000		15,000	50,000	40,000	45,000	60,000	45,000	415,000
Buchanan, g., Cal		25,000							25,000

ASSESSMENTS LEVIED BY MINING COMPANIES.—*Continued.*

Name of Company.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total Levied.
Buckeye, g., Utah	$6,250	$6,250							$16,250
Buckhom, g., Utah					$1,000				1,000
Buffalo H'p Dev.,g.,Was				$200					200
Bullion, s., Nev	20,000	15,000	$10,000	5,000	6,000	$3,000	$8,000	$15,000	3,167,000
Bunker Hill,g.s., Utah'			5,000	6,250					11,250
Burton, g. s. l., Utah							1,000	1,000	2,000
Butler, g., Utah					3,000				3,000
Butte Basin, g., Cal					2,500				2,500
Cactus Oil, Cal							2,000		2,000
Cadmus, g., Cal				10,000		8,000	4,000		22,000
Caledonia, s., Nev				30,000	15,000	30,000	60,000	55,000	3,430,000
California, g., Cal	1,000		2,000		2,000	4,500			26,000
California, g. s. l., Utah						30,000	45,000	42,000	117,000
California Borax, Cal				9,500					13,000
California Dredging, Cal					30,000			30,000	60,000
California Mutual Oil, C.					12,500				12,500
California Oil, Cal					20,000				20,000
Canadian King, Wash					1,000				1,000
Canton Placer, g., Cal						6,000	3,600	720	35,320
Carb.& Rat., g.s.l., Utah						24,000			24,000
Carbon Oil, Cal									8,000
Caribou Oil, Cal				8,000	16,000			26,800	50,800
Carisa, g. s. l., Utah							30,000		30,000
Carmelita Oil, Cal					10,000	10,000			50,000
Cassa Oil, Cal					2,000				2,000
Cedar Creek, g., Cal		2,000							2,000
Centennial, c., Mich	120,000	300,000		270,000	180,000			360, 000	1,270,000
Central Eureka, g., Cal.	20,000			12,000					32,000
Central Mamm'h, g., U.				500					500
Century, g., Utah						10,000	10,000		20,000
Century Oil, Cal					8,600	5,500		6,000	28,200
Cerulean, g., Cal					5,000				5,000
Challenge Con., s., Nev.	50,000	1,000	12,500	22,500	5,000	5,000	10,000	42 ,500	182,303
Champion, g., Cal						17,000	32,300		139,803
Channel Bend, g., Cal		2,000							2,000
Chicago, g.s.l., Utah						2,500	1,250		3,750
Chic.& Mercur. g.s., U			1,000		1,000				2,000
Chloride Queen, Idaho					1,000				1,000
Chollar, s., Nev	44,800	50,400	28,000	39,200	22,400	22,400	39,200	33,600	3,232,400
Christmas, g. Utah				1 500	3,000	1,500	1 500		9,000
Church, g., Cal		3,000							3.000
Cinnabar King, g., Cal		1,000							1,000
Clarissa g. s., Utah			5,000	5,000					10,000
Cleveland, g., Utah		2,000	1,000						3,000
Clyde Oil, Cal					5,000				5,000
Coe, g., Cal						25,000	8,000		33,000
Columbia, g. s., Utah		750							750
Columbus Con., g. s., Cal.				2,000		3,000	4,500		9,500
Columbus, Con., Utah								60,000	60,000
Commonwealth g., Utah.						2,500			2,500
Comstock, g. s. l., Utah					20.000	30,000		45,000	95,000
Confidence, s., Nev	14,976	13,728	8,736	9,984	9,984		9,984	9,984	593,790
Conglomerate,g.s.,Utah.				6,250					6,250
Con. Cal.& Va.,s.. Nev.	108,000	108,000	108,000	97,200		54,000	162,000	162,000	1,261,200
Con. Gold G.& Sulp.,Cal						45,000			45,000
Con. Golden Trout,g.,Cal						25,000			25,000
Con. Imperial, s., Nev	10,000	10,000	10,000	20,000	10,000	10,000		15,000	2,265,000
Con. New York, s., Nev.	60,000	30,000	3,000				25,000		188,500
Con. St. Gothard,g.,Cal.		35,000	15,000		10,000		5,000	17,000	92.000
Constellation, g., Utah				2,250	2,250				63,000
Contra Costa Coal, Cal					30,000				30,000
Contra Costa Oil, Cal					5,000				5,000
Copper Mountain, Utah.								5,000	5,000
Copper Queen, Utah						4,000			4,000
Copper Ranch,g.s.l.,Utah						2,500		4,150	6,650
Corona Oil, Cal					6,000				6,000
Cortez, g. s. l., Cal								5,000	5,000
Crown Point, s., Nev		25,000	20,000	15.000	15,000	20,000	20,000	20,000	3.080.000
Crusader Con., g.s.l., U.				5,000		2,500		2,500	10,000
Dalton, g. s. l., Utah.	2,500	7,500	5,000		5,000	7,500			71,250
Damascus, g., Cal								50,000	50,000
Daylight, g., Utah.					10,000	8.000	10,000		28 000
Del Monte Oil, Cal					20,000				20,000
Devil's Den Oil, Cal					2,000				2,000
Dewey Gravel, g.s.l,.Cal				10,000					10,000
Dexter Tuscarora,g.s.,N		30,000					8, 000	14,000	60,000
Diam'd Con.,g.s.l., Utah.			8,000		8,000		4,000		20,000
Diamond Creek,g.,Cal.						20,000			20,000
Dreisam, g., Cal.			51,000	15,000				50,000	116,000
Dublin, g., Cal					10,000	5,000			15,000
Dudley. g., Cal.						20,000			260.000

ASSESSMENTS LEVIED BY MINING COMPANIES.—*Continued.*

Name of Company.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total Levied.
Dutch, g., Cal			$22,500	$52,500					$75,000
Eagle, g., Oregon		$3,000							3,000
Eagle, g. s. l., Utah								$1,250	1,250
East Honorine, g.s.l., U						$5,000	$800		5,800
East Sierra Nevada, s., N							5,000		25,000
East Valeo, g., Utah					$5,000				5,000
Eclipse, g., Cal							5,000		5,000
Eldorado Oil, Cal						10,000			10,000
Elephant, g.s.l., Utah							5,000		5,000
Ella Eldon, g., S. Dak					500		500		1,500
Elmore, g. s. l., Utah								3,000	3,000
El Rey, g., Utah				8,000					8,000
Elise, g. s. l., Utah						10,000	10,000	10,000	30,000
Ely, g., Utah			22,000	3,000		2,000			7,000
Emerald, g. s., Utah		3,000			1,500	10,750	6,000	6,000	27,250
Empire Oil, Cal					14,000				14,000
Enterprise, g., Cal								5,000	5,000
Equality Oil, Cal						10,000			10.000
Esperanza, g., Cal							5,000	5,000	10,000
Eureka Con., s., Nev.		10,000	5,000						519,000
Eureka Con. Drift g., Cal.	$75,000	5,000	15,000	17,500	10,000	5,000	7,500	5,000	240,500
Eureka-Swan'a Ext. g.s U				5,000					5,000
Eutonia, s. l. g., Utah.				9,000	2,000	6,000	2,000	1,000	20,000
Excelsior, g. s. l., Utah.								75,000	75,000
Excelsior Drift, g. s., Cal		667	5,000	2,000					7,677
Exchange, g. s., Utah				1,000	1,500				2,500
Exchequer, s., Nev	5,000			3,000			8,000	18,000	1,049,000
Fall Creek, g., Cal					10,000				10,000
Fall River, g. s., Cal			2,500						2,500
Fauna Oil, Cal							1,500		1,500
Fifteen-Three Oil, Cal.						10,000			10,000
Fish Springs, g., Utah				1,500					1,500
Florence, g.s., Utah			1,000						1,000
Forest City, g., Cal								2,500	2,500
Forlorn Hope, g., Cal		20,000							20,000
Four Aces, g.s., Utah	2,500	2,500	2,500	17,500	5,000				27,500
Free Coinage, g., Utah					5,000				5,000
Free Silver, s.l., Utah							500		500
Fremont, g.s., Utah				2,500					2,500
Fremont Con, g., Cal						10,000	15,000	12,500	37,500
Fresno & S.Benito Oil, C						4,000			4,000
Frisco, g.s., Utah.			2,000	2,000					32,000
Fullerton & Sunset Oil, C					3,000				3,000
Galata, g., Cal		10,000							10,000
Galena, g., Utah	10,000				5,000	6,000	5,000	2,000	28,000
Galena Treas., g.s., S. Da			200	200					400
Gambetta, g., Cal								9,000	9,000
Garden City, g. s., S. Dak				563					7,105
Garibaldi, g.s., Cal			4,000	4,000		3,000			11,000
Genevieve, g.s., Utah			5,000						5,000
Gerrymander, g.s., Cal.			10,000	5,000		5,000			20,000
Geyser, s.l., Colo		50,000	200,000						1,275,000
Geyser-Marion, g.s., Utah				9,000					9,000
Giant Oil, Cal					24,107				24,107
Gibraltar Con., g., Cal					5,000				5,000
Godiva, g.s.l., Utah.								5,000	5,000
Golconda, g. s., Nev					750		750		2,250
Gold Coin (Gilpin Co)., Col			10,000						10,000
Golden Channel, g., Cal			3,000	2,500			1,500		7,000
Golden Eagle, g.s., Nev			4,000			1,320	1,320	6,000	12,640
Golden Fleece, g., Cal.							25,000		25,000
Golden Gate Ext., Utah							2,000		2,000
Golden Jubilee, g., Cal							5,000	5,000	10,000
Golden King, g., Cal		3,500							3,500
Golden Star, g.s., Cal			2,000	1,500	2,500	4,000			10,000
Golden West, g., Cal								5,000	10,000
Gold Hill, g.s., Cal.				25,000	25,000	25,000	12,000		87,000
Gold Hill, g.s., Utah				1,000	500	500			2,000
Gold Leaf, g.s., Wash			100						100
Gold Run Dev., g. Cal								10,000	10,000
Gold & Sil. Carb., g.s., U			2,500					750	3,250
Goleta, Con., g., C				63,000	30,000				93,000
Gonyon, g.s., Utah				2,500	3,750				6,250
Good Hope, g., Utah					2,000			17,500	19,500
Good Title, g., Cal.		20,000							20,000
Gould Central					5,000				5,000
Gould Oil, Cal					25,000				25,000
Gould & Curry's, Nev	59,400	37,800	49,400	54,800	43,200	32,400	37,800	43,200	4,899,850
Grand Prize Oil, Cal					20,000				20,000
Granite Hill, g. s., Cal.			3,000						3,000
Grape Vine Canyon, g.s.C			10,000	14,000	10,000		5,000	12,000	51,000

ASSESSMENTS LEVIED BY MINING COMPANIES.—*Continued.*

Name of Company.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total Levied.
Great Bonanza, g.s., Utah				$5,000					$5,000
Great Buffalo, g.s.l., U.								$5,000	5,000
Great Dane, g.s.l., Cal.								15,000	15,000
Great Eastern, g.s., Utah		$1,500	$1,500	1,500					4,500
Great Western, q., Cal.		5,000	20,000						75,520
Grizzly, g.s., Cal.		1,500		5,000		$10,000	$30,000	10,000	56,500
Gypsy Blair, g.s.l., Utah							10,000		10,000
Hale & Norcross, s., Nev			39,200	22,400	$11,200	44,800	44,800	33,600	5,874,280
Hanford-Fresno Oil, Cal.					24,140				24,140
Hanford-Sanger Oil, Cal.					6,000				6,000
Hannapah, g., Nev.								7,500	7,500
Hawk-McHenry, g.s.l., U						15,000			15,000
Head Center Con., gsc., Az			25,125						25,125
Hercules, g.s., Utah.				20,000					20,000
Hester A., g.s., S. Dak.				500					3,000
Highland, g.s., Utah.				8,000				5,000	13,000
Highland(Leadvle)g.s.,C				125,000					125,000
Hilda Gravel, g.s., Cal.		2,000		2,000					4,000
Hillside, g.s., Utah.			1,500						1,500
Himalaya, g.s., Utah.			5,000						5,000
Home, g.s., Cal.		3,000		10,000					13,000
Homestake, g.s., Utah.		4,000	4,000			10,000			60,000
Honeune, g.s.l., Utah.								50,000	50,000
Horn Silver Tun'l, g.s., U.			500	500					1,000
Horsefly, g., Cal.		8,000			10,000				18,000
Horseshoe Bar Con., g.s.		6,000	3,000	1,200	600				87,600
Humboldt, g.s., Cal.			2,000					5,000	7,000
Humboldt, g.s.l., Utah.								600	1,800
Imperial, Cal.					2,000	3,000			5,000
Independence, g.s., Utah			6,000	9,000		5,000			15,000
Independent, g., Cal.					10,000		15,000		25,000
Indian Pete, g.s.l., Utah								5,000	5,000
Ingot, g.s.l., Utah.					10,000				10,000
International, g.s., Utah.			1,500		5,000				6,500
Inyo Marble, Cal.					5,000	5,000	6,000		181,000
Iron Prince, g.s.l., Utah.							625		625
Jackson Butte, g., Cal.								5,000	5,000
Jefferson, g.c., Utah.				1,500	1,750				3,250
Jennie Lind, g.s., Cal.			2,000	2,000	8,000	9,000	6,000	5,500	32,500
Joe Bowers, g.s., Utah.				14,000	21,000	10,500	10,500	7,500	63,500
Joe Bowers Ext., g.s., U.				15,000					40,500
Johnny, g.s.l., Utah.								48,000	48,000
Jubilee, g., Cal.						10,000	25,000	25,000	60,000
Julia Con., s., Nev.	$5,500		3,300	3,300		6,600	3,300	9,900	1,521,600
Jumbo, g.s., Utah.		500				1,200	800		2,500
Junction, g.s., Cal.		10,500	6,000						16,500
Junction Oil, Cal					25,000				25,000
Jupiter Gravel, g., Cal.	40,000	40,000							80,000
Justice, s., Nev.		10,500	21,000	15,750	21,000	17,750	31,500	15,750	3,769,500
Karan, g., Cal.		2,500							2,500
Karma, g., Cal.							5,000		5,000
Karl Brown Oil, Cal.					15,000				15,000
Kate Hayes, g.s., Cal.		10,000	10,000						70,000
Kennedy, g., Cal.							10,000		10,000
Kentuck, g., Utah.		30,000							30,000
Kentuck Con., s., Nev.	10,500	5,250		3,150			8,400	5,250	142,100
Kern Canyon Oil, Cal.							6,000		6,000
Kern River Oil, Cal.					40,000	20,000	20,000		80,000
Kern Sunset Oil, Cal.					2,000				2,000
Keystone, g., Cal.						3,000			3,000
Kings County Oil, Cal.					6,000				6,000
Lady Washington, s., Nev			5,400			8,640	5,400	5,400	185,880
La Grange, g.s., Cal.			15,000						15,000
Laird, g., Cal.		10,000							10,000
La Palma, s.l., Mex.							30,000	60,000	90,000
La Reine, g.s.l., Utah.						5,000	3,000	3,000	11,000
Larkin, g.s., Cal.		2,000	2,000	4,000	10,000	12,000	5,000		45,000
Las Gateras, Mex.								60,000	60,000
La Suerte, g.s., Cal.		7,500	7,500	7,500	5,000	4,750	7,500		59,750
Laurel, g., Cal.						2,500			2,500
Leo, g., Mont.					2,500				2,500
Leon, g., Cal.		1,500							1,500
Lilburn, Utah.								2,500	2,500
Linda Vista Oil, Cal.					11,460	3,000			14,460
Lion Con., g.s., Utah.			500	500					1,000
Little Bell, g., Utah.					37,500				37,500
Little Chief, g.s., Utah.			8,000	12,000	16,000	16,000	12,000	12,000	76,000
Little Jimmie, g.s.l., U.						1,875			1,875
Little Pell Con., g.s.l., U							10,000		10,000
Little Pittsburg, g.s., U	4,000	4,000	5,000						23,000
Little Standard Oil, Cal.							10,000		30,000

ASSESSMENTS LEVIED BY MINING COMPANIES.—*Continued.*

Name of Company.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total Levied.
Live Oak Con., g.s., Cal.	....	$20,000	$10,000	$10,000	....	$8,000	....	....	$48,000
Live Yankee, g.s., Cal.	....	5,000	2,000	....	....	....	....	....	7,000
Lombard, g.c., Utah	....	....	....	....	$1,250	....	....	....	1,250
Los Angeles Oil, Cal.	....	....	....	....	....	....	....	$5,000	5,000
Louis S., g., Utah	....	....	....	....	10,000	....	....	....	10,000
Lower Mam'h, g.s.,Utah.	....	12,500	15,000	15,000	....	....	....	7,500	50,000
Lucky Bill, g.s., Utah.	$6,600	1,800	2,500	2,400	12,000	....	$18,000	....	91,300
Lulah Con., g.s., Utah.	....	....	1,500	....	....	....	....	....	1,500
Madeline, g.s.l., Utah	....	....	....	....	....	10,000	....	....	10,000
Madsen, g. Utah.	....	....	....	....	1,250	2,500	2,500	....	6,250
Mammoth, g..s., Nev.	....	....	....	....	....	2,000	....	....	2,000
Mammoth Garfield, g.s.C	....	....	....	17,500	....	....	....	....	17,500
Manhattan, g., Utah.	....	....	....	....	2,500	7,500	5,000	1,250	16,250
Maple, g.s., Utah.	....	....	....	....	3,000	6,000	4,000	2,000	15,000
Maple Creek, g., Cal	....	....	....	....	10,000	....	20,000	10,000	40,000
Marguerite, g.s., Cal.	20,000	15,000	15,000	....	....	....	....	....	85,000
Marina Mariscano,g.s., C	16,360	19,000	19,000	7,000	1,000	24,000	18,000	15,000	119,360
Mar'a Com'l & M'g, g.s. C	....	....	....	50,000	50,000	....	....	....	210,000
Marmaduke,g.s., S. Dak.	....	....	....	500	....	....	....	....	500
Mar. Wash'ton, g.s., U.	....	3,000	6,000	6,000	9,000	15,000	15,500	6,000	60,500
Martin White, s., Nev.	....	....	120,000	....	....	....	....	....	120,000
Maxfield, g. s., Utah	....	6,000	9,000	9,000	....	....	....	....	24,000
Mayday, g.s., Cal	....	5,000	10,000	5,000	2,500	1,500	1,500	....	25,500
Mavday, g.s., Utah	....	2,000	2,000	....	....	....	22,000	6,000	32,000
Mayflower, g.s., Utah.	....	....	....	2,000	5,000	5,000	2,500	2,500	17,000
Mayflower Gravel, g.s., C	....	6,000	....	7,500	6,000	....	....	....	19,500
Mazeppa, g. s., Cal	....	....	....	5,000	....	2,000	2,000	2,000	11,000
McKinley, g., Utah.	....	....	....	....	....	1,250	....	....	1,250
McKittrick Con. Oil, C.	....	....	....	18,000	18,000	....	....	....	36,000
McKittrick Oil, Cal	....	....	....	....	15,000	6,000	....	....	21,000
Melcher. g.s., Utah	....	....	....	1,000	625	1,375	1,500	....	4,500
Menlo, g., Cal	....	....	....	....	....	6,000	....	....	6,000
Mercantile Crude Oil, Ca	....	....	....	....	....	5,000	....	....	5,000
Merrimac, g., Cal.	....	20,000	....	....	....	....	....	....	20,000
Metallic Hill, g.s.l., Utah.	....	....	....	....	....	....	5,000	....	5,000
Meteor, g.s., Utah	....	3,734	4,999	2,997	1,980	....	....	....	13,690
Mexican, s., Nev,	20,000	40,320	25,200	45,360	50,400	30,240	40,320	45,360	2,525,840
Middle Yuba, g., Cal	....	....	....	....	....	....	25,000	20,000	45,000
Midland, g.s., Utah	....	....	....	3,000	....	....	....	....	3,000
Midnight Bowers, g.s.,U	....	....	1,000	1,000	....	....	....	....	2,000
Milford, g.s.l., Utah	....	....	....	....	....	....	2,500	....	2,500
Mineral Hill, g., Cal	....	....	....	....	....	....	2,000	....	6,000
Minnehaha Oil, Cal	....	....	....	....	10,000	....	....	....	10,000
Minnie, g., Utah	....	....	....	....	....	....	1,000	....	4,000
Mistletoe, g., Cal	....	....	....	....	....	1,000	....	....	100,000
Mohave, g.s.l., Utah	....	....	....	....	....	....	5,000	....	5,000
Mohican, g., Cal	....	....	....	....	10,000	5,000	....	10,000	25,000
Molly Bawn, g.s., Utah.	....	....	1,000	....	....	....	....	....	1,000
Montecito, g., Cal	....	10,000	....	....	....	....	....	....	10,000
Monte Cristo, g.s., Utah	....	....	....	....	....	2,500	....	....	2,500
Montreal, g.s., Utah	375	....	25,000	....	....	....	....	....	30,625
Monument, g.s.l., Utah.	....	....	....	....	....	....	....	6,250	6,250
Mooney Con., g.s., Cal.	....	....	....	20,000	....	....	....	....	20,000
Morgan, g., Cal	....	10,000	....	....	....	....	10,000	....	20,000
Morning Glory, g., Wash	....	....	....	....	....	3,000	....	....	3,000
Morning Star, g.s., Nev.	....	....	....	....	....	....	500	....	500
Morrison, g.s.l., Utah	....	....	....	....	....	....	....	8,000	8,000
Mountaineer, g.s., Cal	....	15,000	....	25,000	....	....	....	....	40,000
Mountain Lake, g.s.l., U	....	....	....	....	....	5,000	2,500	....	7,500
Mountain View, g., Cal	....	....	....	....	15,000	....	....	....	15,000
Mt. Blanc Con., g., Cal.	....	....	....	....	1,250	....	....	....	1,250
Mt. Diablo Oil, Cal	....	....	....	....	10,000	5,000	....	....	65,000
Mt. Pleasant Con., g.,Cal.	....	....	....	....	....	....	15,000	15,000	30,000
Murray Hill, g.s.l., Utah.	....	....	....	....	....	....	15,000	....	15,000
Naildriver, g.s.l., Utah.	....	....	....	....	....	....	25,000	15,000	40,000
Nampa, g.s.l., Utah	....	....	....	....	....	....	....	5,000	5,000
Nancy Hanks, g., Cal	....	5,000	....	....	....	....	....	....	5,000
Napa County, c., Cal	....	....	....	....	....	....	5,000	....	5,000
Nashville, g., Cal	....	2,000	....	....	....	....	....	....	2,000
National Con. g.s., Cal.	....	15,000	45,000	15,000	10,000	5,000	5,000	5,000	93,685
Navajo, g. s., Utah	....	....	....	....	2,500	....	....	....	2,500
Nevada County Oil, Cal.	....	....	....	....	....	....	3,000	....	3,000
Nevada, s., Nev.	....	....	....	10,000	....	....	....	....	10,000
Nevada, c., Utah	....	....	....	....	....	5,000	....	....	5,000
Nevada Park, g.s.l., U.	....	....	....	....	....	....	....	1,250	1,250
New Almaden, q., L. Cal	....	....	....	....	....	....	5,000	....	5,000
New Boston, g.s.l., Utah	....	....	....	....	....	....	500	....	500
New Bunker Hill, g., Cal	....	....	....	....	....	....	....	30,000	30,000
New Century Oil, Cal.	....	....	....	....	15,000	....	....	....	15,000
New Erie, g.s., Utah	....	....	2,000	500	7,500	500	....	....	10,500
New Imperial g.s., Utah	....	....	1,000	....	....	....	....	....	1,000

ASSESSMENTS LEVIED BY MINING COMPANIES.—*Continued.*

Name of Company.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total Levied.
New Independence, g., Cal	......	......	......	......	......	......	$20,000	......	$20,000
New Klondike, g.s., Utah	......	......	$2,961	$235	......	......	......	......	3,196
New La Plata, g.s., S.Dak	......	......	......	300	......	......	......	......	1,700
New Mercur, g.s., Utah	......	......	......	......	......	$4,200	2,100	......	6,300
New Montezuma, g., Cal.	......	......	......	......	......	10,492	10,531	$8,425	34,631
New Pass, g.s., Nev	......	......	......	......	......	......	20,000	......	20,000
New Redwing, g.s.l., Utah	......	......	......	......	......	15,000	22,500	15,000	52,500
New So'ern Cross, g., Mt	......	......	......	......	$5,000	......	......	......	5,000
New State, g.c., Utah	......	......	......	1,500	......	......	......	......	4,500
New York Bon'za, g.s.l., U	......	......	......	......	......	......	18,000	42,000	60,000
Niagara M. & S., Utah	......	......	......	......	......	97,500	......	......	97,500
Nineteen Oil, Cal	......	......	......	......	6,000	......	......	......	6,000
Nixon Placer, g., Cal.	......	......	......	......	......	......	5,000	......	5,000
North Bloomfield, g., Cal.	......	$25,000	......	......	......	......	......	......	25,000
North Bonanza, s., Nev.	......	......	......	15,000	......	......	......	......	255,000
No. Gould & Curry, s., Nv	......	20,000	......	......	......	......	......	......	375,000
North Mercur, g., Utah	......	10,000	......	......	......	......	......	......	10,000
Northern Light, g., Cal.	......	......	......	......	......	......	5,000	......	5,000
Northern Light, g.s., U.	......	8,000	......	8,000	18,000	16,000	......	......	50,000
Northern Spy, g.s., Utah.	......	10,000	10,000	......	......	......	......	......	20,000
Nugget Placer, g., Cal.	......	......	......	......	10,000	......	......	......	10,000
Occidental Con., s., Nev.	$30,000	20,000	20,000	5,000	10,000	15,000	20,000	5,000	575,179
Okanogan, g., Wash	......	......	......	10,566	......	......	......	......	10,566
O.K.Extension, g.s.l., U.	......	......	......	......	......	......	5,000	10,000	15,000
Olcorose, Cal	......	......	......	......	......	3,000	......	......	3,000
Old Bonanza, g.s., Cal.	......	......	2,500	......	......	......	......	......	2,500
Old Bullion, g.s., Utah	......	......	......	......	......	4,000	......	......	4,000
Old Col. & Eureka, g.s., U	......	......	......	......	2,500	......	2,500	8,750	18,750
Old Evergreen, g.s., Utah	......	......	......	0	......	......	6,000	6,000	18,000
Old Home, g.s., Cal	......	5,000	3,500	3,500	1,000	......	......	......	13,000
Old Home Con., g.s., Cal	......	......	......	3,50	1,000	2,000	......	......	15,000
Old Indian, g.s., Utah	......	......	......	......	......	2,000	......	......	4,000
Old Susan, g.s., Utah	......	......	......	7,500	500	......	......	......	8,000
Olinda Oil, Cal	......	......	......	......	......	10,000	......	......	10,000
Omaha, g.s., Utah	......	......	......	6,000	......	......	......	......	6,000
Omaha Con., g.s., Cal.	......	10,000	25,000	100,000	......	50,000	66,500	......	251,500
Ophir, s., Nev	25,200	43,200	50,400	60,480	45,360	45,360	45,360	......	4,839,528
Ophir (Cent. Dist.), g., Nev	......	......	......	......	......	6,000	......	......	15,000
Ophir Queen, g.s.l., U.	......	......	......	......	......	......	......	5,000	5,000
Opohonga, g.s., Utah	......	1,500	1,000	......	......	......	......	......	2,500
Orient, g.s., Cal	......	......	50,000	75,000	35,000	......	35,000	35,000	230,000
Orient, g. Utah	......	......	......	......	2,500	2,000	......	......	4,500
Orleans, g.s., Cal	......	15,000	12,000	....	5,000	......	......	75,000	107,000
Oro Quartz, g.s., Cal	......	......	4,500	......	......	......	......	......	4,500
Osborne, g.s.l., Utah	......	......	......	......	......	......	......	625	625
Osceola Con., g.s., Cal.	......	1,000	1,000	2,000	2,000	......	......	......	15,810
Oswego, g., Cal	......	......	......	......	......	......	......	10,000	10,000
Overman, s., Nev	17,280	17,280	11,520	17,268	23,040	23,040	34,560	23,040	4,262,070
Pacific, g.s., Utah	......	......	500	570	......	600	......	600	2,430
Paria, c., Utah	......	......	......	......	......	2,500	......	......	7,500
Park City, g.s.l., Utah	......	......	......	......	......	......	625	6,000	6,625
Patterson Creek, Cal.	......	......	......	......	......	10,000	......	......	10,000
Peabody, g.s., Cal	......	......	......	10,000	......	......	......	......	10,000
Peruvian Con., g.s.l., U.	......	......	......	......	......	......	7,500	......	7,500
Petro, g.s.l., Utah	......	......	......	......	......	......	......	3,250	3,250
Petroleum Center Oil, Cal	......	......	......	20,500	61,500	20,500	......	......	102,500
Petrolia Oil, Cal	......	......	......	......	10,000	......	......	......	10,000
Phoenix, g.s., Utah	1,000	......	......	1,000	......	......	......	......	2,000
Picnic, g.s., Utah	......	......	......	1,000	......	......	......	......	1,000
Pilot, g., Cal	......	......	......	......	......	10,000	......	......	10,000
Pioneer, g.s.l., Utah	......	......	......	......	......	1,000	......	......	1,000
Planet, g., Cal	......	......	......	......	......	10,000	20,000	......	30,000
Posey Con., g., Cal	......	......	......	......	......	......	25,000	......	25,000
Potosi, s., Nev	50,400	50 400	39,200	39,200	28,000	22,400	39,200	33,600	2,358,800
Powning, g.s., Cal	......	......	2,500	......	......	2,500	......	......	5,000
Princess Maud, g.s.l., Was.	......	......	......	......	......	3,000	......	......	3,000
Prior Hill, g.s., S. Dak	......	......	......	200	......	......	......	......	1,000
Prospect M't'n Tun., Nev	......	......	......	......	......	10,000	......	......	10,000
Prosperity Oil, Cal	......	......	......	......	25,000	......	......	......	2,5000
Providence, g., Cal	......	......	......	......	20,000	......	......	......	20,000
Providence, g.s.l., Utah.	......	......	......	......	......	......	......	3,750	3,750
Provident Oil, Cal	......	......	......	......	7,500	......	7,500	......	15,000
Purjue Sur., g.s.l., Utah.	......	......	......	......	......	1,000	......	......	2,000
Queen Esther Oil, Cal.	......	......	......	......	5,000	......	......	......	5,000
Quincy, g., Cal	......	......	10,000	20,000	......	......	......	......	30,000
Raven Oil, Cal	......	......	......	......	10,500	......	......	......	10,500
Raymond, g., Utah	......	......	......	......	12,500	......	......	......	12,500
Reamer Con., Cal	......	......	......	......	......	10,000	20,000	......	30,000
Red Bank Oil, Cal	......	......	......	......	6,000	......	......	......	6,000
Red Cross, g.s.l., Utah.	......	......	......	......	......	......	......	45,000	45,000
Reddick, g.s., Cal	......	5,000	5,000	......	......	3,000	......	......	13,000

ASSESSMENTS LEVIED BY MINING COMPANIES.—*Continued.*

Name of Company.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total Levied.
Red Jacket, s., Nev.	....	....	$2,000	....	....	....	....	....	$2,000
Red Slide, g., Cal,	....	....	....	....	....	....	$20,000	$10,000	30,000
Red Wing, g.s.l., Utah	....	....	....	....	....	$1,000	....	....	1,000
Red Wing Ext, g.s.l., U.	....	....	....	....	....	500	....	....	1,000
Rescue Gold, New.	$3,000	$2,000	500	....	....	....	....	....	5,500
Revenue g.s., Utah	....	....	4,500	....	....	....	....	....	4,500
Reward, g.s., Cal	7,040	3,840	3,200	$9,920	$14,500	6,000	....	....	97,500
R. G. W., g.s., Utah	....	....	2,000	1,000	2,500	1,500	....	....	7,000
Rich Bar Gravel, g.s., Cal	....	....	....	6,000	....	....	....	....	6,000
Richmond, g., Cal.	....	10,000	....	....	....	....	....	....	10,000
Ridge & Valley, g.s., U.	....	....	....	5,000	10,000	....	12,500	....	40,000
Roberts Oil, Cal.	....	....	....	....	3,000	....	....	....	3,000
Rockland, g., Cal.	....	3,000	....	....	....	....	....	....	3,000
Rodesino, g., Cal.	....	....	....	....	....	....	....	15,000	15,000
Romeo Con., g.s.l., Utah	....	....	....	....	....	....	5,000	....	5,000
Rose Creek, g.s., Cal.	....	5,000	5,000	....	....	....	....	....	10,000
Ruby Hill, g.s., Utah	....	....	....	600	1,000	1,000	....	....	2,600
Rusby, g., Cal.	....	....	....	....	....	14,000	7,000	....	21,000
Sacramento, g.s., Utah.	....	....	600	....	2,500	....	....	....	3,100
Sailor Con., g.s., Cal.	....	....	11,000	6,000	3,000	1,000	....	....	21,000
Salmon River, s., Nev.	....	....	1,425	....	....	....	....	....	11,970
Salt Lake & Nev., g.s., U.	....	1,000	....	....	2,500	....	....	....	3,500
Salt Lake R'te, Ext., U.	....	....	....	....	....	....	....	50,000	50,000
Sam Houston, g.s., Cal.	....	....	....	....	....	10,000	5,000	10,000	25,000
Sampson, g.s.l., Utah	....	....	....	....	....	10 000	5,000	....	15,000
San Domingo, g., Cal.	....	....	....	....	....	....	....	50,000	50,000
San Pablo Oil, Cal.	....	....	....	....	....	5 000	....	....	5,000
Santa Eulalia, g., Cal.	....	....	....	....	....	....	....	25,000	25,000
Santa Rosalia, q., Mex.	....	....	....	5,000	....	....	....	....	5,000
Savage, s., Nev.	67,200	44,800	22,400	33,600	22,400	33,600	33,600	33,600	7,466,800
Scorpion, s., Nev.	5,000	....	....	3,000	....	....	5,000	5,000	458,000
Sea Breeze Oil, Cal.	....	....	....	....	20,000	....	....	....	20,000
Sea Swan, g., Utah	....	....	....	....	2,500	....	....	....	2,500
Seg. Belch, & Mides, s., Ne	10,000	8,000	10,000	6,000	6,000	3,000	20,000	10,000	423,000
Sharp, g., Utah	....	....	....	....	5,000	....	....	2,500	7,500
Shasta Co. Sm. & Ref., C.	....	....	....	....	....	....	25,000	....	25,000
Shasta Oil, Cal.	....	....	....	....	20,000	....	....	....	20,000
Sheba, g.s., Cal.	....	....	....	10,000	....	....	....	....	10,000
Sheep Ranch, g., Cal.	....	....	....	....	....	....	115,000	40,000	155,000
Sheep Rock, g.s., Utah.	5,250	....	....	52,500	....	....	....	....	57,750
Shenandoah Con, g., Cal.	....	....	....	....	4,000	....	8,000	6,000	18,000
Shoebridge-Bon'za, g.s. U	....	....	....	3,200	4,000	....	....	....	13,600
Showers Con., g.s., Utah.	....	....	8,000	2,000	24,000	12,000	....	....	46,000
Sierra, g., Cal.	....	....	....	....	....	....	10,000	....	10,000
Sierra Nevada, s., Nev.	40,000	20,000	50,000	45,000	50,000	30,000	40,000	40,000	6,961,910
Sierra Union, W'r & Mg. C	....	....	....	....	....	75,000	....	....	75,000
Silver Bell, s., Utah.	....	5,000	....	....	....	....	5,000	5,000	25,000
Silver Bow, g.s., Utah	....	....	....	5,000	7,500	5,000	....	....	17,500
Silver Cloud, g.s., Utah	....	....	5,000	....	2,500	....	....	....	7,500
Silver Coin, g.s.l., Utah	....	....	....	....	....	....	5,000	....	5,000
Silver Copper, Utah	....	....	....	....	....	....	....	10,000	10,000
Silver King, g.s., Ariz.	50,000	50,000	50,000	25,000	25,000	15,000	....	....	530,000
Silver Park, g.s., Utah	....	....	....	9,000	....	....	....	....	9,000
Silver Queen, g.s., Utah	....	....	....	1,000	....	....	2,500	....	3,500
Silver Shield, g., Utah	....	....	....	....	3,000	6,000	33,000	22,500	64 500
Silver State, g.s., Utah	1,000	....	....	500	....	2,500	....	....	4,000
Siskiyou Con., g.s., Cal.	....	3,000	3,000	6,000	....	....	....	....	55,000
Skagit Cumb., Coal, Was.	....	....	....	7,500	22,500	....	....	15,000	44,500
Skylark, c., Utah.	....	....	....	....	5,000	7,500	5,000	5,000	32,500
Snake Ck Con., g.s.l., U.	....	....	....	....	....	....	2,500	....	2,500
Snow Flake, g.s., Utah	....	2,000	5,000	2,000	7,000	10,000	15,000	20,000	74,500
Snowstorm, g.s., Utah	....	....	....	....	2,500	....	....	....	2,500
Socrates, g., Cal.	....	....	....	....	....	....	....	15,000	15,000
Solden, g., Cal.	....	....	....	....	....	....	....	16,000	16 000
Sonora, g., Cal.	....	....	....	5,000	4,000	8,000	2,500	3,000	22,500
South Bingham, g.s., U.	....	....	2,500	2,500	....	....	....	....	5,000
So. Columbus, g.s.l., U.	....	....	....	....	....	....	....	5,000	5,000
South Eureka, g.s., Cal.	....	....	6,000	....	....	3,000	8,000	8,000	25,000
South Fork, g., Cal.	....	....	....	....	....	....	....	40,000	40,000
So. Fork Con., g.s., Utah.	....	5,000	....	....	....	....	....	....	5,000
South Lily, g.s.l., Utah.	....	....	....	....	....	500	....	1,000	3,000
South Paloma, g.s., Cal.	....	....	....	1,200	....	....	....	....	1,200
South Queen, g.s.l., Utah	....	....	....	....	....	1,250	....	....	1,250
South Sliger, g., Cal.	....	....	....	....	10,000	....	3,000	....	13,000
South Swansea, g.s., U.	....	....	....	....	....	....	24,000	....	24,000
Spanish Bar, g.s., Cal.	....	2,000	5,000	11,000	5,000	....	....	....	23,000
Spence Mineral, Cal.	....	....	....	....	....	6,000	....	....	6,000
Spider, g.s.l., Utah	....	....	....	....	....	....	2,000	4,000	6,000
Springfield, g.s.l., Utah	....	....	....	....	....	5,000	....	....	5,000
Stansbury, g.s.l., Utah	....	....	....	....	....	....	....	2,500	2,500
Star, g.s., Utah	....	5,000	30,000	25,000	....	7,500	5,000	51000	77,500
Steamboat, g.s.l., Utah	....	....	....	....	....	....	750	....	750

ASSESSMENTS LEVIED BY MINING COMPANIES.—*Concluded.*

Name of Company.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Total Levied.
St. George c., Utah								$10,000	$10,000
St. Louis-Vassar, g.s.l., U.							$10,000		10,000
Stockton, g.s.l., Utah						$5,000	1,000	1,000	7,000
Success, g.s., Utah			$9,730	$3,000					12,750
Sumdum, g., Alaska						25,000	25,000	50,000	100,000
Sumdum Chief, g., Alas.						25,000			25,000
Sunbeam Con , g.s., Utah	$11,250	$5,000	50,000	55,000					131,383
Sunrise, g.s.l., Utah						750	1,000	1,000	2,750
Sunset District Oil, Cal.					$7,500				7,500
Superior Oil, Cal.					4,600				4,608
Susannah, g.s.l., Utah								2,500	2,500
Swansea, g.s.l., Utah							15,000		18,500
Sweet Vengeance, g.s., C				10,000					130,000
Tanama, g.s., Cal			10,000		30,000	10,000	10,000	4,000	64,000
Tesora, g.s., Utah				2,750	80,000				102,000
Tetro, g.s., Utah		18,000	15,000	15,000	27,000	12,000	12,000		102,500
Texas, g.s., Cal			15,000	30,000	10,000				55,000
Thorpe, g.s., Cal		5,000	5,000						10,000
Tintic, g.s., Utah			4,375						4,375
Tintic Copper King, U.						2,500			2,500
Tomboy, g., Utah				5,000		2,500			7,500
Tonopah-Monarch, g., Ne.								10,000	10,000
Tonopah, Salt Lake, Ne							20,000		20,000
Trade Dollar, g.s.l., Utah								50,000	50,000
Tracy, g.s., Cal			5,000						5,000
Trent, g., So. Dak					1,500				7,500
Troy, g.s., Alaska	2,000	6,250	6,250						16,750
Tule Belle, g., Cal					10,000		10,000	30,000	50,000
Turngreen, g.s.l., Utah								1,250	1,250
Tuscarora Chief, g.s., U.			2,000						2,000
Twentieth Cen., g.s.l., U.						1,250			2,500
Ukiah Oil, Cal					10,000				10,000
Ultimo, g., Cal						30,000	21,000	20,000	71,000
Uncle Sam, g.s.l., Utah						6,000			6,000
Union Con., s., Nev.	20,000	30,000	18,000	30,000	25,000	30,000	30,000	45,000	2,820,000
United Sunbeam, g., U.					30,000	20,000			50,000
U. S. Grant, g.s., S. Dak.				1,000					4,500
Usona Oil, Cal						1,000			1,000
Utah Con., s., Nev.	30,000	20,000	15,000	15,000	20,000	20,000	10,000	25,000	575,000
Utah-Montana, g.s.l., U.								5,000	5,000
Utah Wyoming Oil, U.						2,500	2,500		5,000
Uyak Bay, g., Alaska						30,000		20,000	50,000
Valeo, g.s., Utah			10,000	10,000					20,000
Vallejo, q., Cal.		2,000	2,000						4,000
Valley View Oil, Cal					17,500				17,500
Valley View, g.s.l., Utah.								625	625
Vernon Oil, Cal.					25,000				25,000
Victor, g.s., Utah				15,000	5,000	15,000		11,250	46,250
Victoria, g.s., Utah				4,000					4,000
Victory, g.s., S. Dak				200					2,825
Virginia Con., g., Cal						10,000			120,000
Vulcan Sm.& Ref., Cal.						5,000	10,000		15,000
Wabash, g.s.l., Utah							75,000	60,000	135,000
Wandering Jew, g.s.l., U						500			3,500
Wasatch, Utah					6,000				6,000
Washington Con, g.s. Wa				200					2,000
Washington Oil, Cal					7,000				7,000
Watt Blue Gravel, g.s., C			3,000						58,000
Wedge Exten, g.s.l., U.						500			500
Wellington Oil, Cal					7,000	7,500	5,000		19,500
West Argent, Utah					10,000				10,000
West Century, g.s.l., U.						5,000	5,000	1,250	11,250
West Comstock, s., Nev.								50,000	50,000
Western Union Oil, Cal.						1,000			3,000
West Lake Oil, Cal					10,000				10,000
West Mrn'g Glory, g.s., U				1,250	1,250	13,750			21,000
West M't'n Placer, g.s., U				8,000	3,750				11,750
White Pine, g.s., Nev.							5,000	30,000	35,000
William Tell, g., Cal							1,500		1 500
Willietta, g., Cal					10,000	20,000	45,000	30,000	120,000
Wilson & Barrett, g.s.l. U.						30,000			30,000
Wisconsin Oil, Cal.					25,000				25,000
Yankee Con., g.s., Utah.			2,500	5,000	10,000				17,500
Yankee Girl, g.s., Utah.			5,000						5,000
Ybarra, g., Cal.						10,000	20,000	5,000	35,000
Yellow Jacket, s., Nev.		24,000	36,000	42,000	36,000	36,000	30,000		5,970,000
Young America, g.s., U.				8,000					8,000
Yuba Con., g., Cal.		2,500			45,000	6,000		5,000	58,500
Zacca Lake Oil, Cal.					1,875				1,875
Zenas, g.s.l., Utah								2,500	2,500
Zubiate, g., S. D.								100,000	100,000

c., copper; g., gold; i., iron; l., lead; q., quicksilver; s., silver; z., zinc.

UNITED STATES.

We give below the amounts and values of mineral and metallic substances imported and exported by the United States during the last five years. The 'Value per Unit' is, in each case, the value of the customary unit, in terms of which are stated the amounts in the first column.

IMPORTS. (a)

YEAR	ALUMINUM.					AMMONIUM SULPHATE.			
	CRUDE.				MFRD.				
	Lb.	Kg.	Value.	Value per Unit.	Value.	Lb.	Metric Tons.	Value.	Value. per Unit
1900....	256,559	116,374	$44,455	$0.172	$3,111	24,024,188	10,897	$591,937	$0.025
1901....	564,803	251,657	104,168	.186	5,580	31,711,085	14,384	728,085	.023
1902....	745,217	338,028	215,032	.290	3,645	35,535,558	16,119	858,036	.024
1903....	498,655	226,190	139,298	.279	4,273	29,104,817	13,199	765,230	.026
1904....	515,416	234,293	128,350	.249	478	39,859,690	18,077	1,058,981	.027

YEAR.	ANTIMONY.				ANTIMONY ORE.			
	Lb.	Metric Tons.	Value.	Value per Unit.	Lb.	Metric Tons.	Value.	Value per Unit.
1900...	3,632,843	1,648	$285,749	$0.079	6,035,734	2,738	$78,581	$0.013
1901...	3,674,923	1,667	255,346	.069	1,731,756	786	24,256	.014
1902...	5,742,703	2,605	347,899	.061	1,639,043	743	29,476	.018
1903...	5,125,515	2,325	279,957	.054	2,673,142	1,213	51,489	.019
1904...	4,056,299	1,840	235,401	.058	2,490,011	1,129	50,959	.020

YEAR.	ASBESTOS.			ASPHALTUM.			
	Crude Value.	Mfd. Value	Total Value.	Long Tons.	Metric Tons	Value.	Value per Unit.
1900.........	$331,796	$24,155	$355,951	113,557	115,374	$404,921	$3.57
1901.........	667,087	24,741	691,828	132,079	134,192	516,515	3.85
1902.........	729,421	33,013	762,434	139,944	142,183	439,570	3.09
1903.........	657,269	32,058	689,327	167,554	170,235	514,051	3.06
1904.........	700,572	51,290	751,862	119,575	121,489	510,524	4.27

YEAR.	ARSENIC (b).				BARYTES.				BAUXITE.			
	Lb.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons	Value.	Value per Unit.
1900...	(f)	....	......	....	(f)	....	.....	....	8,656	8,795	$32,967	$3.81
1901...	(f)	....	......	....	(f)	....	.....	....	17,866	18,153	66,107	3.70
1902...	(f)	....	......	....	(f)	....	.....	....	15,790	16,043	54,410	3.45
1903...	7,146,362	3,241	$256,097	$0,036	6,344	6,446	$22,777	$3.59	14,889	15,127	49,684	3.34
1904...	6,391,566	2,900	226,481	0,036	6,689	6,796	27,463	4.11	15,475	15,723	49,577	3.20

YEAR.	BRASS AND MFRS. OF, Value.	CHLORIDE OF LIME.				CEMENT.			
		Lb.	Metric Tons.	Value.	Value per Unit.	Barrels (a).	Metric Tons.	Value.	Value per Unit.
1900....	$20,113	132,520,478	60,111	$1,524,205	$0.012	2,386,684	433,037	$3,330,453	$1.40
1901....	35,976	120,611,346	54,709	1,673,190	.014	944,892	170,431	1,305,692	1.38
1902....	51,626	112,374,478	50,973	1,456,435	.013	1,994,790	361,932	2,581,883	1.29
1903....	206,905	113,285,240	51,586	912,843	.008	2,317,951	420,569	3,027,111	1.30
1904....	366,220	87,909,168	39,876	707,174	.008	1,046,279	189,839	1,338,044	1.32

YR.	CHROME ORE.				BISMUTH.				CLAYS AND EARTHS.			
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Lb.	Kg.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.
1900.	17,572	17,823	$305,001	$17.38	.....	....	.....	....	146,524	148,868	$966,579	$6.59
1901.	20,112	20,434	363,108	18.04	.....	....	.....	....	181,013	183,589	1,176,633	6.51
1902.	39,570	40,203	582,597	14.72	.....	....	.....	....	191,764	194,832	1,228,945	6.41
1903.	22,932	23,299	302,025	13.17	147,324	66,826	235,199	$1.59	203,173	206,424	1,264,544	6.22
1904.	24,227	24,615	348,527	14.38	147,712	67,002	268,837	1.82	191,853	194,923	1,168,527	6.09

YR.	ANTHRACITE.				BITUMINOUS.				TOTAL COAL.	
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Value.
1900.	118	120	$549	$4.65	1,909,258	1,939,806	$5,019,553	$2.63	1,909,366	5,020,102
1901.	286	291	1,844	6.45	1,919,962	1,950,681	5,291,429	2.75	1,920,248	5,293,273
1902.	73,006	74,174	323,517	4.43	2,478,375	2,518,029	7,016,274	2.84	2,551,381	7,339,791
1903.	151,023	153,439	675,623	4.47	3,295,379	3,348,105	9,329,221	2.83	3,446,402	10,004,844
1904.	72,526	73,686	220,665	3.04	1,556,149	1,581,047	3,915,613	2.52	1,628,675	4,136,278

YR.	COKE.				COBALT OXIDE.				COPPER, ORE AND MATTE.			
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Lb.	Kg.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.
1900.	103,175	104,826	$371,341	$3.60	54,073	24,527	$88,651	$1.64	54,329	55,201	$5,195,010	$92.23
1901.	172,729	173,893	266,078	3.67	71,969	32,645	134,208	1.86	96,047	97,584	14,692,645	152.99
1902.	107,437	109,156	423,774	4.05	79,984	36,281	151,115	1.89	181,566	184,470	8,695,780	47.89
1903.	127,479	129,519	437,625	3.43	73,350	33,272	145,264	1.98	284,912	289,471	3,177,582	11.15
1904.	161,476	164,060	648,520	4.01	42,352	19,211	86,925	2.05	268,235	272,527	4,308,410	16.06

YEAR.	COPPER, INGOTS, OLD, ETC.				COPPER MANUFACTURES.	TOTAL COPPER.	CRYOLITE.			
	Lb.	Metric Tons.	Value.	Value per Unit.			Long Tons.	Metric Tons	Value.	Value per Unit.
1900...	68,796,808	31,206	$10,557,870	$0.153	$23,390	$15,776,270	5,437	5,524	$72,763	$13.38
1901...	73,826,406	33,488	11,812,216	.160	24,775	26,529,636	5,383	5,469	70,886	13.17
1902...	103,129,568	46,778	13,051,159	.126	52,464	21,799,403	6,188	6,287	85,640	13.83
1903...	136,707,995	62,011	17,262,148	.126	31,624	20,471,354	7,708	7,831	102,879	13.35
1904...	142,344,433	64,567	18,374,959	.129	37,913	22,721,282	959	974	13,708	14.30

YR.	CERAMICS.	EMERY GRAINS.				EMERY ROCK.				EMERY MFRS.	TOTAL EMERY.
		Lb.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.		
1900	$9,143,536	661,482	300	$26,520	$0.040	11,392	11,574	$202,980	$17.82	$10,006	$239,506
1901	9,816,074	1,116,729	506	43,207	.039	12,441	12,640	240,856	19.35	10,927	294,990
1902.	9,838,426	1,665,737	756	60,079	.036	7,166	7,281	151,959	21.21	13,776	225,814
1903	11,582,013	3,595,239	1,630	109,272	.030	10,885	11,059	188,985	17.36	23,317	321,574
1904	11 656,571	2,281,193	1,035	109,772	.048	7,054	7,167	131,493	18.64	19.059	260,324

YEAR.	FERTILIZERS.									FULLER'S EARTH.	
	GUANO.				CRUDE PHOSPHATES.				ALL OTHER.		
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.		Long Tons.	Value.
1900......	6,620	6,726	$67,413	$10.18	137,086	139,272	$791,189	$5.77	$1,400,336	....	......
1901......	4,949	5,028	71,140	14.37	175,765	178,577	872,503	4.97	1,506,965	....	......
1902......	8,407	8,542	164,783	19.60	137,386	139,584	646,264	4.70	1,725,333	....	......
1903......	21,007	21,343	251,966	12.00	132,965	134,092	679,112	5.11	2,353,496	15,267	$120,671
1904......	35,876	36,430	478,388	13.33	130,214	132,297	745,744	5.73	2,856,141	9,126	78,006

YR	GOLD.		IRON ORE.				PIG IRON.			
	In Coin and Bullion.	In Ore.	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.
	$	$			$	$			$	$
1900	45,703,256	21,045,828	879,831	893,908	1,303,196	1.48	52,565	53,406	1,907,361	36.28
1901	33,237,629	21,524,251	966,950	982,421	1,659,273	1.72	62,930	63,937	1,792,014	28.48
1902	22,710,957	21,482,360	1,165,470	1,184,118	2,583,077	2.22	619,354	629,264	10,935,831	17.66
1903	44,054,902	21,212,794	980,440	996,127	2,261,008	2.31	599,574	609,167	11,173,302	18.64
1904	75,646,128	9,157,106	487,613	495,415	1,101,384	2.26	79,500	80,772	1,765,107	22.20

YEAR.	IRON MFRS.	SCRAP IRON AND STEEL.				BAR IRON.			
		Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.
1900........	$8,747,089	34,431	34,982	$663,231	$19.26	19,685	19,094	$1,058,761	$56.34
1901........	8,356,646	20,130	20,452	339,827	16.88	20,792	21,126	1,093,736	52.60
1902........	11,779,530	109,510	111,262	1,606,720	14.67	28,844	29,307	1,286,238	44.58
1903........	12,041,771	82,921	84,248	1,273,941	15.36	43,392	44,090	1,904,469	43.89
1904........	10,352,931	13,461	13,676	189,506	14.08	20,911	21,247	918,842	43.94

YR.	RAILS.				HOOP, BAND OR SCROLL.				INGOTS, BLOOMS, SLABS, BILLETS, ETC.			
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons	Metric Tons	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.
1900.	1,448	1,471	$56,129	$38.77	165	167	$12,409	$75.26	12,709	12,913	$1,332,896	$104.84
1901.	1,905	1,935	67,052	35.19	2,974	3,021	116,841	39.29	8,164	8,295	1,340,112	164.15
1902.	63,522	64,538	1,576,679	24.82	3,362	3,416	131,052	38.97	289,318	293,965	7,943,818	27.76
1903.	95,555	97,083	2,159,273	22.59	1,525	1,550	74,898	49.11	261,570	265,932	7,331,299	28.03
1904.	37,776	38,380	808,775	21.41	2,135	2,169	60,934	28.54	55,444	56,331	1,535,943	27.70

YEAR.	SHEET, PLATE AND TAGGERS IRON OR STEEL.				TIN PLATES, TERNE PLATES AND TAGGERS TIN.			
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.
1900	5,143	5,226	$426,541	$82.93	60,386	61,356	$4,617,813	$76.46
1901	5,626	5,716	443,880	79.10	77,395	78,638	5,294,789	68.41
1902	7,156	7,270	545,739	76.26	60,115	61,080	4,023,421	66.93
1903	11,557	11,741	540,272	46.75	47,360	48,118	2,999,252	63.33
1904	4,165	4,232	302,500	72.63	70,652	71,782	4,354,761	61.63

YEAR	WIRE-RODS.				WIRE AND ARTICLES MADE FROM.				TOTAL IRON IMPORTS. (e)
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.	
1900	21,092	21,430	$1,212,594	$57.49	1,848	1,877	$409,087	$221.37	$20,443,911
1901	16,804	17,073	964,744	57.40	4,129	4,192	585,354	141.77	20,404,122
1902	21,382	21,725	1,033,074	48.31	3,469	3,525	606,724	174.90	41,468,826
1903	20,836	21,169	1,028,977	49.39	5,018	5,098	728,430	145.16	41,258,864
1904	15,313	15,558	707,779	46.22	3,956	4,019	624,892	157.96	21,621,970

YEAR.	LEAD IN ORE AND BASE BULLION.				LEAD IN PIGS AND OLD.			
	Short Tons.	Metric Tons.	Value.	Value per Unit.	Short Tons.	Metric Tons.	Value.	Value per Unit.
1900	(g)114,397	103,780	$3,957,695	$34.60	......	......	....	....
1901	111,867	101,486	4,807,762	47.37	604	548	$33,882	$56.10
1902	105,186	95,425	4,424,511	46.37	2,529	2,294	132,500	52.40
1903	103,384	93,790	3,596,635	38,35	3,023	2,742	164,528	54.42
1904	104,127	94,464	3,517,691	37.24	8,724	7,914	461,316	52.88

YEAR.	LEAD, SHEET, PIPE, SHOT, ETC.				OTHER LEAD MFRS.	TOTAL LEAD.	WHITE LEAD.			
	Lb.	Metric Tons.	Value.	Value per Unit.			Lb.	Metric Tons.	Value.	Value per Unit.
1900	27,945	13	$1,393	$0.050	$5,854	$3,964,942	456,872	207	$ 28,366	$0.062
1901	56,735	26	2,773	.048	4,654	4,849,071	384,673	174	21,226	.055
1902	224,208	102	7,765	.034	18,918	4,583,694	506,423	230	25,320	.050
1903	17,008	8	810	.048	8,071	3,770,044	453,284	206	24,595	.054
1904	69,581	32	2,441	.035	7,755	3,989,203	587,338	266	33,788	.058

YR.	LITHARGE.				RED LEAD.				ORANGE MINERAL.			
	Lb.	Metric Tons.	Value.	Value per Unit.	Lb.	Metric Tons.	Value.	Value per Unit.	Lb.	Metric Tons.	Value.	Value per Unit.
1900	77,314	35	$2,852	$0.032	549,551	249	$25,532	$0.046	1,068,793	485	$61,885	$0.059
1901	49,306	22	1,873	.038	485,467	220	19,370	.040	977,644	443	52,409	.053
1902	88,115	40	2,908	.033	1,075,839	488	37,383	.035	997,494	452	49,060	.049
1903	42,756	19	1,464	.034	1,152,715	523	40,846	.035	756,742	343	36,407	.048
1904	44,541	20	1,500	.034	836,077	379	30,115	.036	766,469	348	37,178	.049

YEAR.	MAGNESITE.				MANGANESE ORE.			
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.
1900	......	......	....	.. ...	256,252	260,352	$2,042,361	$7.97
1901	30,350	30,835	....	.....	165,720	168,372	1,486,573	8.97
1902	45,157	45,880	$373,928	8.28	235,576	239,345	1,931,282	8.20
1903	49,684	50,479	461,399	9.29	146,056	148,393	1,278,108	8.75
1904	35,106	35,668	286,828	8.17	108,459	110,194	901,592	8.31

YEAR.	MARBLE AND STONE, MFRS.		METAL COMPOSITIONS.		MICA.	NICKEL. (h)	NICKEL ORE AND MATTE.			
	Marble.	Stone(d).	Bronze.	All Other.			Long Tons.	Metric Tons.	Value.	Value per Unit.
1900	$945,705	$256,624	$791,306	$5,420,483	$319,560	(f)	(f)	....	....	....
1901	1,226,524	237,191	945,702	5,162,392	335,054	.....	(f)	....	....	....
1902	1,435,457	222,435	816,668	5,942,453	466,332	.....	(f)	....	....	....
1903	1,502,111	258,968	790,639	6,402,215	317,969	207,954	15,936	16,191	$1,285,935	$80.70
1904	1,270,443	294,035	745,993	5,909,338	269,808	206,021	8,548	8,685	915,470	107.10

YEAR	OIL, MINERAL.				PAINTS AND COLORS.	PLATINUM, UNMANFD.				PLATINUM MFRS.
	Gal.	Liters.	Value	Value per Unit.		Lb. Troy.	Kg.	Value.	Value per Unit.	
1900	3,039,094	11,503,913	$274,766	$0.091	$1,491,902	9,246	3,450	$1,728,777	$187.00	$36,714
1901	2,294,684	8,686,389	151,913	.066	1,524,125	7,496	2,797	1,673,713	223.30	24,482
1902	3,578,393	13,545,646	207,310	.058	1,745,989	8,670	3,235	1,950,362	224.96	37,618
1903	4,266,974	16,152,203	261,199	.061	1,811,902	1,425	532	328,103	230.25	1,727,830
1904	4,846,159	18,344,650	277,397	.057	1,526,072	6,986	2,606	1,773,519	253.87	105,636

YR.	POTASSIUM SALTS.											
	CHLORATE.			CHLORIDE.			CHROMATE AND BICHROMATE.			NITRATE.		
	Lb.	Value.	Value per Lb.	Lb.	Value.	Value per Lb.	Lb.	Value	Value per Lb.	Lb.	Value.	Value per Lb.
		$	$		$	$		$	$		$	$
1900.	1,243,612	68,772	0.055	130,175,481	1,976,604	0.015	111,761	7,758	0.069	10,545,392	276,664	0.026
1901.	811,127	61,348	.076	148,189,337	2,316,577	.015	430,996	29,224	.068	9,656,393	253,286	.026
1902.	1,209,148	60,429	.050	140,980,460	2,141,553	.015	231,009	15,161	.066	10,505,474	299,416	.028
1903.	468,042	19,308	.041	169,337,673	2,550,478	.015	41,229	2,784	.067	13,835,668	367,721	.026
1904.	95,889	4,209	.044	176,865,872	2,832,554	.016	26,053	1,817	.069	14,184,287	376,931	.027

YR.	POTASSIUM SALTS. ALL OTHER.			PRECIOUS STONES.			PYRITES (i).			
	Lb.	Value.	Value per Lb.	Uncut.	Cut, not Set.	Jewelry.	Long Tons.	Metric Tons.	Value.	Value per Unit.
1900	54,904,088	$1,407,303	$0.025	$3,751,219	$9,612,127	(f)	332,517	337,837	$1,095,598	$3.30
1901	72,489,913	1,636,856	.022	6,637,860	17,166,049	(f)	398,969	405,353	1,407,244	3.53
1902	91,857,009	1,820 585	.020	8,282,760	18,494,288	(f)	437,319	444,316	1,623,430	3.71
1903	70,205,850	1,593,380	.023	10,374,877	15,428,819	$954,456	427,319	434,156	1,636,450	3.83
1904	74,720,241	1,678,699	.023	10,386,341	15,254,293	803,952	413,585	420,202	1,533,564	3.73

YEAR.	SALT.				SILVER.		SODIUM NITRATE.			
	Short Tons.	Metric Tons.	Value.	Value per Unit.	In Coin and Bullion.	In Ore.	Long Tons.	Metric Tons.	Value.	Value per Unit.
1900...	207,933	188,636	$633,192	$3.05	$14,695 965	$25,404,378	182,108	185,022	$4,935,520	$27.12
1901...	194,967	176,872	670,648	3.44	12,957,987	18,188,795	208,654	211,992	5,997,595	28.82
1902...	188,775	167,481	654,990	3.47	8,502,614	17,900,321	205,245	208,529	5,996,205	29.21
1903...	157,201	142,494	489,179	3.11	7,935,844	16,038,664	272,947	277,314	8,700,806	31.88
1904...	167,295	151,742	515,813	3.08	11,865,805	14,221,237	288,012	292,520	9,333,613	32.41

YEAR.	SODIUM HYDROXIDE (Caustic).			SODA ASH AND CARBONATE.			ALL OTHER SODIUM SALTS.		
	Lb.	Value.	Value per Unit.	Lb.	Value.	Value per Unit.	Lb.	Value.	Value per Unit.
1900....	8,403,749	$150,530	$0.018	73,815,425	$613,379	$0.008	20,484,938	$259,802	$0.012
1901....	3,812,847	94,303	.025	31,415,788	276,261	.009	14,491,559	189,543	.013
1902....	3,334,697	77,482	.020	31,889,252	284,634	.009	17,151,682	283,745	.016
1903....	2,970,426	73,647	.025	25,313,370	228,041	.009	14,272,646	268,738	.019
1904....	2,570,434	64,405	.025	23,631,832	205,496	.009	10,399,711	281,527	.027

YEAR.	SULPHUR.											
	Crude.				Flowers.				Refined.			
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.
1900...	166,457	169,120	$2,918,610	$17.53	628	638	17,437	$27.77	243	247	$6,279	$25.84
1901...	174,162	176,949	3,256,951	18.70	748	761	20,201	26.98	268	272	6,308	23.57
1902...	176,951	179,782	3,360,562	19.00	738	750	19,954	27.04	14	15	369	24.99
1903...	188,888	191,910	1,649,756	19.32	1,854	1,883	52,680	28.42	189	192	7,254	38.44
1904...	128,885	130,947	2,463,779	19.12	1,332	1,353	39,133	29.38	204	207	9,776	47.92

YEAR.	TALC.				TIN.			
	Short Tons.	Metric Tons.	Value.	Value per Unit.	Lb.	Metric Tons.	Value.	Value per Unit.
1900............	79	72	$1,070	$13.54	69,989,502	31,747	$19,458,586	$0.278
1901............	2,386	2,164	27,015	11.74	74,560,487	33,820	19,024,761	.255
1902............	2,859	2,594	35,336	12.35	85,043,353	38,575	21,263,337	.250
1903............	1,790	1,623	19,635	11.00	83,133,847	37,702	22,265,367	.268
1904............	3,268	2,964	36,370	11.13	83,168,657	37,718	22,356,896	.270

YEAR.	ZINC.								
	Blocks, Pigs and Old.				Oxide (j).		Sulphide.		Mfrs.
	Lb.	Metric Tons	Value.	Value per Unit.	Lb.	Value.	Lb.	Value.	Value.
1900.......	2,013,196	913	$97,772	$0.048	2,657,514	....	....	......	$36,836
1901.......	775,881	352	30,920	.040	3,327,976	....	....	......	42,643
1902.......	1,238,091	561	46,713	.038	3,434,466	....	1,247,936	$32,879	37,191
1903.......	728,614	330	30,900	.042	3,653,076	$188,495	1,229,806	33,077	18,938
1904.......	933,474	423	44,455	.048	2,809,905	165,110	1,228,875	31,382	11,789

Note.—For explanation of references, see second note, page 546.

EXPORTS.

DOMESTIC PRODUCTS. (a)

YEAR	ALUMINUM AND MFRS OF.	ASBESTOS AND MFRS OF.	BRASS AND MFRS OF.	BRKS.	CEMENT.				CHEMICALS, DRUGS AND MEDICINES.
					Bbl.(i)	Metric Tons.	Value.	Value per Unit.	
1900..	$281,821	$124,971	$2,068,072	$	100,400	18,216	$ 225,306	$2.24	$13,771,682
1901..	183,579	113,316	2,078,178	541,589	373,934	67,393	679,296	1.82	14,267,110
1902..	116,052	130,437	1,809,312	501,434	340,821	61,838	526,471	1.54	13,437,367
1903..	157,187	158,360	2,063,569	439,277	285,463	51,748	433,984	1.52	14,276,465
1904..	166,876	223,096	3,093,803	587,385	774,940	140,898	1,104,086	1.42	14,821,808

YR	COAL.									
	ANTHRACITE.				BITUMINOUS.				TOTAL.	
	Long Tons.	Metric Tons.	Value.	Val. per Unit	Long Tons.	Metric Ton.	Value.	Val. per Unit	Long Unit,	Value.
			$	$			$	$		$
1900	1,654,610	1,681,084	7,092,489	4.29	6,262,909	2,363,631	14,431,590	2.31	7,917,519	21,524,079
1901	1,993,307	2,025,200	8,937,147	4.48	5,390,086	3,476,327	13,085,763	2.53	7,383,393	22,022,910
1902	907,977	922,505	4,301,946	4.73	5,218,969	5,302,472	13,927,063	2.66	6,126,946	18,229,009
1903	2,008,857	2,040,999	9,780,044	4.86	6,303,241	6,404,093	17,410,385	2.76	8,312,098	27,190,429
1904	2,228,392	2,264,046	11,077,470	4.97	6,345,126	6,446,648	17,160,538	2.74	8,573,518	28,238,008

YEAR.	COPPER.									TOTAL EXCEPT ORE.
	IN ORE AND MATTE (b).				INGOTS, BARS, PLATES AND OLD.				MFRS.	
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Lb.	Metric Tons.	Value.	Value per Unit.	Value.	
			$	$			$	$	$	$
1900....	10,007	10,168	1,332,829	133.18	337,973,751	153,304	55,285 047	0.164	2,257,563	57,542,610
1901....	19,613	19,924	2,536,549	129.40	194,249,828	88,111	31,692,563	.164	1,842,336	33,384,899
1902....	18,035	18,321	1,326,131	73.53	354,668,849	160,876	43,393,800	.122	2,092,798	45,485,598
1903....	12,291	12,488	855,367	69.59	310,720,524	140,920	41,170,059	.132	2,339,729	43,509,788
1904....	18,927	19,230	1,202,537	63.54	554,549,880	251,497	71,488,116	.129	3,328,818	74,816,934

YR.	Earthen and China Ware.	FERTILIZERS.								GLASSWARE	GOLD.	
		CRUDE PHOSPHATES.				ALL OTHER.					In Coin and Bullion (c)	In Ore (d)
		Long Tons	Metric Tons.	Value.	Val. per Unit	Long Tons.	Metric Tons.	Value.	Value per Unit.			
	$			$	$			$	$	$	$	$
1900	558,794	619,995	629,915	5,217,560	8.38	25,976	26,392	537,908	20.71	2,042,633	54,064,697	69,926
1901	526,820	729,539	741,212	5,839,245	8.01	14,153	14,379	332,964	23.54	2,087,043	56,717,350	1,012,589
1902	604,646	802,086	814,919	6,193,372	7.73	16,451	16,714	383,438	23.31	2,094,701	35,722,835	307,756
1903	589,001	785,259	797,823	6,109,230	7.78	20,343	20,668	557,059	27.38	2,053,516	43,765,360	581,474
1904	791,739	842,484	855,964	6,521,555	7.74	25,549	25,958	714,367	27.96	2,130,267	120,153 47	1,985,403

YEAR.	GUNPOWDER AND OTHER EXPLOSIVES.	IRON.							
		ORE.				PIG.			
		Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value Per Unit.
1900....	....	51,460	52,283	$154,756	$3.01	286,687	291,404	$4,654,582	$16.23
1901....	$1,965,875	64,703	65,748	163,465	2.54	81,211	82,510	1,257,699	15.65
1902....	2,393,480	88,445	89,860	294,168	3.32	27,487	27,927	502,947	18.30
1903....	2,367,148	80,611	81,901	255,728	3.17	20,379	20,705	384,334	18.86
1904....	2,466,278	213,865	217,287	458,823	2.14	49,025	49,809	764,543	15.60

YR	IRON, BAR.				IRON, BAND, HOOP AND SCROLL.				BILLETS, INGOTS AND BLOOMS.			
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.
1900	13,298	13,512	$558,576	$42.04	2,976	3,024	$137,437	$46.20	107,385	109,103	$2,915,371	$27.15
1901	17,708	17,993	674,671	38.16	1,561	1,586	74,056	47.44	28,614	29,072	708,887	24.78
1902	22,249	22,605	869,519	39.08	1,674	1,701	82,322	49.18	2,409	2,447	74,938	31.11
1903	19,380	19,690	796,631	41.11	2,141	2,175	101,839	47.56	5,445	5,532	141,924	26.07
1904	29,582	30,055	1,133,128	34.93	3,435	3,489	162,039	47.18	314,324	319,353	6,150,035	19.56

YEAR	IRON, NAILS AND SPIKES, CUT.				IRON, NAILS AND SPIKES, ALL OTHER.				IRON, PLATES AND SHEETS.			
	Lb.	Metric Tons.	Value.	Value per Unit.	Lb.	Metric Tons.	Value.	Value per Unit.	Long Tons	Met. Tons	Value.	Value per Unit.
			$	$			$	$			$	$
1900..	25,005,308	11,342	626,497	0.025	65,444,387	29,681	1,816,813	0.028	9,331	9,481	600,600	64.35
1901..	20,835,944	9,452	450,331	.021	46,298,262	21,001	1,152,368	.025	6,909	7,020	452,695	65.52
1902..	16,122,775	7,312	339,227	.021	64,565,650	29,287	1,456,768	.022	3,434	3,489	229,887	66.94
1903..	19,912,563	9,031	424,985	.021	75,654,532	34,310	1,698,500	.024	4,782	4,858	273,618	57.22
1904..	20,772,817	9,422	416,455	.020	80,268,978	36,403	1,949,842	.024	4,728	4,804	248,120	52.48

YR	STEEL, SHEETS AND PLATES.				IRON RAILS.				STEEL RAILS.			
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.
			$	$			$	$				$
1900	45,534	46,264	1,638,478	35,98	5,374	5,460	119,206	22.18	356,245	361,945	10,895,416	30.58
1901	23,923	24,303	959,471	40.11	901	915	32,357	35.93	318,055	323,044	8,628,781	27.14
1902	14,866	15,104	725,547	48.80	211	214	4,639	22.02	67,455	68,534	1,902,396	28.09
1903	13,312	13,525	657,713	49.47	181	184	8,808	48.67	30,656	31,146	937,779	30.59
1904	50,477	51,278	2,064,241	40.89	1,405	1,427	23,870	17.00	414,845	421,482	10,661,222	25.72

YR.	STRUCTURAL IRON AND STEEL.				WIRE.				STEEL WIRE RODS.			
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value	Value per Unit.
			$	$			$	$			$	$
1900.	67,714	68,797	3,570,769	52.73	78,014	79,262	4,604,047	59.77	10,652	10,822	505,529	47.37
1901.	54,005	54,869	3,031,861	56.10	88,238	89,650	4,805,608	54.36	8,165	8,296	271,552	33.26
1902.	53,859	54,721	2,828,460	52.52	97,843	99,414	5,140,702	52.54	24,613	25,007	831,067	33.76
1903.	30,641	31,131	1,788,556	58.37	108,521	110,258	5,528,726	50.94	22,360	22,718	713,718	31.92
1904.	55,514	56,402	2,777,768	50.04	118,581	120,478	5,935,093	50.05	20,073	20,394	695,448	34.64

YR	LEAD AND MFRS OF.	MARBLE STONE, ETC.(h)	MICA	NICKEL (e)	PETROLEUM PRODUCTS. (In Thousands of Units.)* Crude.				Naphtha.			
					M Gals.	M Liters.	M Value.	Value per Unit.	M Gals.	M Liters	M Value.	Value per Unit.
	$	$	$	$			$	$			$	$
1900	459,574	1,556,981	165	1,382,727	138,161	523,000	7,341	0.053	18,570	70,295	1,681	0.081
1901	625,234	1,785,515	3,584	1,521,291	127,008	480,781	6,038	.050	21,685	82,087	1,742	.079
1902	696,010	1,587,957	....	924,579	145,234	549,775	6,331	.042	19,683	74,509	1,393	.071
1903	491,362	1,688,316	760	703,550	126,512	478,847	6,782	.054	12,973	49,103	1,519	.017
1904	616,337	1,337,754	1,770	2,130,933	111,176	420 801	6,351	.057	24,989	94,583	2,322	.093

YEAR.	PETROLEUM PRODUCTS. (In Thousands of Units).* Illuminating Oil.				Lubricating Oil.				Residue, Etc.			
	M Gals.	M Liters.	M Value.	Value per Unit.	M Gals.	M Liters.	M Value.	Value per Unit.	M Gals.	M Liters.	M Value.	Value per Unit.
1900...	739,163	3,104,593	$54,693	$0.074	71,211	269,540	$9,933	$0.139	19,750	74,760	$845	$0.042
1901...	827,479	3,131,399	53,491	.065	75,306	285,010	10,260	.136	27,596	104,463	1,255	.046
1902...	778,801	2,947,762	49,079	.063	82,201	311,163	10,872	.133	38,316	145,043	922	.024
1903...	691,837	2,618,603	51,356	.074	95,622	361,929	12,690	.133	9,753	36,916	282	.029
1904...	761,358	2,881,740	58,384	.077	89,688	339,469	12,393	.138	34,904	132,072	1,174	.034

YR.	PETROLEUM PRODUCTS.* Paraffine.				QUICKSILVER.				SILVER.	
	M Lb.	M Metric Tons.	M Value.	Value per Unit.	Lb.	Metric Tons.	Value.	Value per Unit.	In Coin and Bullion (c)	In Ore(d)
1900.	157,108	71.2	$8,186	$0.052	778,191	353	$425,812	$0.547	$65 705,909	$515,755
1901.	151,694	68.8	7,960	.052	843,938	383	475,609	.563	55,526,975	111,383
1902.	175,269	79.5	8,398	.048	1,013,434	459	575,099	.568	49,228,303	44,651
1903.	204,120	92.6	9,596	.047	1,344,615	610	719,119	.535	40,531,095	79,247
1904.	174,582	79.2	8,273	.047	1,611,365	731	847,108	.526	50,152,870	159,875

YEAR.	TIN MFRS.	ZINC ORE.				ZINC, PIGS, BARS, PLATES AND SHEET.			
		Long Tons.	Metric Tons.	Value.	Value per Unit.	Lb.	Metric Tons.	Value.	Value per Unit.
1900.......	$467,354	37,555	38,158	$1,133,663	$30.19	44,802,577	20,322	$2,217,693	$0.050
1901.......	495,435	39,425	40,056	1,167,684	29.62	6,780,221	3,071	288,906	.043
1902.......	529,061	49,762	50,558	1,449,104	29.12	6,473,135	2,936	300,557	.046
1903.......	777,917	35,188	35,751	987,000	28.05	3,041,911	1,380	163,379	.053
1904.......	701,625	32,063	32,576	905,782	28.25	20,293,869	9,204	1,094,490	.053

YEAR.	ZINC OXIDE.				ZINC MFRS.	TOTAL (EXCEPT ORE).
	Lb.	Metric Tons.	Value.	Value per Unit.		
1900.............	11,391,666	5,167	$496,380	$.44	$99,288	$2,813,361
1901.............	9,122,283	4,138	393 259	0.43	82,046	764,211
1902.............	10,716,364	4,861	433,722	0.40	114,197	848,476
1903.............	14,429,885	6,544	578,215	0.41	71,354	812,948
1904.............	16,313,826	7,399	628,494	0.39	117,957	1,840,941

FOREIGN PRODUCTS. (a)

YEAR.	Lb.	ANTIMONY.			ANTIMONY ORE.			
		Metric Tons.	Value.	Value per Unit.	Short Tons.	Metric Tons.	Value.	Short per Unit.
1900....................	23,520	10.7	$2,352	$0.100	Nil.	....	....	....
1901....................	Nil.	....	....	....	25	22.1	$1,536	$63.05
1902....................	37,184	16.9	2,710	.073	104	94.6	4,602	44.13
1903....................	79,917	36	4,478	.056	Nil.	....	....	....
1904....................	31,077	14	1,734	.056	214	194	10,775	50.35

YEAR.	ASPHALTUM, CRUDE.				BRASS AND MFRS.	CEMENT. (i)			
	Long Tons.	Metric Tons.	Value.	Value per Unit.		Bbl. (b)	Metric Tons.	Value.	Value per Unit.
1900.......	629	639	$10,044	$15.98	$2,155	39,540	7,174	$63,880	$1.62
1901.......	2,209	2,244	18,078	8.19	813	43,691	7,927	72,761	1.67
1902.......	2,930	2,977	23,564	8.11	938	32,594	5,913	48,797	1.50
1903.......	1,605	1,631	13,894	8.66	7,576	25,362	4,601	32,156	1.27
1904.......	1,887	1,917	26,272	13.92	2,517	39,711	7,186	54,486	1.37

YR.	CHEMICALS.											
	SALTS OF POTASSIUM. (f)				CHLORIDE OF LIME.				NITRATE OF SODIUM.			
	Lb.	Kg.	Value.	Value per Unit.	Lb.	Kg.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.
1900.	808,701	366,824	'3,524	$0.054	148,116	67,185	$1,987	$0.014	3,089	3,139	$112,550	$36.43
1901.	633,100	287,182	43,446	.068	13,916	6,312	312	.023	2,482	2,519	101,489	40.90
1902.	1,266,145	574,323	59,789	.048	198,794	90,172	2,997	.014	3,675	3,734	144,650	39.36
1903.	1,299,905	589,637	33,264	.026	836,411	379,696	7,609	.009	4,417	4,488	184,657	41.81
1904.	1 262,222	572,544	33,358	.027	1,434	650	13	.009	6,076	6,173	279,864	46.06

YEAR.	CHEMICALS.—Continued.											
	CAUSTIC SODA.				SODA ASH AND CARBONATE				SODIUM SALTS, ALL OTHER.			
	Lb.	Kg.	Value.	Value per Unit.	Lb.	Kg.	Value	Value per Unit.	Lb.	Kg.	Value.	Value per Unit.
1900....	1,139,954	517,080	24,228	0.023	78,017	35,388	1,126	0.014	270,307	122,610	2,788	.009
1901....	1,001,940	452,482	21,511	.023	369,521	167,614	5,184	.014	133,400	60,510	3,398	.023
1902....	1,343,132	609,246	28,704	.023	62,653	28,419	931	.014	115,491	52,386	1,626	.014
1903....	1,116,354	506,378	23,227	.028	30,030	13,622	464	.015	42,540	19,294	437	.010
1904....	1,115 600	506,036	23,608	.021	40,351	18,303	593	.014	1,778,616	806,780	25,312	.014

YEAR.	CLAYS OR EARTHS				COAL, BITUMINOUS.				COPPER.			
									ORE AND MATTE.			
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.	L. T.	Metric Tons.	Value.	Value per Unit.
1900.....	78	79	$572	$7.34	6,740	6,848	$19,740	$2.93	964	979	$170,191	$176.53
1901.....	80	81	825	10.34	3,796	4,403	10,627	2.45	9,891	10,050	1,406,648	142 19
1902.....	123	125	1,284	10.43	7,559	7,680	22,153	2.93	14,446	14,657	2,229,912	154.57
1903.....	88	89	621	7.06	88,468	89,883	453,613	5.13	5,150	5,232	852,726	165.58
1904.....	210	214	2,466	11.74	7,250	7.366	21,910	3.02	Nil.	....	....	.....

YR	COPPER.—Continued.					EARTHEN, STONE AND CHINA WARE.	FERTILIZERS.	GLASS AND GLASSWARE.	GRAPHITE	
	PIGS, BARS, INGOTS, OLD, AND ALL UNMANUFACTURED.				MFRS.					
	Lb.	Metric Tons.	Value.	Value per Unit.			Total Value.		Long Tons.	Value.
1900	1,281,782	581	$212,264	$0.166	$21,032	$38,008	$32,102	$14,614	3	$115
1901	12,888,083	5,846	2,145,468	.166	9,462	24,080	2,833	16,749	Nil.	....
1902	11,629 877	5,275	1,604,522	.138	10,939	18,989	31,476	34,236	12	834
1903	2,093,103	949	261,413	.125	13,027	19,411	3,281	19,116	63	4,223
1904	1,088,672	494	140,695	.129	19,461	32,640	139,363	20,522	8	455

YEAR.	IRON AND STEEL.											
	Pig Iron.				Scrap.				Bar Iron.			
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.
1900........	151	153	$6,579	$43,69	9,079	9,224	$131,241	$14.46	48	49	$2,447	$51.00
1901........	189	191	6,148	32.70	3,331	3,384	61,663	18.51	67	68	7,569	113.00
1902........	250	254	6,286	25.14	1,542	1,567	25,020	a16.23	22	22	1,875	86.56
1903........	1,863	1,893	33,996	18.25	262	266	2,862	10.92	16	16	2,108	130.93
1904........	1,646	1,672	25,910	15.74	190	193	2,367	12.46	7	7	765	102.55

YEAR.	IRON AND STEEL.—Continued.											
	Rails.				Steel Ingots, Blooms, Etc.				Sheets, Plates, Rods, Wire.			
	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.	Long Tons.	Metric Tons.	Value.	Value per Unit.
1900........	Nil.	....	....	....	2	2	$1,342	$559.33	209	213	11,599	$55.41
1901........	Nil.	....	....	....	2	2	1,059	504.30	190	193	17,272	90.81
1902........	297	302	$7,184	$24.20	106	108	6,774	64.09	236	240	14,221	60.26
1903........	739	751	17,560	23.76	60	61	5,316	88.01	55	56	5,532	100.04
1904........	96	98	2,305	24.00	40	41	6,208	154.81	108	110	6,482	60.01

YR.	IRON AND STEEL.—Concluded.					LEAD AND MFRS.	MARBLE AND STONE MFRS.	METAL COMPOSITION.
	Tin and Terne Plates, Taggers Tin.				Mfrs.			
	Long Tons.	Metric Tons.	Value.	Value per Unit.				
1900..	464	470	$37,395	$80.60	$328,704	$3,843,881	$5,721	$79,218
1901..	118	120	8,519	72.20	149,771	4,190,525	17,063	35,438
1902..	98	100	7,471	76.24	242,225	3,553,144	11,210	108,575
1903..	2	2	184	118.71	399,147	2,917,957	7,389	54.490
1904..	81	82	5,306	65.86	518,564	2,880,907	21,055	42.730

YEAR.	SALT.				PAINTS. AND COLORS.	SULPHUR—CRUDE .			
	Lb.	Metric Tons.	Value.	Value per Unit.		Long Tons.	Metric Tons.	Value.	Value per Unit
1900....	3,548,724	1,610	$3,907	$0.0011	$13,814	590	599	$13,495	$22.89
1901....	3,699,411	1,678	7,155	.0019	17,923	207	210	5,086	24.60
1902....	2,310,759	1,048	4,544	.0020	14,217	1,253	1,273	28,024	22.37
1903....	7,804,215	3,585	26,636	.0034	13,467	967	982	22.658	23.43
1904....	2,089,234	948	2,814	.0013	11,888	2,493	2,533	58,887	23.62

YEAR.	TIN IN BLOCKS, PIG AND GRANULATED.				ZINC. AND MFRS.
	Long Tons.	Metric Tons.	Value.	Value per Unit.	
1900	495	503	$335,377	$677.96	$3,048
1901	939	954	562,350	598.89	1,641
1902	479	486	286,897	598.95	765
1903	512	520	317,805	620.47	2,362
1904	519	527	322,234	620.87	1,236

*For convenience in tabulating, the quantities of all the petroleum products and their gross values have been divided by 1,000.

(a) From Summary of Commerce and Finance of the United States.
(b) Very little ore, mainly matte.
(c) Total exports of coin and bullion; that is, includes both foreign and domestic.
(d) Only approximately correct. The Bureau of Statistics reports only the value of silver ores exported, but a much larger amount of silver leaves the country in copper matte, which is classified as copper ore, and no record is kept of its silver contents. The gold in copper matte exported is not included in the exports of gold given in the above table. These figures include ore of both domestic and foreign origin.
(e) Includes nickel oxide and nickel matte.
(f) Includes chlorate, chloride, nitrate and all other salts of potassium.
(g) Reported in bbl., but calculated to gal., on a basis of 42 gal. to the bbl.
(h) Includes slate.
(i) Barrel of 400. bl.

(a) From Summary of Commerce and Finance of the United States.
(b) Includes arsenic sulphide. (c) Barrels of 400 lb. (d) Including slate. (e) Not including iron ore. (f) Not reported. (g) Includes pigs and old. (h) Includes nickel oxide, alloys in which nickel is the principal constitutent and manufactures of nickel. (i) Containing more than 25% sulphur. (j) Includes white pigments containing zinc but not lead, dry and in oil.

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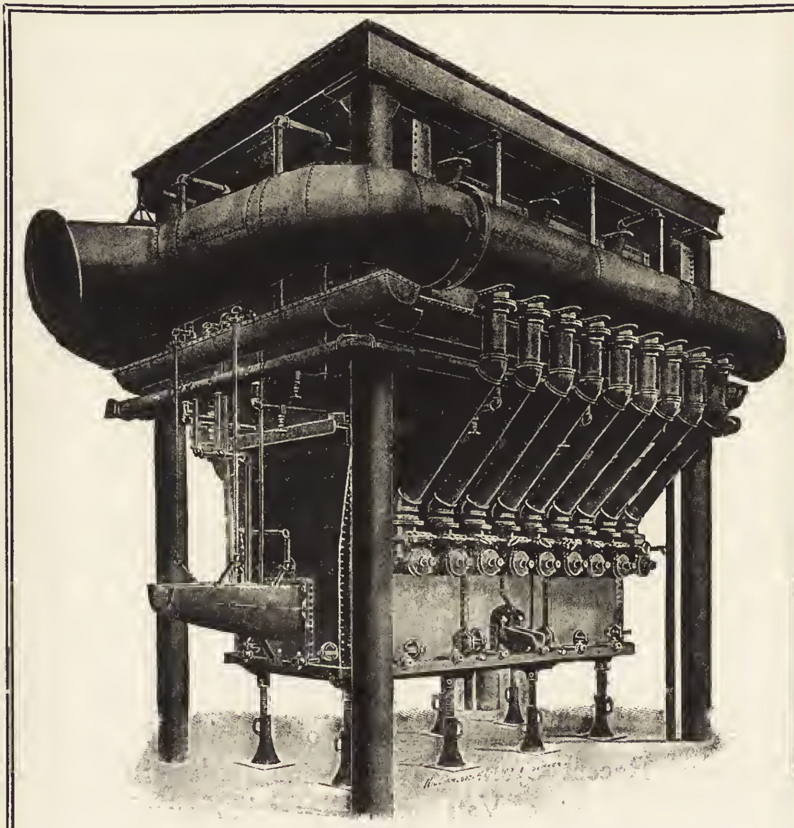

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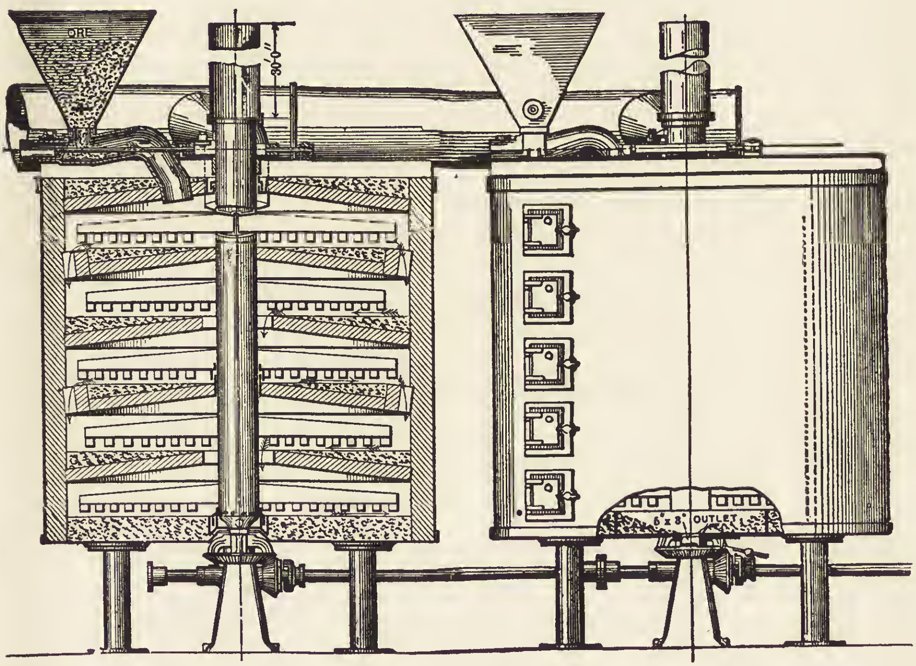

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The skill and knowledge acquired in building up in a very few years an industry whose output last year had an aggregate market value at the place of production exceeding $1,600,000,000 are sought for by those in every land who wish to utilize its mineral resources. It is not surprising, therefore, to find American mining engineers and metallurgists in such request that their services command far higher salaries than are paid to the engineers of any other country. The names of most of the eminent men in the profession, those who have largely contributed to this marvelous growth of the mineral industry, are found in the pages of this Professional Directory. All engaged in the industry look here when they wish to find experts eminently qualified to assist them; it is therefore not only in accord with the highest code of professional ethics, but also very desirable, that the names of all those most skillful in the arts treated of in this work should be found in this Directory.

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