DEPARTMENT OF THE INTE
JOHN BARTON PAYNE, Secretary

UNITED STATES GEOLOGICAL
GEORGE OTIS SMITH, Director

MINERAL RESO
OF THE
UNITED STA
1917

H. D. McCASKEY
Geologist in Charge, Division of Mineral

PART I—METALS

H. D. McCASKEY, Geologist in

WASHINGTO
GOVERNMENT PRINTIN
1921

ZINC.

(GENERAL REPORT.)

By C. E. Siebenthal.

SUMMARY.

Zinc produced and consumed in the United States, 1911–1917.

	1911	1912	1913	1914	1915
Production of primary zinc: [a]					
From domestic ore	271,621	323,907	337,252	343,418	458,1
From foreign ore	14,905	14,899	9,424	9,631	31,3
	286,526	338,806	346,676	353,049	489,5
Production of secondary zinc: [a]					
Redistilled	14,043	26,064	25,991	20,545	29,7
Remelted	26,470	26,187	24,014	22,424	23,1
	327,039	391,057	396,681	396,018	542,4
Apparent consumption of primary zinc.	280,059	340,341	295,370	299,125	364,6

[a] "Primary zinc," which is produced directly from ore, is here distinguished from which is obtained by refining zinc ashes, skimmings, drosses, and old metals. These are given on page 860. Wherever in this report the word "zinc" is used without q primary zinc.

The production of primary zinc from domestic ores 384,597 short tons, valued at $119,258,000, based on the ing price, as compared with 563,451 short tons, valued at based on the average selling price, in 1916—an increa tons, or about 4 per cent, in quantity and a decrease o or about 21 per cent, in value.

INTRODUCTION.

Though the publication of this final report has be delayed by the press of work growing out of the war th mainly as a statistical record, the essential figures wer ble to the public early in 1918.

The statistics of production in this country have bee the United States Geological Survey from confidential ach zinc-smelting company in operation during 1917. he recovery of secondary zinc were collected from all econdary smelters and refiners. The statistics of dome ion are taken in part from the smelter returns and in ecords of the Bureau of Foreign and Domestic Com Department of Commerce, and the tables for foreign p onsumption were compiled from the sources indicated

PRODUCTION.

ANNUAL PRODUCTION, 1873–1917.

The smelting of zinc in the United States began in an experimental way in 1858,[1] and regular production began in 1860 at the Lehigh Zinc Works in the East and at the Matthiesson & Hegeler works in the West. Between 1864 and 1870 nine or ten other zinc smelters were established. Statistics of production are recorded for the years 1873 and 1875 and for the census year ending May 31, 1880. Annual statistics have been collected by the United States Geological Survey since 1882. The progress of the zinc-smelting industry since 1873 is shown in the following table:

Zinc produced in the United States from domestic and foreign ores, 1873–1917, in short tons.

Year.	From foreign ore.	From domestic ore.	Total.	Year.	From foreign ore.	From domestic ore.	Total.
1873		7,343	7,343	1899		129,051	129,051
1876		15,833	15,833	1900		123,886	123,886
1880 (census year)		23,239	23,239	1901		140,822	140,822
1882		33,765	33,765	1902		156,927	156,927
1883		36,872	36,872	1903		159,219	159,219
1884		38,544	38,544	1904		[a] 186,702	186,702
1885		40,688	40,688	1905		[a] 203,849	203,849
1886		42,641	42,641	1906	25,076	199,694	224,770
1887		50,340	50,340	1907	26,115	223,745	249,860
1888		55,903	55,903	1908	19,675	190,749	210,424
1889		58,860	58,860	1909	25,535	230,225	255,760
1890		63,683	63,683	1910	16,705	252,479	269,184
1891		80,873	80,873	1911	14,905	271,621	286,526
1892		87,260	87,260	1912	14,899	323,907	338,806
1893		78,832	78,832	1913	9,424	337,252	346,676
1894		75,328	75,328	1914	9,631	343,418	353,049
1895		89,686	89,686	1915	31,384	458,135	489,519
1896		81,499	81,499	1916	104,005	563,451	667,456
1897		99,980	99,980	1917	84,976	584,597	669,573
1898		115,399	115,399				

[a] Including an unknown quantity smelted from foreign ore, small in 1904, but larger in 1905.

Zinc produced in the United States, 1906–1917, apportioned according to States in which it was made, in short tons.

Year.	Arkansas.	Illinois.	Kansas.	Oklahoma.	Pennsylvania.	Other States.	Electrolytic zinc.	Total.
1906		47,939	129,561		8,659	38,608		224,770
1907		58,056	134,108	5,035	11,266	43,395		249,860
1908		50,244	99,298	14,861	6,818	39,200		210,424
1909		67,653	103,299	28,782	15,222	40,804		255,760
1910		73,033	105,697	34,760	16,459	39,230		269,184
1911		83,130	98,413	46,315	15,337	43,331		286,526
1912		88,397	101,104	76,925	18,254	54,126		338,806
1913		106,654	74,106	83,214	26,934	55,768		346,676
1914		127,946	44,510	91,367	28,095	61,131		353,049
1915		159,958	101,423	109,208	44,167	74,511	252	489,519
1916	7,503	181,433	141,286	168,206	76,545	82,254	10,229	667,456
1917	25,660	172,489	76,048	204,394	86,995	78,778	25,209	669,573

[1] Ingalls, W. R., Lead and zinc in the United States, p. 314, 1908.

ROLLED ZINC.

For many years nearly all the sheet zinc made States was produced by two of the older and larger Matthiessen & Hegeler Zinc Co., of La Salle, Ill., Zinc Co., in the adjoining town of Peru, Ill. Other ticularly the manufacturers of glass fruit jars ha have rolled zinc for their own use, and some that fu to lithographers have also rolled their own zinc. Th since the beginning of the war for sheet zinc to lin made for shipment overseas, especially cases contai or other material that is likely to be affected by salt other firms into the business of rolling zinc. In two companies mentioned specifically above the now make rolled zinc: Ball Brothers Glass Man Muncie, Ind.; Hazel Atlas Glass Co., Wheeling, W. Zinc Co., Palmerton, Pa.; American Zinc Products Ind.; Edes Manufacturing Co., Plymouth, Mass.; Sons, South Hanover, Mass.; and The Platt Brother bury, Conn.

The United States Geological Survey has for n lected statistics showing the production of zinc, but i of rolled zinc was practically limited to that of the in Illinois mentioned above the Survey could not p showing that output without disclosing individual increase in the number of producers, however, ha possible to give these figures. A canvass of the writer gives the statistics presented in the followin figures showing the exports, as published by the Bu and Domestic Commerce, are subtracted from the the production, the result will represent the domest It should be borne in mind, however, that the she the Government in shipping munitions overseas is exported.

Zinc rolled in the United States, 1915–191

	1915.
Zinc sheets:	
Quantity.....pounds.	60,007,725
Value	$9,744,026
Average value per pound	$0.141
Boiler plates and special sheets:	
Quantity.....pounds.	2,562,856
Value	$345,572
Average value per pound	$0.135
Zinc strips:	
Quantity.....pounds.	20,208,058
Value	$2,937,213
Average value per pound	$0.145
Total rolled zinc.....pounds.	91,778,639
Total value	$13,026,811
Average value per pound	$0.142
Rolled zinc exported:	
Quantity.....pounds.	
Value	
Average value per pound	
Domestic consumption of rolled zinc.....pounds.	

The New Jersey Zinc Co. made its first output American Zinc Products Co. in 1918. Additions to

ing to nearly 5[illegible]er cent are being made at four of the principal mill[illegible] to meet the increased demand for zinc for war uses and that which will result from the prevailing strong movement to find and establish new uses for sheet zinc and to extend the present uses. Every such extension, especially the substitution of sheet zinc for sheet copper and brass and for tin plate, will stimulate the zinc market and relieve to some extent the shortage of copper and tin. The War Industries Board ordered the use of sheet zinc instead of galvanized iron or steel for refrigerator linings, a use that was expected to require about 10,000 tons of rolled zinc. Sheet zinc can also be substituted for galvanized iron in roofing, spouting, guttering, garages, household utensils, and hospital ware.

Rolled zinc has always been quoted at so much per pound with discounts and extras for different gages and special sizes and shapes. In 1914, according to Metal Statistics, the base price ranged from[illegible] to 8.75 cents a pound. In 1915 the price began at 8.75 cents and rose to 33 cents on June 9, fell to 15 cents August 23, and rose to 23 cents at the end of the year. In 1916 the price reached 25.5 cents on April 22, but dropped to 15 cents on July 11 and ended the year at 21 cents. In 1917 the base price of sheet zinc remained nearly stationary, declining to 20 cents on April 25 and to 19 cents on April 26. On February 15, 1918, the base price of zinc sheets was fixed by the Government at 15 cents and the price of rolled zinc plates at 14 cents.

Both the production and the value by classes of product given in the table are subject to slight correction because some producers that sell from a single base price do not keep their sales separated according to classes of product (which are arbitrary anyhow) and were to that extent obliged to make estimates; others, who themselves use the greater part of their output, had to estimate values. But the total production, value, and average price given may be considered accurate. The average price agrees closely with the average price shown by the exporters' manifests.

ZINC DUST.

Zinc dust has been marketed by domestic smelters since 1910. The United States Zinc Co., at Pueblo, Colo., was the first to prepare it for the market; the Grasselli Chemical Co. followed later; and one by one other companies began to save zinc dust, until in 1917 all the companies named below reported production, a small part of which consisted of "atomized" zinc dust made by subjecting a small stream of molten zinc to a blast of air. Some of these companies prepared zinc dust for the first time in 1914–1917 by reason of the high price of zinc dust consequent upon the inability of Belgium and Germany to export any to the United States.

American Zinc & Chemical Co., Langeloth, Pa.
Anaconda Copper Mining Co., Great Falls, Mont.
Bartlesville Zinc Co., Bartlesville, Okla.
Clarksburg Zinc Co., Clarksburg, W. Va.
Grasselli Chemical Co., Clarksburg and Meadowbrook, W. Va.
Illinois Zinc Co., Peru, Ill.
Metals Disintegrating Co., New York, N. Y.
National Zinc Co., Bartlesville, Okla., and Springfield, Ill.
New Jersey Zinc Co., Palmerton, Pa.
United States Smelting Co., Altoona, Kans.
United States Zinc Co., Pueblo, Colo.

The following table gives the output of zinc dust production in a commercial way in the United States

Zinc dust produced in the United States, 1910–

	Short tons.		
1910	69	1914	
1911	254	1915	
1912	492	1916	
1913	423	1917	

As will be seen from the table of imports of zinc page 871, the imports fell off about two-thirds in 19 smaller in 1916 and 1917, on account of the increase duction.

ZINC PIGMENTS.

Zinc forms the base, either in whole or in part pigments—zinc oxide, leaded zinc oxide, zinc-lead pone. All of these may be and in the United States usually have been made directly from zinc ore. No has been made since 1909, when the plant at Ca was closed. The output of zinc oxide and leaded zi been disclosed, as it was confined to one very large p eral smaller ones.

Lithophone is an intimate mixture by chemical zinc sulphide and barium sulphate. It may be ma zinc ore, or zinc oxide, but in the United States it i from zinc skimmings, zinc ashes, and scrap zinc, of lithophone is growing rapidly, as is shown in the The figures for 1906–1914, inclusive, represent mark those for subsequent years give the total quantity

Lithopone produced in the United States, 1906–1917,

1906	4,300	1912	
1907	10,275	1913	
1908	8,292	1914	
1909	14,847	1915	
1910	12,655	1916	
1911	16,866	1917	

The zinc content of the various pigments mad States from ore, both domestic and foreign, for the is given in the table below. On page 860 a portion zinc recovered in the form of pigments is given.

Primary zinc content of zinc pigments made in the Unite in short tons.

1908	48,004	1913	
1909	54,139	1914	
1910	50,592	1915	
1911	46,122	1916	
1912	64,032	1917	

SECONDARY ZINC.

By the ordinary method of galvanizing, in whic be coated is dipped into a bath of molten zinc, ther zinc in the form of semioxidized skimmings and of

consisting of the alloy formed by the zinc with the iron of the tank and the iron of the article that is being galvanized. The larger galvanizing plants have furnaces to resmelt these skimmings and drosses and to recover the zinc. There are also many small plants and some large ones which make a practice of buying galvanizers' skimmings and drosses and of recovering the zinc. A considerable quantity of old metal in the form of various alloys of zinc with copper and other metals is also worked over and brought up to the desired composition by the addition of new metal. At almost every brass foundry and machine shop in the country it is the custom to remelt and use brass filings, grindings, and scrap copper and brass, and it is manifestly impracticable to attempt to take full account of such material. Some of the zinc smelters running on ore find it advantageous to work in a quantity of secondary material, because the loss of zinc in distillation is practically a fixed quantity per charge, whether the charge is of low or high tenor. If secondary material high in zinc is mixed with low-grade ore, the loss per unit of metal recovered is thereby greatly lessened. Where this is done the smelters make proper returns to the United States Geological Survey, and in these reports prior to 1907 account has been taken of such production, the output being recorded as dross or secondary zinc. As such metal has been recovered by redistillation, it is practically indistinguishable in quality from zinc of ordinary grades made from ore. Several secondary smelters recover zinc from drosses by redistillation, and these plants are included in the list of smelters on a later page. In the table below the secondary zinc recovered by redistillation is separated from that recovered by remelting. The canvass of secondary smelters was made by J. P. Dunlop, of the United States Geological Survey.

Secondary zinc produced in the United States, 1912–1917, in short tons.

	1912	1913	1914	1915	1916	1917
Secondary zinc, redistilled	26,064	25,991	20,545	29,764	29,663	16,836
Secondary zinc, remelted	26,187	24,014	22,424	23,136	21,037	14,595
Recovered zinc in alloys, excluding old brass remelted	3,912	3,743	3,914	5,300	2,600	4,800
Recovered zinc in remelted brass	28,426	25,822	24,759	34,375	61,700	80,000
Secondary zinc recovered as metal	84,589	79,570	71,642	92,575	115,000	116,200
Secondary zinc recovered in pigment	4,619	3,705	6,536	8,323	8,749	9,204
Secondary zinc recovered in zinc chloride [a]	4,903	6,253	6,429	7,860	6,319	6,248
Total secondary zinc	94,111	89,528	84,607	108,758	130,000	132,000

[a] These figures include only the quantity of zinc chloride used in wood preservation and were furnished by courtesy of the Forest Service, Department of Agriculture.

COMPARISON OF PRODUCTION BASED ON SMELTER AND ON MINE REPORTS.

The figures of the production of domestic zinc given in the foregoing pages are compiled from reports from individual zinc smelters. Since 1904 statistics of the production of the more valuable metals in the Western States have been obtained by the United States Geological Survey from reports of individual mines, and since 1907 this compilation has been extended over the whole country. In order

to put the smelter production on the same basis as
all the zinc which is manufactured into pigments d
(exclusive of the quantity in zinc oxide manufactur
zinc, the inclusion of which would entail its duplicat
is added to the production of metallic zinc. The z
powder" only, not "atomized" zinc dust—made fro
for the reason given above) produced during the
cluded here. The zinc recovered from secondary so
for it has already been once reckoned as zinc. The
borne in mind in comparing the subjoined table with
ing the production of zinc.

Comparison of production of domestic zinc by smelters and
in short tons.

Year.	Totals compiled from smelter reports.	Totals compiled from mine reports.
1907	280,676	289,95
1908	238,030	234,52
1909	283,173	305,42
1910	303,139	327,71
1911	315,029	345,26
1912	386,783	378,21
1913	408,289	406,41
1914	424,672	406,95
1915	539,074	586,49
1916	656,075	703,81
1917	686,604	713,35
	4,521,544	4,668,29

The smelter totals represent actual recovery a
summing up the total production reported by all c
culating all pigments and zinc dust back to equiva
on the basis of average analysis of product. In co
totals each producing operator is requested to repo
of zinc ores and concentrates shipped, and from
zinc content is reckoned by assay value. From th
to 20 per cent, according to the character of the or
smelting losses, and the sum of the remainders th
all the producing properties in each State gives
State. Where the ore is concentrated at a custom m
ance is also made for the loss of metal in the proces
by either method the correctness of the totals is
complete and correct returns from each producing
It is further essential to the correctness of the mi
assay content and the theoretical recovery be co
The totals, as compiled from smelter reports and f
respectively, should be in reasonable agreement. A
for any year they show considerable divergence
ancies, giving rise to "smelter excess" or "mine e
result of one cause or of a combination of causes,
lag in the smelting of the ore, resulting in accumul
at the smelters; lag in the mining, owing to whi
pletes its ore stocks; error in calculating metallic
and in estimating recovery.

The smelter reports give the exact annual production of zinc and serve as a check on the mine production, and they also give the form in which the zinc was recovered, whether as metal or as pigment. For more exact statements of distribution of zinc production according to origin, recourse must be had to the reports of production by mines.

MINE PRODUCTION.

Mine production of zinc in the United States, 1908–1917, in short tons.

State.	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917
Arizona	339	2,989	2,742	2,281	4,379	4,714	4,896	9,110	9,839	10,447
Arkansas	605	510	994	604	748	478	608	3,209	6,815	6,691
California				1,404	2,173	529	195	6,517	7,628	5,436
Colorado	15,065	25,605	38,545	47,304	60,111	59,673	48,387	52,297	67,143	60,158
Idaho	19	676	2,802	4,170	6,953	11,587	21,006	35,077	43,253	39,927
Illinois	1,717	2,103	3,549	4,219	4,005	2,236	4,811	5,534	3,404	4,267
Iowa	395	35	96						21	18
Kansas	14,119	11,445	13,229	10,272	10,033	10,088	11,284	14,365	12,448	20,249
Kentucky		56	6	158	491	327	230	764	1,096	751
Missouri	107,404	130,162	128,589	122,515	136,551	124,993	105,994	130,300	155,960	132,018
Montana	820	4,080	15,819	21,935	13,459	44,337	55,790	93,573	114,630	93,130
Nevada	558	1,507	1,354	1,774	6,661	7,210	6,490	12,188	16,222	11,134
New Hampshire						15	6	24	36	45
New Jersey	67,165	82,510	68,678	77,445	69,755	72,156	74,253	116,618	112,020	120,846
New Mexico	1,788	6,543	9,044	5,119	6,783	8,262	9,202	12,702	18,285	15,100
New York				81				2,455	4,507	5,192
North Carolina					142	10				
Oklahoma	4,529	7,806	6,394	5,150	5,769	11,664	13,992	14,314	28,754	85,835
Tennessee	344	596	966	1,117	2,191	5,583	10,425	16,461	26,428	28,498
Texas	18				119	326	108	15	116	11
Utah	730	4,930	8,184	8,920	8,534	9,429	7,995	12,146	14,786	10,643
Virginia	705	58	794	1,032	249	2,719	174	1,267	2,276	1,703
Washington				10				122	847	598
Wisconsin	18,206	23,152	25,927	29,720	33,050	33,110	31,113	41,403	56,803	59,742
	234,526	305,423	327,712	345,260	378,816	406,416	406,959	586,491	703,317	713,359

The following table shows for each zinc-producing State the total quantity of zinc ore produced and the output of each kind of zinc-bearing ore. The column headed "All other ore" includes lead ore, copper ore, copper-lead ore, and dry or siliceous ore, no zinc of consequence being recovered from any of them except in California and Colorado. "Dry" ores produced in Colorado in 1917 contained 1,549 short tons of recoverable zinc. Copper-zinc ores produced in California contained 3,459 tons of recoverable zinc. These ores, however, were concentrated from parts of the ore from certain counties and were not distributed through the whole of the "All other ore" credited to those States in 1917. The total crude ore yielding either gold, silver, copper, lead, or zinc is given for each zinc-producing State, so that a comparison may be made of the relative extent of deep mining operations for all five metals in these States, the quantity of crude ore raised being the best measure for this purpose. The table discloses the fact that Missouri produced a little more than one-fifth of the crude-ore output of the zinc-producing States, her production being 17,024,000 short tons of crude ore, of which 11,136,100 tons was zinc-lead ore. Exclusive of iron ore, this was the largest production of metalliferous crude ore in the United States. Next in rank was Arizona, with 15,770,193 tons of crude copper ore; Utah ranked third, with 15,358,481 tons of crude ore; Michigan, which formerly ranked second in quantity of crude ore raised, was fourth in 1917, with 12,400,723 tons.

The table gives also the quantity of recoverabl
the crude ores of each State and the quantity of z
each kind of zinc ore. The percentage of recover
in the zinc ore and the zinc-lead ore of each S
The recoverable zinc content of crude-zinc ore
per cent for a small quantity produced in Cali
per cent in Tennessee; the Western States show u
percentages. The zinc-lead ore of Missouri avera
recoverable zinc—the leanest average shown by
worked in any State in 1917. The average recov
of the zinc ore of the United States in 1917 was 9
zinc-lead ore was 2.2 per cent. Of the total r
zinc in 1917, a quantity corresponding to 31.7 pe
from zinc ore, 67.5 per cent from zinc-lead ore, an
all other ores. The figures of mine production
from the chapters on gold, silver, copper, lead, a
duction) in the various States, as indicated in

Mine production of zinc in the United States in 1

State.	Zinc ore.			Zinc-lead ore.			All
	Crude ore.	Recoverable zinc content.		Crude ore.	Recoverable zinc content.		
		Quantity.	Percentage.		Quantity.	Percentage.	
Arizona	62,839	5,309	8.5	43,071	4,738	9.7	15,65
Arkansas	203,600	6,691	3.3				
California	125	53	42.4	26,501	1,924	7.3	2,97
Colorado	140,455	23,791	16.9	412,371	34,818	8.4	2,12
Idaho	19,269	5,412	28.1	1,118,075	34,515	3.1	1,62
Illinois				327,340	4,267	1.3	
Iowa				[b] 1,000	18	1.8	
Kansas				903,400	20,249	2.2	
Kentucky	[b] 9,000	751	8.3				
Missouri				11,136,100	132,018	1.2	5,8
Montana	258,846	17,010	6.6	726,280	78,051	10.8	8,3
Nevada	18,393	5,909	32.1	27,943	5,245	18.8	6,4
New Hampshire				3,000	45	1.5	
New Jersey	727,498	120,846	16.6				
New Mexico	135,129	14,496	10.7	10,899	694	6.4	4,4
New York	47,961	5,192	10.8				
Oklahoma				3,523,200	85,835	2.4	
Tennessee	883,341	18,239	2.1	61,638	10,259	16.6	8
Texas	40	11	27.5				
Utah	6,535	1,832	28.0	421,704	8,811	2.1	14,9
Virginia	900	328	33.1	34,211	1,375	4.0	
Washington	114	22	19.3	14,953	576	3.9	1
Wisconsin				3,014,800	59,742	2.0	
	2,514,133	225,808	9.0	21,812,486	482,090	2.2	60,1
Percentage of total zinc derived from each kind of ore		31.7			67.5		

[a] Exclusive of fluorspar. [b] Esti

Mining districts are established with little r
restrictions of political boundaries and may inclu
States. The following table has been compiled
tion of zinc in the principal districts so that th
as to extent of zinc mining operations, as shov
crude ore; as to character of ores, whether sulph
finally, as to relative rank as zinc producers,

LEAD.

By C. E. SIEBENTHAL.

SUMMARY.

Summary statistics of refined lead in the United States, 1

	1912	1913	1914
Total production of refined primary lead [a] in the United States	480,894	462,460	542,12
Production of desilverized lead in the United States	339,646	330,593	383,9
Production of soft lead in the United States (including desilverized soft)	171,037	161,300	201,7
Production of antimonial lead in the United States	13,552	16,665	16,6
Production of lead from domestic ores	392,517	411,878	512,7
Production of secondary lead in the United States	67,168	72,834	61,0
Consumption of primary lead in the United States (disregarding stocks)	394,113	414,283	451,2

[a] "Primary lead," which is produced directly from ore, is here disti
which is obtained by refining skimmings, drosses, and old metals. T
given on p. 886. Wherever in this report the word "lead" is used with
lead.

The output of refined lead in the United Sta
in 1917 was 548,450 short tons, valued at $94,3
sales price of refined lead compared with 55
$76,207,000 based on the average "outside" s
York in 1916—a loss in quantity of 3,778 tons
and a gain in value of $18,126,000, or nearly 2

INTRODUCTION.

Though the publication of this chapter has b
by press of work growing out of the war tha
chiefly for purposes of statistical record, nev
figures have been available since the beginning
of the production of refined lead in 1917 was
of a press bulletin on January 10, 1918. Th
on reports received from every lead smelter in
actual production for the first 10 or 11 months
for the remainder of the year.

The statistics of production of lead in this
been compiled by the United States Geologi
fidential reports submitted by each lead-smelt
tion during the year. The statistics of the
lead were also collected by the Geological Sur
domestic consumption are taken in part from

SOFT LEAD.

The lead ores of the Mississippi Valley are almost free from silver and the lead produced from them is known as "soft lead."

A little lead ore of this kind is also mined in Washington and other Western States, but in the last few years this ore has been smelted by plants treating argentiferous lead ore and thus the resulting lead has not been distinguished from the desilverized product of those plants. With two exceptions, the smelters running exclusively on these soft-lead ores do not desilverize their product. Their output is shown in the column headed "Soft lead" in the table on page 882, giving the production of refined lead for 1720–1917. However, considerable soft-lead ore has been annually smelted and some purchased pig soft lead has been desilverized by the silver-lead smelters. Since 1904 the St. Louis Smelting & Refining Co. has regularly desilverized its product. In 1915 the St. Joseph Lead Co. installed desilverizing kettles and a part of its product has since been desilverized. This desilverized soft lead, for the years prior to 1906, has not been recorded separately from the lead produced from silver-lead ores, though the lead content of the soft-lead ores so smelted and desilverized has been recorded since 1894. Since 1906 the quantity of soft lead produced by each State has been recorded, as shown in part in the preceding table. In the following table the undesilverized output of the soft-lead smelters is given in the first column and the refined lead output from soft-lead ores smelted and desilverized is given in the second column. The figures do not give the total quantity of lead recovered from soft-lead ores, for the lead recovered in the form of pigments, which are made principally from soft-lead ores, should be taken into account. The lead content of pigments smelted directly from ore in 1917 is given on page 886.

Soft lead produced in the United States, 1907–1917, in short tons.

Year.	Undesilverized.	Desilverized.	Total soft lead.
1907	99,801	29,829	129,630
1908	101,012	29,869	130,881
1909	117,158	32,532	149,690
1910	141,318	27,952	169,270
1911	155,947	35,667	191,614
1912	141,248	29,789	171,037
1913	131,367	29,433	161,300
1914	158,219	43,506	201,725
1915	161,461	44,001	205,462
1916	167,515	68,244	235,759
1917	188,503	56,268	244,771

ANTIMONIAL LEAD.

The output of by-product antimonial lead from argentiferous lead ores derived from all sources, as reported by all lead refineries operating in this country, is shown for the period 1871–1906 (earlier years being estimated from the output of desilverized lead) in a table in the chapter on lead in Mineral Resources, 1914. The figures for later years are given in the table below. Since 1909 producers have been asked to distinguish between the by-product antimonial lead derived from ore and bullion of foreign origin and that from domestic ores. Inasmuch as the antimonial skimmings are worked up in

batches, the output of antimonial lead in any one ye essarily correspond strictly to the bullion refined du hence the antimonial lead output is distributed as be and foreign in proportion to the lead refined from dor foreign bullion during the year. This method has g sistent results up to 1915. For the period 1909 to the domestic antimonial lead reported amounted to the refined lead produced from domestic bullion antimonial lead equaled 4.5 per cent of the lead sme from foreign ores and bullion. The total antimonia during the period 1907–1917 was equal to 5.16 per lead refined from domestic and foreign bullion duri Since the beginning of the war, however, the returns sistent and it is not believed that they represent ac tribution as between domestic and foreign sources. only the total production of by-product antimonial the table below.

By-product antimonial lead produced in the United States

Year.	Total lead refined from base bullion (short tons).	Percentage of by-product antimonial lead.	Antimonial lead.		Antimon
			Quantity (short tons).	Value.	Quantity (short tons).
1907	283,759	3.5	9,910	$1,322,985	1,561
1908	265,683	5.1	13,629	1,264,771	2,440
1909	297,219	4.3	12,896	1,231,019	2,360
1910	301,002	4.7	14,069	1,338,090	2,229
1911	295,305	4.8	14,078	1,380,656	2,254
1912	309,857	4.4	13,552	1,311,348	1,949
1913	301,160	5.5	16,665	1,591,854	2,508
1914	340,397	4.9	16,667	1,572,167	2,693
1915	344,593	6.7	23,224	3,665,736	3,425
1916	335,375	7.2	24,038	4,483,582	3,496
1917	365,998	5.1	18,646	3,781,560	2,759
Average		5.16			

Details of the production and consumption of United States are given in the chapter on antir Resources, 1917.

LEAD PIGMENTS.

PIGMENTS SMELTED DIRECTLY FROM

In addition to leaded zinc oxide and zinc-lead noted more particularly in connection with the p pigments, two other lead pigments are made d namely, sublimed white lead and sublimed blue white lead consists of lead sulphate 75 per cent, cent, and zinc oxide 5 per cent. Sublimed blue lea sulphate 50 to 53 per cent, lead oxide 41 to 38 per proportions of lead sulphide, lead sulphite, and z lead oxide contains from 46 to 50 per cent of lead to 46 per cent of zinc oxide, and a small quantity No zinc-lead oxide is made at present. Leaded zin from 4 to 20 per cent in lead sulphate, the rem oxide, with a small portion of zinc sulphate.

Lead content of pigments smelted from ore in the United States, 1907–1917, in short tons.

1907	7,099	1913	10,998
1908	8,278	1914	11,914
1909	7,292	1915	12,782
1910	7,603	1916	13,252
1911	7,678	1917	12,870
1912	10,323		

In order to avoid disclosing individual business, the statistics of production of leaded zinc oxide and sublimed lead (basic sulphate white and blue lead) are combined with those of zinc oxide. The sales of these pigments in 1917 amounted to 140,636 short tons, valued at $26,972,137, compared with 135,606 short tons, valued at $23,515,803, in 1916. The output of sublimed lead and of leaded zinc oxide decreased somewhat.

PIGMENTS MANUFACTURED FROM PIG LEAD.

Manufactured lead pigments marketed in 1916–17.

Pigment.	1916			1917		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
Basic carbonate white lead:						
In oil	96,041	$16,560,137	$172.43	87,331	$17,608,967	$201.63
Dry	32,938	4,714,343	143.13	27,869	4,920,864	176.57
Red lead	23,035	3,933,566	170.76	25,478	5,523,018	216.78
Orange mineral						
Litharge	37,739	5,853,543	155.11	44,102	8,611,074	195.25
	189,753	31,061,589	.....	184,780	36,663,923	.....

SECONDARY LEAD.

Secondary lead is obtained mainly from skimmings, drosses, old metal, and alloys, such as babbitt, solder, and type metal. The recovery of lead by refining these materials constitutes an integral part of the lead industry. This business is carried on mostly at small refineries scattered over the United States, but the large smelters and refineries working primary lead frequently find it advantageous to incorporate material from secondary sources. The product of such secondary refineries is of two classes—pig lead and lead in alloys. The lead in alloys may have been recovered in the form of pig lead and alloyed at the refinery, or it may have been refined as an alloy, being brought to the desired composition by the addition of the requisite metal.

Secondary lead produced in the United States, 1909–1917, in short tons.

Year.	Pig lead.	Lead in alloys.	Total recovered lead.	Value.
1909	18,360	23,327	41,687	$3,585,000
1910	29,492	25,930	55,422	4,877,000
1911	27,389	26,895	54,284	4,886,000
1912	30,266	36,902	67,168	6,045,000
1913	33,104	39,730	72,834	6,409,000
1914	29,337	31,725	61,062	4,763,000
1915	36,400	42,500	78,900	7,416,000
1916	56,700	39,600	96,300	13,289,000
1917	45,100	48,400	93,500	16,082,000

MINE PRODUCTION.

The first table below shows for each lead-producing S quantity of lead-bearing ores produced and the output kinds of lead-bearing ore. The column headed "All includes copper ore, copper-lead ore, and dry or siliceous ores produced in Colorado contained 9,779 short ton California 4,437 tons, and in Nevada, 3,739 tons. Thi other States, was concentrated from parts of the ore counties, however, and was not distributed through the "All other ore." The total crude ore yielding either copper, lead, or zinc is given for each lead-producing St comparison may be made of the relative extent of deep-m tions in these States, of which the quantity of crude ore best measure. As shown by the table, Missouri took position in the production of crude lead ore and lead- ores, having produced more than two-thirds of the cr and more than one-half of the crude lead-bearing zinc the United States in 1917, and thus occupied the first ra of crude ore carrying any or all of the five metals name

The table also gives the quantity of lead contained in t of each State in 1917 and the lead content of each kind of ore. The percentage of lead contained in the lead ore, ore, and the zinc ore of each State is also given. The of lead ore, in States having a considerable production, 29.7 per cent in Washington, down to 3.5 per cent in average for all the States was 5.4 per cent. The lead-z somewhat richer in lead than the zinc ores, averaging whereas the average lead content of the zinc ores was this low figure being due to the preponderance of lo bearing zinc ores in the Central States. Of the total tion of lead in 1917, a quantity corresponding to 69.1 derived from lead ores, 26.8 per cent from lead-zinc ores from zinc ores, and 3.5 per cent from all other ores. mine production of lead are taken from the chapters o copper, lead, and zinc in the various States, as indicate tory note.

The second of the following tables shows the mine lead by individual districts so that they may be co extent of mining operations, shown by the output of cr character of ores, whether sulphide or oxidized, whethe and as to relative rank as lead producers.

Mine production of lead in the United States in 1917, by States and kinds of ore.

State.	Lead ores.			Lead-zinc ores.			Zinc ores.			All other ores.		Total.	
	Crude ore (short tons).	Lead content.		Crude ore (short tons).	Lead content.		Crude ore (short tons).	Lead content.		Crude ore (short tons).	Lead content. (short tons).	Crude ore (short tons).	Lead content (short tons).
		Quantity (short tons).	Percentage.		Quantity (short tons).	Percentage.		Quantity (short tons).	Percentage.				
Alaska	42	8	19.0							4,074,615	844	4,074,657	852
Arizona	82,285	8,145	9.9	49,071	3,081	6.3	62,839	91	0.1	15,575,998	416	15,770,193	11,733
Arkansas							203,600	382	.2			203,600	382
California	29,651	2,694	9.1	26,501	3,803	14.4	125			2,946,973	4,437	3,003,250	10,934
Colorado	103,081	10,344	10.0	412,371	13,372	3.2	140,455	500	.4	2,032,799	9,779	2,688,706	33,995
Idaho	1,448,285	137,510	9.5	1,118,075	58,938	5.3	19,269	301	1.6	172,878	31	2,758,507	196,780
Illinois				327,340	594	0.2				(a)	845	a 327,340	1,439
Iowa				b 1,000	34	3.4						b 1,000	34
Kansas				903,400	3,025	.3						903,400	3,025
Kentucky							b 9,000			(a)	123	a b 9,000	123
Missouri	5,887,900	204,545	3.5	11,136,100	29,611	.3						17,024,000	234,156
Montana	28,923	2,778	10.0	726,280	5,728	.8	258,846	1,770	.7	5,293,115	700	6,307,164	10,976
Nevada	66,614	7,678	11.5	27,943	2,400	8.6	18,393	22	.1	6,360,569	3,739	6,473,519	13,839
New Hampshire				3,000	48	1.6						3,000	48
New Mexico	17,426	2,818	16.2	10,899	542	5.0	135,129	697	.5	4,413,373	497	4,576,827	4,554
North Carolina	32	1	3.1							2,055		2,087	1
Oklahoma				3,523,200	26,358	.8						3,523,200	26,358
South Dakota	369	34	9.2							1,867,941		1,868,310	34
Tennessee				61,638	2,525	4.1	883,341	6	.0006	589,004		1,533,983	2,531
Texas										52,382	1	52,382	1
Utah	638,071	68,623	10.8	421,704	19,394	4.6	6,535	30	.5	14,292,171	1,214	15,358,481	89,261
Virginia				34,211	855	2.5	990	4	.4	350		35,551	859
Washington	16,407	4,870	29.7	14,953	23	.2	114			140,645	2	172,119	4,895
Wisconsin				3,014,800	4,139	.1						3,014,800	4,139
	8,319,086	450,048	5.4	21,812,486	174,470	.8	1,738,636	3,803	.2	57,814,868	22,628	89,685,076	650,949
Percentage of total lead derived from each kind of ore		69.1			26.8			.6			3.5		100.0

a Lead concentrates are obtained as a by-product in milling fluorspar ores in southern Illinois and Kentucky, but the quantity of crude fluorspar would not properly be classified among "All other ores" and is therefore omitted.
b Estimated.

Mine production of lead in districts producing more than [illegible] tons, 1917.

District.	State.	Crude lead-bearing ore sold or treated.	Shipping ore and concentrates.			Lead content siliceous ore, iron ore, zinc ore, etc.	Total lead content.	Percentage of total production.
			Total quantity.	Sulphides.		Carbonates.		
				Quantity.	Lead content.	Quantity.	Lead content.	
1. Southeastern Missouri	Missouri	5,887,900	306,071	306,071	204,255			204,255	31.4
2. Coeur d'Alene	Idaho	2,470,364	549,359	549,359	185,702		302	186,004	28.6
3. Joplin	Southwestern Missouri	11,136,100	39,040	38,646	29,371	394	240	58,994	9.1
	Southeastern Kansas	903,400	3,929	3,929	3,025				
	Northeastern Oklahoma	3,523,200	32,775	26,358					
4. West Mountain (Bingham)	Utah	410,089	336,451	336,451	36,609		153	36,762	5.6
5. Tintic	do	132,139	152,139	13,249	1,350	138,890	16,189	17,529	2.7
6. Park City	do	229,259	75,842	55,669	11,019	20,173	5,463	16,858	2.6
7. Leadville	Colorado	342,565	275,408	213,738	7,042	16,416	1,429	8,922	1.4
8. Aspen	do	124,655	74,389	74,389	7,176			7,176	1.1
9. Ophir and Rush Valley	Utah	90,211	79,679	77,788	6,125	1,891	321	6,449	1.0
10. Big Cottonwood and Little Cottonwood	do	36,700	36,700	1,087	172	35,613	5,506	5,964	.9
11. Butte	Montana	633,901	6,373	6,373	1,330		3,846	5,176	.8
12. Warren	Arizona	29,863	28,165	2,994	470	25,181	4,393	4,868	.7
13. Upper Mississippi Valley	Wisconsin	3,014,800	5,544	5,544	4,139			4,767	.7
	Illinois	327,340	788	788	594				
	Iowa	500	43	43	34				
14. Northport	Washington	15,788	15,788	1,973	1,357	13,815	3,376	4,733	.7
15. Keeler	California	31,331	31,331	31,331	4,701			4,701	.7
16. Yellowpine	Nevada	44,058	10,228	5,780	2,785	4,448	1,279	4,849	.7
17. Pioche	do	21,468	6,359	2,689	381	3,670	536	3,633	4,550	.7
18. Animas	Colorado	74,481	19,256	19,256	3,590			3,590	.5
19. Texas	Idaho	13,995	13,995			13,996	3,258	3,258	.5
20. Priest Lake	do	38,486	5,362	5,362	3,246			3,246	.5
21. Upper San Miguel	Colorado	46,526	29,487	29,487	3,071			3,071	.5
22. Wallapi	Arizona	45,666	11,437	11,358	3,029	79	13	2	3,044	.5
23. Magdalena	New Mexico	41,875	33,828	27,293	1,489	6,535	953		2,442	.4
24. Troy	Montana	61,647	6,083	6,083	1,964				1,964	.3
25. Tecopa	California	24,759	24,759	24,759	1,813				1,813	.3
26. San Francisco	Utah	57,406	15,610	15,537	1,765	73	56	10	1,771	.3
27. Eureka	Colorado	60,204	14,673	14,673	1,667				1,667	.2
28. Red Cliff	do	61,482	20,689	20,689	1,213				1,213	.2
29. Alder Creek	Idaho	12,610	12,610	17	7	12,593	1,171		1,178	.2
30. Central	New Mexico	16,521	9,390	4,556	351	3,655	757	17	1,125	.2
31. Dome	Idaho	4,201	2,113	2,113	1,113				1,113	.2
32. Trona	California	4,401	4,401	4,401	1,071				1,071	.2
33. Georgetown-Silver Plume	Colorado	29,057	7,007	7,007	1,063				1,063	.2
34. Zabriskie	California	5,105	5,105	5,105	1,011				1,011	.1
		30,026,023	2,302,206	1,958,352	561,398	297,421	44,940	9,664	616,002	94.7
All other districts									34,947	5.3
Total for United States									650,949	100.0

LEAD SMELTERS.

ACTIVE SMELTERS AND REFINERIES.

UNITED STATES.

(Operated in 1917.)

CALIFORNIA: Selby—Selby Smelting & Lead Co.[1] Refinery also.
COLORADO:
Denver—Globe plant, American Smelting & Refining Co.
Durango—Durango plant, American Smelting & Refining Co.
Leadville—Arkansas Valley plant, American Smelting & Refining Co.
Pueblo—Pueblo plant, American Smelting & Refining Co.
Salida—The Ohio & Colorado Smelting & Refining Co.[2]
IDAHO: Kellogg—Bunker Hill & Sullivan Smelter.
ILLINOIS:
Aurora—Aurora Metal Co.[3]
Chicago—Goldsmith Bros.' Smelting & Refining Co.[3]
Chicago—Great Western Smelting & Refining Co.[3]
Collinsville—St. Louis Smelting & Refining Co.[4] Refinery only.
Federal—Federal Lead Co.[1]
INDIANA:
East Chicago—International Lead Refining Co.[5] Refinery only.
Grasselli—United States Metals Refining Co.[6] Refinery only. Betts electrolytic process.
KANSAS: Galena—Galena Smelting & Manufacturing Co.[7]
MISSOURI:
Granby—Granby Mining & Smelting Co.
Herculaneum—St. Joseph Lead Co.
Joplin—Eagle-Picher Lead Co.
Webb City—Webb City Smelting & Manufacturing Co.[7]
MONTANA: East Helena—East Helena plant, American Smelting & Refining Co.
NEBRASKA: Omaha—Omaha & Grant Smelting Co.[8] Refinery only. Betts electrolytic process.
NEW JERSEY:
Newark—Balbach Smelting & Refining Co.[9] Refinery also.
Perth Amboy—Perth Amboy plant, American Smelting & Refining Co.[5] Refinery also.
NEW MEXICO: Deming—Empire Smelting & Refining Co.
OKLAHOMA: St. Louis—Ontario Smelting Co.
PENNSYLVANIA: Carnegie—Pennsylvania Smelting Co. Refinery also.
TEXAS: El Paso—Kansas City Consolidated Smelting & Refining Co.[1]
UTAH:
Midvale—United States Smelting Co.[6]
Murray—Murray plant, American Smelting & Refining Co.
International—International Smelting Co.[5]
WASHINGTON: Northport—Northport Smelting & Refining Co.[9]

CANADA.

BRITISH COLUMBIA: Trail—Consolidated Mining & Smelting Co. of Canada. Refinery also. Betts electrolytic process.
ONTARIO:
Kingston—Kingston Smelting Co. (Ltd.).
Galetta—Estate of James Robertson.

MEXICO.

AGUASCALIENTES: Aguascalientes—American Smelting & Refining Co.
CHIHUAHUA:
Chihuahua—American Smelting & Refining Co.
Uruachic—Uruáchic Mining & Smelting Co. (Ltd.).

[1] Subsidiary of American Smelters Securities Co.
[2] Subsidiary of American Metal Co.
[3] Smelters of secondary materials but treating some lead ores.
[4] Subsidiary of National Lead Co.
[5] Subsidiary of Anaconda Copper Mining Co.
[6] Subsidiary of United States Smelting, Refining & Mining Co.
[7] Subsidiary of Eagle-Picher Lead Co.
[8] Subsidiary of American Smelting & Refining Co.
[9] Affiliated with Pennsylvania Smelting Co.

COAHUILA:
Saltillo—Mazapil Copper Co. (Ltd.).
Torreon—Compañía Metalúrgica de Torreón.[1]
DURANGO:
Asarco (Velardena)—American Smelters Securities Co.
Mapimi—Compañía Minera de Penoles.[1]
GUERRERO: Campo Morado—Reforma Mining & Milling Co.
NUEVO LEON: Monterey—American Smelting & Refining Co.
SAN LUIS POTOSI:
Matehuala—American Smelters Securities Co. (National Metallu
San Luis Potosi—Compañía Metalúrgica Mexicana.
SONORA:
Guaymas—Pacific Smelting & Refining Co. (Mexican-Americ
Refining Co. (Ltd.).)
Ures—Yaqui Smelting & Refining Co., S. A. Refinery also.
ZACATECAS: Chalchihuites—National Smelting Co.

SMELTER CHANGES IN 1917.

The Bunker Hill Smelter began operating in July, 19
000-ton blast furnace. By the end of the year three
he refining plant were in operation. The Empire Sm
ining Co. rebuilt the old National (Luna) plant at Dem
1917, and treated ore from April until October, when
estroyed by fire. The Ontario Smelting Co. began the
a soft-lead smelter at St. Louis, a village in the nort
Oklahoma. The plant is expected to be finished e
nd will be equipped with four Newnam automatic o
ead stack, and a bag house.

TRADE CONDITIONS.

WORLD'S PRODUCTION.

Official statistics of the world's output of lead for
he war are incomplete, for the reason that many of th
ountries did not permit the publication of such inform
oped that the data may be sufficiently complete to m
ication of value by the time the lead chapter for 1918 is p

IMPORTS AND EXPORTS.

WAREHOUSE TRANSACTIONS.

Lead imported into the United States as metal or i
ntered for immediate consumption, the duty being
ead going direct to the consumer; or it may be entered f
ond being given for double the amount of the estima
he accompanying tables the phrase "general imports"
otal imports, including both lead entered for immediate
nd lead entered for warehouse. From warehouse the
withdrawn for consumption by payment of duty, or it m
ond for smelting and refining, finally being either w
consumption or exported from warehouse with cancella
The lead entered for immediate consumption and th
rom warehouse for consumption make up the "imports
lon," which are expressed in the same terms as those
hey were imported. The lead imported for consum
ctually used in this country, or it may be manufacture
hich are exported; in the latter event the manufactu
o the benefit of a drawback of 99 per cent of the duties

[1] Subsidiary of American Metal Co.

table below, showing foreign lead exported in manufactures with benefit of drawback, the lead is shown in the form in which it was originally imported. On account of diversity of form it is not feasible to show the articles exported with benefit of drawback. The foreign lead given in the table below as exported from warehouse is likewise shown in the form in which it was imported and entered for warehouse. Foreign lead exported from warehouse has, since July 1, 1913, been included by the Bureau of Foreign and Domestic Commerce with the domestic exports as "from foreign ore."

The items foreign lead exported from warehouse, domestic exports of lead "from foreign ore," and foreign lead exported in manufactures with benefit of drawback make up the total foreign lead going out of the country. Lead in warehouse and deductions by liquidation being disregarded, the difference between the sum of these exports of foreign lead and the total imports of lead constitutes the foreign lead consumed in this country. For the sake of simplicity this foreign lead is carried on the bonded customs warehouse records in the form in which the lead was entered until the bond is canceled. It must be clearly understood, therefore, that the lead listed in the table of foreign exports of lead, on a later page, was not exported as lead content of ore and base bullion but as refined lead smelted and refined from them. Since 1914, however, all foreign lead exported has been classed as lead, "pigs and bars," except a portion of the articles manufactured from foreign lead and exported with benefit of drawback. For articles not made wholly of lead it would be useless to give weights, but each shipment on which drawback is claimed is accompanied by a manifest of the imported lead used in making the articles and the duty paid thereon. From these manifests is derived the statement of the total quantity of foreign lead used in manufactures exported with the benefit of drawback. For this reason the lead is given in the form in which it was imported.

The following table is taken from the reports of the Bureau of Foreign and Domestic Commerce. For the reasons given above, the lead is shown in the terms in which it was imported. For instance, a considerable part of the lead stated as remaining in ore and base bullion doubtless represents refined lead waiting at the bonded refinery for a favorable market for shipment. If this is borne in mind, the table gives a fair idea of the fluctuations of foreign stock at different times and in different localities.

Lead remaining in warehouse in the United States Dec. 31, 1910–1917, in pounds.

Year.	Form in which lead was entered for warehouse.		Remaining at—					
			New York.		Chicago, Ill.	El Paso, Tex.	St. Louis, Mo.[a]	San Fra...
	Lead in ore and base bullion.	Pigs, bars, and old.	Newark, N. J.	Perth Amboy, N. J.				
1910	71,794,443	149,082	7,548,936	36,112,136	21,090,631	6,937,667	.....	.....
1911	8,869,713	93,082	2,777,692	2,308,322	954,884	2,555,733	273,082	.....
1912	20,891,182	93,802	1,880,828	17,666,768	484,671	767,533	91,382	.....
1913	10,620,953	.....	8,785,551		80,880	1,683,091	71,431	.....
1914	15,333,064	3,837	10,309,592		94,775	4,802,961	125,736	.....
1915	24,338,933	.....	8,401,728		165,257	14,678,809	104,922	988,2...
1916	23,667,358	1,070,298	8,575,115		4,732,535	6,814,844	3,286,189	258,6...
1917	47,853,945	5,370,445	19,015,511		4,757,315	18,951,649	2,306,855	2,822,6...

[a] Kansas City before 1914.

IMPORTS.

The following tables are taken from the reports and record... Bureau of Foreign and Domestic Commerce:

Lead imported and entered for consumption in the United States, 1910–...

Year.	Lead in ore.		Base bullion.		Pigs, bars, and old.		Sheets, pipe, and shot.		N... of... w... sp... fo...
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity, pounds.	Value.	
1910....	7,998,859	$198,196	16,543,167	$337,223	6,776,006	$212,858	39,779	$1,972	$4,...
1911....	1,474,254	26,563	17,376,459	352,595	7,112,749	242,423	63,151	2,355	7,...
1912....	935,861	24,760	22,729,467	462,559	5,101,823	110,459	31,184	2,305	5,...
1913....	2,300,972	75,835	17,665,227	388,116	4,621,270	105,738	39,171	3,291	12,...
1914....	5,459,961	188,749	8,904,643	301,195	575,290	12,281	62,552	2,753	81,...
1915....	2,865,792	90,010	15,496,230	519,355	997,368	32,951	201,510	17,059	107,...
1916....	10,125,983	369,824	5,242,171	208,277	6,388,097	331,235	532	63	106,...
1917....	5,438,931	207,370	6,965,849	470,539	1,750,223	85,743	12,538	2,699	10,...

Type metal imported and entered for consumption in the United States, 19...

Year.	Type metal.		Lead c...
	Gross weight (pounds).	Value.	Quantity (pounds).
1904	8,143,749	$221,127	6,884,42...
1905	13,932,013	456,165	11,476,62...
1906	19,602,471	900,008	16,896,62...
1907	14,832,673	932,027	12,095,02...
1908	4,110,486	156,847	3,265,81...
1909	13,993,389	532,108	11,339,37...
1910	13,394,199	485,493	11,176,83...
1911	8,390,470	310,658	6,936,71...
1912	581,411	18,668	477,00...
1913	567,004	20,098	467,68...
1914	1,509,538	45,373	1,322,18...
1915	2,768,261	107,607	2,424,30...
1916	1,162,386	83,816	923,47...
1917	.....	.....	.....
Average lead content, 1904–1917	.....	.....	.....

[a] Prior to 1904 the lead content of the type metal was not given. Besides lead, the chief... the type metal is antimony.

General imports of lead into the United States, in ore, base bullion, and refined... by sources, in pounds.

Country.	1910	1911	1912
United Kingdom	1,874,750	401,686	279,546
Germany	421,377	56,286	494,237
Other European countries	418,669	111,189	55,356
Total from Europe	2,714,796	569,161	829,139
Canada	206,979	270,947	319,497
Mexico	203,290,307	172,633,479	159,455,664
South America	6,598,263	4,778,221	3,207,936
Other countries	4,394,421	1,651,544	3,309,356
Total imports	217,204,766	179,903,352	167,121,592

Country.	1914	1915	1916
United Kingdom	245,548	185,236	261,406
Germany	4,529,919	.....	.....
Other European countries	123,085	32,537	314,353
Total from Europe	4,898,552	217,773	575,759
Canada	384,007	2,303,170	12,606,216
Mexico	46,282,207	94,247,384	48,395,670
South America	2,417,744	5,420,567	6,235,758
Other countries	2,694,293	802,516	2,845,949
Total imports	56,676,803	102,991,410	70,659,352

General imports of lead into the United States, 1910–1917, by classes, in pounds.

Year.	Lead in ore (lead content).	Base bullion.		Pigs, bars, sheets, and old.	Total (lead content)
		Gross weight.	Lead content.		
1910	91,751,054	118,061,415	115,183,542	6,970,170	217,204,766
1911	35,686,180	141,481,852	138,952,372	5,264,800	179,903,352
1912	19,577,499	152,420,624	146,999,168	544,925	167,121,592
1913	19,883,313	96,908,170	94,327,654	82,999	114,293,966
1914	23,619,037	33,444,503	32,730,320	296,846	56,646,203
1915	18,185,119	86,247,995	83,986,988	819,282	102,991,389
1916	35,068,100	24,943,660	24,202,435	11,310,817	70,581,352
1917	41,202,876	109,279,997	103,664,970	11,585,974	156,453,820

Basic carbonate white lead, red lead, litharge, and orange mineral, imported and entered for consumption in the United States, 1911–1917.

Year.	Corroded white lead.		Red lead.		Litharge.		Orange mineral.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
1911	741,071	$46,213	1,063,533	$42,471	24,662	$1,196	501,734	$23,[illegible]
1912	687,705	46,494	757,908	33,851	32,443	1,550	334,551	20,[illegible]
1913	672,109	45,266	99,832	4,903	34,023	1,750	330,525	22,[illegible]
1914	596,567	40,203	12,554	2,934	33,651	1,805	210,388	16,[illegible]
1915	339,157	21,608	1,968	132	20,650	1,422	171,572	14,[illegible]
1916	88,617	8,050	20,467	5,302	1,320	150	70,934	8,[illegible]
1917	20,238	1,905	50	13	.....	.....	33,294	[illegible]

EXPORTS.

DOMESTIC EXPORTS.

The average difference between the prices of lead at New York and at London for the 10 years prior to 1914 was not far from 1¼ cent a pound and the price at New York was the higher. This being the case, exports of domestic pig lead should be expected only under temporary or very unusual circumstances. The practice of the Bureau of Foreign and Domestic Commerce has been to class all exports of lead articles manufactured in this country as domestic exports, whether the lead is of domestic or foreign origin. For this reason no table of exports of domestic lead manufactures has been given, because such a table would duplicate the table showing foreign lead in manufactures exported with benefit of drawback. Since the exports of domestic pig lead began, however, they have been shown separately.

In 1914 the price of lead at London rose above the price at New York early in January and remained between one-fourth and one-half cent a pound above throughout the year. This made it possible to export domestic lead at a profit, and the decrease in imports of lead ore and bullion from Mexico rendered it necessary to satisfy the foreign demand with domestic lead, the exports of which assumed large proportions. The movement commenced in March, 1914, and by the end of the year 58,722 short tons, valued at $4,501,674, had been exported. Likewise in 1915 the price of lead at London was from one-fourth to 1 cent a pound higher than the price at New York except for the period of high prices in the United States during June and July. Exports of domestic lead continued heavy throughout the year, reaching a total of 88,306 tons, valued at $7,928,518. In 1916 [illegible] exports of domestic lead amounted to 100,500 tons [illegible] lued at $13,494,065.

In 1917 the exports of domestic lead fell to 53,688 tons, va [illegible] ,560,598.

White lead exported from the United States, 1913–1917.

	Quantity (pounds).
[illegible]	15,062,384
[illegible]	17,645,538
[illegible]	25,810,3[illegible]
[illegible]	27,435,054
[illegible]	19,737,399

FOREIGN EXPORTS.

By exports of foreign lead are meant the exports of lead of [illegible] igin which has been smelted, refined, or manufactured in thi [illegible] y and then shipped abroad. The following table, made u [illegible] e records of the Bureau of Foreign and Domestic Commerce [illegible] e total lead exported for a period of years; but it must be [illegible] mind, as pointed out in a previous page, that prior to 19 [illegible] tual exports were not in the form shown in the table, whic [illegible] port form, but instead consisted of refined lead and lead [illegible] ctures. Since July 1, 1915, the exports of foreign lead he [illegible] assed as "ore," "base bullion," and "pigs, bars, and old" [illegible] cluded in "pigs, bars, and old" as domestic manufactures [illegible] om foreign ore. The quantities given for lead exported fro [illegible] use are exact, but the quantities given for lead in manufactu [illegible] bject to the waste in manufacturing.

Foreign lead exported from the United States, 1910–1917.

Year.	Exported from warehouse.							Exported factures fit of dra [illegible]
	Lead content of ore.		Lead content of base bullion.		Pigs, bars, and old.		All other manufactures.	Lead content of ore.
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Value.	Quantity (pounds).
[illegible] 0	22,508,090	$248,220	117,045,333	$2,262,057	19,507	$703	$870	6,592,294
[illegible] 1	39,276,820	730,247	151,986,265	3,093,290	12,311,102	244,037	1,504	674,321
[illegible] 2	12,796,703	219,859	116,907,305	2,478,256	107,170	3,826	2,121	150,617
[illegible] 3	11,721,714	271,985	77,253,891	1,827,538	111,506	4,851	3,422	74,628
[illegible] 4	6,724,525	245,206	10,944,350	378,286	25,421,500	913,306	2,242	4,040,924
[illegible] 5	(a)	.....	(a)	.....	77,236,303	2,738,263	40,112	7,96
[illegible] 6	(a)	.....	(a)	.....	19,760,086	1,111,853	541	10,34
[illegible] 7	(a)	.....	(a)	.....	75,304,480	6,650,157	900	15,07

[illegible] Since July 1, 1915, the Bureau of Foreign and Domestic Commerce has classed all foreign le [illegible] domestic exports, of pigs, bars, etc., produced from foreign."

CONSUMPTION.

In statements of consumption of lead in these reports prior [illegible] was the custom to take into account the smelter stocks of [illegible] e beginning and at the end of the year. It is not to be deni

TITANIUM.

By Frank L. Hess.

PRODUCTION.

Rutile (titanium dioxide) and ilmenite (titanium-iron
produced in 1917 by the American Rutile Co., at Rosela
County, Va., and ilmenite was produced by Buckman &
(Inc.), 4 miles south of Pablo Beach, Fla. For years th
Rutile Co. has been the only producer of rutile in the Un
and until 1916 the only company producing ilmenite, alth
highly titaniferous iron ore has been produced in the Adi
New York. During 1917 the production was 206 short to
concentrates carrying 93 per cent of TiO_2, valued at $
1,339 short tons of ilmenite concentrates carrying 53–55
TiO_2, valued at about $12,677.

OCCURRENCE AND USES.

The American Rutile Co. quarries and crushes a co
rock composed of feldspar, blue quartz, and in places h
mostly altered to hornblende. The feldspar is mostl
largely intergrown with orthoclase (microcline). The ro
tains a considerable quantity of apatite. Part of the ro
what decayed so that it crushes easily, but other parts a
hard. The rock as mined contains from 4 to 5 per cent o
about the same quantity of ilmenite, so that electromagn
tion is necessary. The rutile as separated has a pleas
color. It is used in the making of electrodes for arc lamp
quantity for ferrotitanium, ceramic glazes, and chemical
leather and cloth. The ilmenite from this quarry seems
liarly adapted to the making of electrodes for arc lamp
better satisfaction than other ilmenites that have been
The market for both substances is small, and the quan
produced by the American Rutile Co. is practically a me
total market in this country and in part of the foreign m
market for ilmenite is likewise small, although experim
making of pigments with titanium dioxide (TiO_2) derive
nite have long been carried on and may provide an ou
product.

Rutile is found near Custer, S. Dak., in an amphibolite
perhaps 1 per cent of rutile in very small prisms. At M
Ark., titanium dioxide in the form of rutile, octahedrite,
is found in connection with nephelite syenite, and rutile
found in considerable quantity in the stream beds of th
morphic rocks of the southern Appalachian region.

95186°—M R 1917, PT 1——59

found in lenticular pegmatite, dikes of which are crushed to gneiss in Hanover and Goochland Counties, Va. All these properties have been prospected, but none have been found to be serious rivals to the deposits at Roseland, where the quantity available is very large. The ilmenite obtained near Pablo Beach, Fla., is in the form of fine sand concentrated along high-tide line on the beautiful sloping beach at that place. Accompanying it is a small quantity of rutile, zircon, and monazite.

The only known foreign deposits of rutile that may be competitors are near Baie St. Paul, Quebec, where it is found in ilmenite with sapphirine, but these deposits apparently can not be mined profitably in competition with the Roseland deposits. Fine specimens of rutile-bearing rock have come from Sonora, Mexico, apparently from a quartz vein or pegmatite, but little is known of the occurrence. Near Adelaide, South Australia, rutile is found in what appear to be crushed pegmatite dikes. A very dark rutile is found in granitic rocks at Kragerö, in southern Norway, where it has been mined and the rutile placed on the European market for a number of years. Rutile in fair quantity is found in placers in Queensland, whence little has been marketed, and also in Western Australia.

RECENT PATENTS.

A British patent (No. 127922) was issued December 31, 1917, to the United States Alloys Corporation for an alloy containing titanium. The notice in Chemical Abstracts, volume 13, p. 2334, October 10, 1919, is as follows:

> An alloy for use in freeing molten iron or steel from slag or oxide distributed in its mass consists of iron, titanium, and silicon, the iron being in the largest proportion and the silicon in such less proportion than the titanium that, on oxidation in contact with the iron or steel, easily fusible silico-titanates are formed. The alloy contains 15 to 25 per cent of titanium, 3 to 5 per cent of silicon, and some carbon, and is made from mixtures of rutile, titaniferous iron ore, or ilmenite, quartz, charcoal, and scrap, preferably in an electric furnace having a carbon crucible and a carbon electrode.

Other recent patents dealing with the use of titanium in alloys are noted under cobalt in this volume under the names of American Alloys Co.; Radclyffe Furness; James H. Parker and B. H. De Long; K. Shiga; and United States Alloys Corporation.

TUNGSTEN.

By Frank L. Hess.

GENERAL CONDITIONS.

The tungsten concentrates and ore mined and ma
United States in 1916, equivalent to 5,923 short to
trates carrying 60 per cent of tungsten trioxide (WO_3),
previous records for any country, and the records were
by the output of 1917, during which 6,144 tons, valued
was produced.

The excessive prices of the early part of 1916, wh
$93.50 per unit was reached, and the high prices foll
great number of men to operate known tungsten
could not be worked profitably at the prices prevail
imes and to prospect for new deposits. It also caus
n the output of properties already in operation. Pr
ll through that year, though low when compared wit
oint. By 1917 operations on many of the smaller
eased, but on deposits on which machinery had been
hich had been proved to carry more tungsten-bea
mpetus received in 1916 carried production on, at
ractically all fields gave a lower production except,
ields of California, Colorado, and South Dakota, and
n increase sufficient to overcome the decrease in the

PRODUCTION.

The production of tungsten ores in the United Sta
has been as shown in the table below; the productio
was negligible.

Concentrated tungsten ores produced in the United States,

Year.	Quantity (short tons).	Value.	Year.	(s
1900	46	$11,040	1909	
1901	179	27,720	1910	
1902	184	34,040	1911	
1903	292	43,639	1912	
1904	740	184,000	1913	
1905	803	268,676	1914	
1906	928	348,867	1915	
1907	1,640	890,048	1916	
1908	671	229,955	1917	

a The production of tungsten ores in this country from year to year, except in
pared in this table only since and beginning with 1906, as before that date no effort
ores to a common basis of concentration. For the five years 1901 to 1905, inclusive,
ably carried a little more than 60 per cent of WO_3. Since 1906 the ores have been, as
to an equivalent of ore carrying 60 per cent of tungsten trioxide (WO_3), which is t
asis in the United States.