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PART I—METAL

UNITED STATES
GOVERNMENT PRINTING O
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1927

LEAD AND ZINC PIGMENTS AND

By C. E. Siebenthal and A. Stoll

GENERAL CONDITIONS

Lead and zinc pigments and salts are made both
by chemical processes. Sublimed lead, or basic le
he various lead oxides are lead pigments produced
n oxidizing furnaces; basic carbonate white lead and
ade by chemical processes. Sublimed lead, or bas
made directly from ore, but the lead oxides as w
nd lead salts are made from pig lead.

Zinc oxide and leaded zinc oxide are made by the
irectly from ore by sublimation in an oxidizing fu
nc oxide is made in this country by the French
etallic zinc is sublimated in an oxidizing furnace.
nc salts are made by chemical processes, the zinc ba
om zinc ore, metallic zinc, galvanizers' ashes, or scr
one is made by mixing equivalent portions of
lphate and barium sulphide, which brings abou
pitation of zinc sulphide and barium sulphate ei
mbination or as a very intimate mixture.

The sales of nearly all lead and zinc pigments and
producers, showed gains in 1924 as compared w
sublimed lead, or basic lead sulphate, made the g
cent. Demand for white lead, or basic carb
ported good and sales increased 15 per cent. S
owed a continued increase, making a gain of 11 pe
1923. The sales of zinc oxides also kept pac
mands and advanced 5 per cent.

The French process zinc oxide plants of the In
fining Co., at Akron, Ohio, and East Chicago, Ind
peration in January, 1924, and October, 1924, resp
ubling their capacity. Some crude zinc oxide was
year at the Bully Hill plant of the California Zinc
lif. The lithopone plant of the Chemical & P
lena, Md., doubled its capacity. Increased capac
the lithopone plants of the Krebs Pigment &
wport, Del., and the St. Louis Lithopone Co.,
new lithopone plant of the Mineral Point Zinc C
orted a substantial output. Former producers o

have either permanently or temporarily discontinued the manufacture of this product are: American Smelting & Refining Co., Omaha, Nebr.; American Steel & Wire Co., Donora, Pa.; American Zinc & Chemical Co., Langeloth, Pa.; Bartlesville Zinc Co., Bartlesville, Okla.; Bertha Mineral Co., Austinville, Va.; Trenton Zinc & Chemical Co., Trenton, N. J.; and Utah Zinc Co., Murray, Utah

PRODUCTION

In this chapter the pigments and salts sold are taken to represent the production, no account being taken of the stocks on hand at the beginning and end of the year. The amounts used by producers at their own plants are included under sales.

Lead pigments and salts sold by domestic manufacturers in the United States, 1923 and 1924

	1923			1924		
	Short tons	Value (at plant, exclusive of container)		Short tons	Value (at plant, exclusive of container)	
		Total	Average		Total	Average
Sublimed lead, or basic lead sulphate:						
White	11,949	$1,959,008	$164	14,572	$2,391,038	$164
Blue	800	134,350	168	1,088	178,899	164
Red lead	38,037	7,611,508	200	36,813	7,707,264	209
Orange mineral	646	181,066	280	331	89,825	271
Litharge	75,107	14,059,979	187	74,724	14,597,434	195
White lead:						
Dry	37,786	6,615,114	175	42,622	7,900,519	185
In oil	125,087	27,010,116	216	144,872	35,003,984	242
Lead acetate	616	160,133	260	(a)	(a)	(a)
Lead arsenate	5,378	2,229,431	415	(a)	(a)	(a)

a Statistics for lead arsenate and lead acetate collected biennially by the Bureau of the Census, for odd years.

Zinc pigments and salts sold by domestic manufacturers in the United States, 1923 and 1924

	1923			1924		
	Short tons	Value (at plant, exclusive of container)		Short tons	Value (at plant, exclusive of container)	
		Total	Average		Total	Average
Zinc oxide a	126,987	$18,750,972	$148	131,470	$19,784,257	$151
Leaded zinc oxide a	23,504	2,815,986	120	20,729	3,356,065	162
Lithopone	98,199	11,008,443	118	109,409	12,531,397	115
Zinc chloride, 50° Baumé	42,431	1,968,187	46	51,054	2,051,782	40
Zinc sulphate	5,376	261,449	49	4,674	228,709	49

a Zinc oxide containing 5 per cent or more of lead is classed as leaded zinc oxide.

Lead pigments sold by domestic manufacturers in the United State short tons

Year	White lead		Sublimed lead or basic lead sulphate		Red lead
	Dry	In oil	White	Blue	
1920	33,678	112,017	12,412	928	a34,431
1921	26,738	143,545	11,568	463	21,805
1922	41,598	153,393	13,765	972	30,509
1923	37,786	125,087	11,949	800	38,037
1924	42,622	144,872	14,572	1,088	36,813

a Figures for red lead include orange mineral prior to 1921.

Zinc pigments and salts sold by domestic manufacturers in the Uni 1924, in short tons

Year	Zinc oxide	Leaded zinc oxide	Lithopone	Zi r
1920	99,444	30,460	80,373	
1921	74,329	16,103	55,016	
1922	128,405	19,613	83,360	
1923	126,987	23,504	98,190	
1924	131,470	26,729	109,409	

a Figures represent production.

SOURCE

Metal content of lead and zinc pigments and salts sold by domesti 1923–1924, by sources, in short tons

Source	1923				1	
	Lead		Zinc		Lead	
	Pigments a	Salts b	Pigments	Salts	Pigments a	Salts b
Domestic ore	13,612	(b)	115,490	1,573	15,338	(b)
Foreign ore		(b)	480		545	(b)
Metal	236,541	(b)	25,780	6	250,930	(b)
Secondary materials c		(b)	10,322	10,719		(b)
	250,153	(b)	152,072	12,298	266,813	(b)

a Includes also lead recovered in zinc oxide and leaded zinc oxide.
b The source of the lead contained in lead salts is unknown to the authors, as st collected biennially by the Bureau of the Census and for odd years only. Lead charge, from granulated lead, and from white-lead residues. Lead arsenate is mad d nitrate. All having been derived from pig lead, their content has already been count.
c Zinc ashes, skimmings, drosses, and old metal.

IMPORTS AND EXPORTS

The following statistics of imports and exports of l igments and salts have been compiled from the pu ords of the Bureau of Foreign and Domestic Comm Dorsey, of the Bureau of Mines.

Basic carbonate white lead, red lead, litharge, and orange mineral imported for consumption in the United States, 1920–1924

Year	Basic carbonate white lead		Red lead		Litharge		Orange mineral	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1920	159,077	$19,449	23,076	$1,789	21,002	$2,647	52,094	$5,352
1921	124,176	12,598	12,236	689	100	7	77,937	7,830
1922	222,405	21,385	1,405	94	1,770	162	111,419	9,729
1923	336,892	31,386	3,600	220	22,525	1,314	116,293	9,031
1924	141,156	13,478	1,874	155	1,838	193	99,341	8,047

Zinc oxide, lithopone, zinc sulphide (white), zinc chloride, and zinc sulphate imported for consumption in the United States, 1920–1924

Year	Zinc oxide				Lithopone	
	Dry		In oil			
	Short tons	Value	Short tons	Value	Short tons	Value
1920	1,431	$289,800	14	$3,596	1,714	$263,240
1921	1,286	145,071	57	17,549	5,247	432,019
1922	2,712	361,599	42	8,595	10,203	885,071
1923	1,036	169,415	89	21,934	10,440	776,383
1924	1,703	229,020	110	25,874	6,830	543,025

Year	Zinc sulphide*		Zinc chloride		Zinc sulphate	
	Pounds*	Value	Short tons	Value	Short tons	Value
1920	45,482	$15,027	565	$76,495	50	$3,038
1921	93,537	8,330	2,199	213,905	17	820
1922	27,150	8,453	1,374	87,509	17	1,064
1923	11,844	5,403	551	44,164	20	3,466
1924	9,678	5,727	319	28,911	13	1,265

*Zinc sulphide is stated in pounds rather than tons because of its high value and smaller quantities.

White lead and red lead exported from the United States, 1920–1924

Year	White lead *		Red lead †	
	Short tons	Value	Short tons	Value
1920	14,901	$3,195,101	1,532	$365,575
1921	5,161	993,130	548	115,500
1922	4,598	710,765	1,683	294,133
1923	*5,172	836,261	†1,840	372,823
1924	*5,055	853,444	†940	210,593

* White lead and sublimed lead not classified separately after 1922; the figures for 1923 and 1924 may include an unknown quantity of sublimed lead.
† Exports of red lead and litharge not classified separately after 1922; the figures for 1923 and 1924 may include an unknown quantity of litharge.

White lead[a] exported from the United States, 19

[Figures in parentheses not duplicated in total]

Destination	1923	
	Short tons	Val
Africa	(b)	
Asia	53	8,
Australia and Oceania	277	60,
Australia	(11)	(2,
New Zealand	(b)	
Philippine Islands	(254)	(54,
Canada	216	36,
Cuba	126	25,
Europe	2,680	362,
Belgium	(1,272)	(165,
Great Britain	(909)	(128,
Netherlands	(490)	(67,
Mexico	99	24,
Panama	288	60,
South America	1,309	229,
Brazil	(12)	(1,
Colombia	(9)	(2,
Uruguay	(144)	(24,
Venezuela	(9)	(2,
Other countries	124	29,
	5,172	836,

[a] White lead and sublimed lead not classified separately after 1922; the figu
quantity of sublimed lead.
[b] Less than 1 ton.

Zinc oxide and lithopone exported from the United S

Year	Zinc oxide	
	Short tons	Val
1920	11,164	$2,151
1921	2,511	426
1922	3,977	593
1923	5,024	743
1924	3,927	606

* Not classified separately prior to 1922.

Zinc oxide exported from the United States, 192

[Figures in parentheses not duplicated in total]

Destination	1923	
	Short tons	Val
Asia	68	$10,
Australia and Oceania	115	19,
Philippine Islands	(49)	(8,
Canada	3,200	477,
Cuba	42	9,
Europe	1,188	153,
France	(91)	(14,
Great Britain	(1,074)	(134,
Italy	(23)	(4,
Mexico	104	18,
Panama	25	5,
South America	149	31,
Brazil	(14)	(2,
Other countries	73	17,
	5,024	743,

PRICES AND VALUE

The total value and the average price per ton received from sales of lead and zinc pigments and salts in 1924 are given on preceding pages of this chapter.

Figure 3 shows the relation of the average weekly price of lead in New York in 1924 to the weekly quotations on the lead pigments—sublimed lead, white lead, litharge, red lead, and orange mineral—

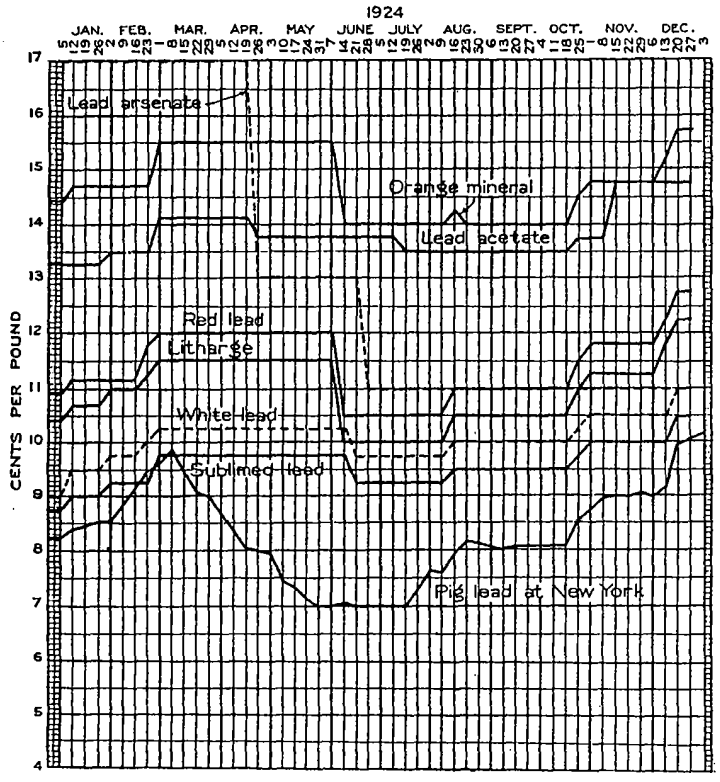


FIGURE 3.—Relation of weekly prices of lead pigments and salts to the average weekly quoted price of lead at New York, 1924

and the lead salts—lead arsenate and lead acetate. The quotations, taken from issues of the Oil, Paint, and Drug Reporter, represent the following grades and forms:

Sublimed lead, or basic lead sulphate (white), "in casks."
White lead, basic lead carbonate, "American, dry, in casks."
Litharge, "commercial, powdered, in casks."
Red lead, "dry, in casks."
Orange mineral, "American, in casks."
Lead acetate, "brown, broken, in barrels."
Lead arsenate, "paste, in barrels."

Figure 4 shows the relation of the average quote western slab zinc in St. Louis to the weekly quota ments—zinc oxide and lithopone—and on the sa

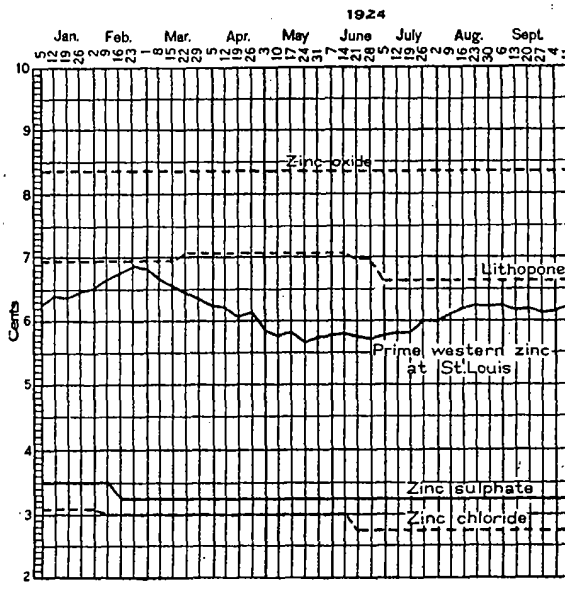


FIGURE 4.—Relation of weekly prices of zinc pigments and salts to the aver prime western zinc at St. Louis, 1924

and zinc sulphate. The quotations, taken from Paint, and Drug Reporter, represent the following g

Zinc oxide, "commercially lead-free, in barrels."
Lithopone, "in barrels."
Zinc chloride, "solution, in drums."
Zinc sulphate, "industrial, in barrels."

PRODUCERS

The following companies reported sales of lead and zinc salts of their own production in 1924:

White lead:

Anaconda Lead Products Co. (electrolytic process)	East
Carter White Lead Co	West
E. I. du Pont de Nemours & Co	Philad
Eagle-Picher Lead Co	East S
Do	Cincin
Euston Lead Co	Scrant
W. P. Fuller & Co	South
John T. Lewis & Bros. Co	Philad
Matheson Lead Co	Long
National Lead Co. of California	Melro
National Lead Co	Chicag
Do	St. Lo
Do	Brook
Do	Port
Do	Cincin
National Lead & Oil Co. of Pennsylvania	New
Sherwin-Williams Co	Chica

White lead—Continued.	
United Lead Co	Perth Amboy, N. J.
Wetherill & Bro	Philadelphia, Pa.
Sublimed lead, or basic lead sulphate:	
Eagle-Picher Lead Co	Joplin, Mo.
St. Louis Smelting & Refining Works of National Lead Co	Collinsville, Ill.
Red lead, orange mineral, and litharge:	
Eagle-Picher Lead Co	East St. Louis, Ill.
Do	Joplin, Mo.
Do	Newark, N. J.
Do	Cincinnati, Ohio.
Evans Lead Co	Charleston, W. Va.
W. P. Fuller & Co	South San Francisco, Calif.
Grasselli Chemical Co	Grasselli, Ind.
John T. Lewis & Bros. Co	Philadelphia, Pa.
Matheson Lead Co	Long Island City, N. Y.
National Lead Co. of California	Melrose, Calif.
National Lead Co	Chicago, Ill.
Do	St. Louis, Mo.
Do	Brooklyn, N. Y.
National Lead & Oil Co. of Pennsylvania	New Kensington, Pa.
Pennsylvania Smelting Co	Carnegie, Pa.
Sherwin-Williams Co	Chicago, Ill.
Wetherill & Bro	Philadelphia, Pa.
Zinc oxide and leaded zinc oxide:	
American Zinc Co. of Illinois	Hillsboro, Ill.
American Zinc Oxide Co	Columbus, Ohio.
Bertha Mineral Co	Austinville, Va.
Eagle-Picher Lead Co	Hillsboro, Ill.
Empire Zinc Co	Canon City, Colo.
Grasselli Chemical Co	Grasselli, Ind.
International Lead Refining Co. (French process)	East Chicago, Ind.
Do. (French process)	Akron, Ohio.
Mineral Point Zinc Co	Mineral Point, Wis.
New Jersey Zinc Co. (of Pennsylvania)	Palmerton, Pa.
Do. (French process)	Freemansburg, Pa.
Ozark Smelting & Mining Co	Coffeyville, Kans.
River Smelting & Refining Co	Florence, Colo.
U. S. Zinc Co	Pueblo, Colo.
Western Zinc Oxide Co	Leadville, Colo.
Lithopone:	
Chemical & Pigment Co. (Inc.)	St. Helena, Md.
E. I. du Pont de Nemours & Co	Newark, N. J.
Do	Philadelphia, Pa.
Grasselli Chemical Co	Grasselli, N. J.
Krebs Pigment & Chemical Co	Newport, Del.
Midland Chemical Co. (Eagle-Picher Lead Co.)	Argo, Ill.
Mineral Point Zinc Co	Depue, Ill.
New Jersey Zinc Co. (of Pennsylvania)	Palmerton, Pa.
St. Louis Lithopone Co	Collinsville, Ill.
Sherwin-Williams Co	Chicago, Ill.
United Color & Pigment Co	Newark, N. J.
Zinc salts:	
American Zinc & Chemical Co	Langeloth, Pa.
Arkansas Preservative Co	North Little Rock, Ark.
By-Products Steel Corporation	Weirton, W. Va.
Charles Cooper & Co	Newark, N. J.
General Chemical Co	Chicago, Ill.
Grasselli Chemical Co	Grasselli, Ind.
Do	Cleveland, Ohio.
Great Western Electro-Chemical Co	Pittsburg, Calif.
Charles Lennig & Co. (Inc.)	Philadelphia, Pa.
Merrimac Chemical Co	Everett, Mass.
Monsanto Chemical Works	East St. Louis, Ill.
New Jersey Zinc Co. (of Pennsylvania)	Palmerton, Pa.

LEAD [1]

By C. E. Siebenthal and A. St

SUMMARY

Statistics of refined lead, 1923 and 1924, in s

PRODUCTION	
Domestic desilverized lead	
Domestic soft lead	
Domestic desilverized soft lead	
Foreign desilverized lead	
Total refined primary lead [a]	
Antimonial lead	
Secondary lead [a]	
CONSUMPTION [b]	
Apparent consumption of primary lead, refinery stocks disregarded	

[a] "Primary lead," which is produced directly from ore, is here distingu which is obtained by refining skimmings, drosses, and old metals. The s given on p. 152. In this report the word "lead" used without qualificatio
[b] For method of calculating consumption see p. 164.

The output of refined lead in the United State in 1924 was 566,407 tons, valued at $90,625, selling price of pig lead, a gain, as compared wit in quantity and of 19 per cent in value.

PRODUCTION

Quantity and value.—The total refined lead pr States from 1720 to 1924 from domestic ores a and base bullion and its value are shown in the

Refined lead produced in the United States,

Year	Short tons					
	Desilverized lead [a] [b]	Desilverized soft lead	Soft lead [b]	Total production [a]	From domestic ores and base bullion	From foreign ores
1720–1912	7,176,407	326,991	2,929,180	10,432,608	8,545,383	1,8
1913	301,160	29,433	131,667	462,460	411,878	13,22
1914	340,307	43,500	158,219	542,122	512,794	7,63
1915	344,593	44,001	161,461	550,055	507,926	9,58
1916	336,375	68,244	167,515	571,134	552,228	6,08
1917	365,998	56,268	188,503	610,769	548,450	15,87
1918	382,314	47,418	210,463	640,195	539,905	15,33
1919	256,538	67,938	147,744	482,220	424,433	7,65
1920	273,135	66,608	189,854	529,057	476,849	8,41
1921	238,329	52,747	157,513	448,589	398,222	[c] 7,12
1922	249,107	74,305	209,250	532,662	468,746	13,89
1923	366,241	61,332	190,749	618,322	543,841	24,28
1924	423,428	63,449	203,615	690,493	566,407	46,38
	11,063,113	1,002,300	5,045,933	17,111,346	14,496,162	2,

[a] The lead content of antimonial lead is excluded; see p. 151.
[b] Desilverized soft lead is excluded.
[c] Revised figures.

[1] Chapters on lead giving more than ordinary detail were published in torical table of production) and 1918 (the lead industry in relation to the

Details for years prior to 1913 are shown in the annual chapters. The value for years prior to 1917 is based upon the average price in New York; beginning with 1917 the value is based on the total sales of each producing company.

The argentiferous lead ores of the Western States are desilverized to recover the silver and to refine the lead. The nonargentiferous or soft lead ores of the Central and Eastern States do not carry enough silver on the average to pay for desilverizing or to make that operation necessary. For certain purposes, however, a considerable quantity of lead ore from southeast Missouri has been desilverized each year.

Production by States.—In addition to the domestic lead ores smelted in this country, small quantities of domestic lead ore have been exported to smelters in Canada. Ores from Washington yielded 1,388 tons of lead at Canadian smelters in 1918 and 3 tons in 1919, but no lead ore from the United States was treated in Canada in 1920–1924.

Primary lead smelted or refined in the United States, 1920–1924, by sources, in short tons

Source of ore	1920	1921	1922	1923	1924
Domestic ore:					
Alaska	591	773	324	400	582
Arizona	5,987	3,313	7,218	8,828	9,372
California	2,260	614	3,018	5,168	2,305
Colorado	17,752	12,104	11,108	23,885	25,491
Idaho	117,191	99,707	91,487	127,797	123,769
Illinois *	948	271	750	1,286	1,089
Kansas *	8,421	10,930	10,900	20,207	12,805
Kentucky *	114	41	73	66	201
Missouri *	171,990	151,028	202,245	169,323	191,501
Montana	13,231	11,566	14,551	18,345	21,226
Nevada	8,650	3,553	4,204	8,044	8,070
New Mexico	1,123	384	1,230	1,038	2,263
Oklahoma *	68,494	40,902	67,436	59,602	56,017
Oregon			37	47	
South Dakota	6	2	2		2
Tennessee *	2,705		751	1,020	985
Texas	1	1	5	40	27
Utah	64,000	51,872	63,130	104,078	110,318
Virginia *					1,582
Washington	2,460	325	478	2,008	2,057
Wisconsin *	3,841	1,070	1,323	601	1,073
Undistributed	201	101	75	601	15
Zinc residues	4,366	713	1,284	302	1,320
	494,347	395,287	481,689	554,030	582,000
Foreign ore:					
Africa	1,171			99	6
Australia	450				
Canada	1,186	2,877	3,604	3,632	4,633
Central America	22	0	14	18	30
Europe	19	17	519	130	328
Mexico	2,729	1,912	7,200	18,867	33,328
South America	2,747	2,235	2,458	1,461	7,663
Other foreign	90	73	43	72	207
Foreign base bullion:					
Canada	1,010	1,509	2,900		
Mexico	42,421	41,648	47,118	50,103	77,701
South America	54				
	52,808	50,367	63,016	74,481	124,086
Grand total	547,155	445,654	545,605	628,517	706,086

* The lead produced by these States is nonargentiferous or soft lead. A small quantity of the lead produced from Colorado and New Mexico ores is also nonargentiferous.

Soft lead.—The lead ores of the Mississippi
from silver, and the lead produced from them
The output of the lead pigment basic lead sulp
is derived from these ores.

The lead ores from the southeastern Misso
little more silver (slightly over an ounce to th
in all) than those from other regions of the M
likewise small quantities of other metals, so th
though soft, is resistant to acids and is much
acid chambers. It is known to the trade as '

Soft lead produced in the United States from domestic ore

Year	Soft pig lead			Soft lead re covere in pig ment
	Undesilverized	Desilverized	Total	
1920	189,854	66,068	255,522	15,2
1921	157,513	52,747	210,260	9,9
1922	209,250	74,305	283,555	13,8
1923	190,740	61,332	252,081	13,6
1924	203,615	63,449	267,064	15,3

* Includes domestic refined lead, domestic lead in antimonial lead, a

The zinc ores from Western States that ar
may contain some lead which goes into the p
it is not strictly accurate to speak of the lead
entirely soft lead.

In addition to the domestic lead so recover
is also recovered in pigments. Prior to 1919
not distinguished from that of domestic origin.
of foreign lead recovered in zinc pigments w
1920, 808 tons; in 1921, 169 tons; and in 1924,
lead was used in pigments in 1922 or 1923.

Antimonial lead.—The production of by-pr
from argentiferous lead ores derived from all s
all lead refineries operating in this country, is
1871–1914 in Mineral Resources, 1914, and for
Resources, 1920.

By-product antimonial lead produced in the Unite

Year	Total lead refined from base bullion (short tons)	Percentage of by-product antimonial lead	Antimonial			
			From domestic ore (short tons)	From foreign ore (short tons)	Short tons	Value
1920	273,135	4.6	9,604	2,931	12,535	$1,963,2
1921	238,329	4.2	7,881	2,183	10,064	870,0
1922	249,107	3.2	7,068	1,007	8,075	844,9
1923	366,241	3.9	11,635	2,555	14,190	1,950,3
1924	423,420	4.9	13,693	7,194	20,787	3,376,7
Average		4.2				

Lead pigments.—Leaded zinc oxide, zinc-lead oxide, sublimed white lead, and sublimed blue lead are made directly from ore; white lead, red lead, orange mineral, and litharge are manufactured from pig lead. These pigments are discussed and their output given elsewhere in this volume in the chapter on lead and zinc pigments and salts.

The lead recovered from domestic and foreign ore in the form of pigments during recent years is given in the following table, which also gives the primary and secondary lead used in making those pigments that are made from pig lead:

Quantity and source of lead in pigments,[a] 1920–1924, in short tons

Year	Domestic ore	Foreign ore	Primary metal [b]	Secondary metal [b]
1920	15,212	808	215,431	
1921	9,989	169	200,599	
1922	13,892		241,006	111
1923	13,612		230,541	
1924	15,338	545	250,930	

[a] Includes lead recovered in zinc oxide and leaded zinc oxide.
[b] Primary metal is that made from ore; secondary metal is that derived from old metal and from drosses and skimmings.

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.

Secondary lead recovered in the United States, 1920–1924, in short tons,

Year	Pig lead	Lead in alloys	Total recovered lead	Value
1920	56,350	68,300	124,650	$10,914,000
1921	40,370	67,410	103,780	9,340,000
1922	75,480	84,080	159,560	17,552,000
1923	96,430	98,060	194,490	27,229,000
1924	90,400	114,100	204,500	32,720,000

Mine production.—The preceding tables give the quantity of lead recovered by smelting and refining operations either as metallic lead, or in the alloy antimonial lead, or as lead in pigments. The origin of the lead is much more accurately shown by the reports of mines, because smelters necessarily treat mixtures of ores, sometimes long after they have been received, so that the actual output of metallic lead may not correspond at all closely to the product of the mines for the same year.

The following table gives the mine output of lead from 1920 to 1924, inclusive. The statistics of mine production, which for years prior to 1921 had been expressed as lead content of ore mined, were reduced to recoverable lead in the chapter on lead for 1923 by deducting an assumed loss in smelting and refining, thus making the figures comparable to the statistics of mine production of zinc, which have always been stated as recoverable zinc. In these calculations the loss

in smelting and refining has been taken as
(at plants with bag houses) the soft nonarg
the Mississippi Valley, and about 5 per cent
the argentiferous lead ores of the Wester
assumed factors are close to the truth is sh
crepancy between the mine and smelter outp
the table of comparison on page 136 of the ch
Resources, 1923, and in the following sectio

Mine production of recoverable lead, 1920–1924,

State	1920	19
Alaska	875	
Arizona	6,935	3
Arkansas	8	
California	2,407	
Colorado	23,315	9
Georgia	2	
Idaho	118,565	9
Illinois	1,708	
Kansas	10,452	1
Kentucky	120	
Massachusetts	14	
Missouri	161,812	18
Montana	14,846	1
Nevada	10,100	
New Mexico	1,435	
Oklahoma	64,086	4
Oregon		
Pennsylvania	7	
South Dakota	6	
Tennessee	1,880	
Texas		
Utah	60,898	4
Virginia		
Washington	2,749	
Wisconsin	2,594	
	496,814	41

[a] It is said that a few tons of lead ore were mined at the old Chipr
treated at a small smelter owned by the mine operators.
[b] 513 pounds.

The following table lists the princ
the order of magnitude of their output in
production during the period beginning in t
production took its stride, and continuing d
the production of domestic lead ores was
peak. It shows the fluctuation in the outp
and demonstrates the security of the sout
in first place and of the Coeur d'Alene regio
The figures by districts for years prior to
duced in the following table to recoverable
explained above.

Mine production of recoverable lead in the principal lead-producing districts of the United States, 1916–1924, in short tons

District	1916	1917	1918	1919	1920	1921	1922	1923	1924
Southeastern Missouri region	197,509	200,454	177,764	154,015	158,033	178,735	176,768	167,458	187,737
Coeur d'Alene region, Idaho	169,211	176,704	132,342	79,641	112,200	94,543	91,216	114,426	118,327
Joplin region (Kansas, Missouri, and Oklahoma)	44,315	57,814	74,609	69,861	84,317	61,581	87,771	86,787	92,110
Bingham, Utah	40,848	34,924	37,803	26,940	24,932	12,288	19,348	25,353	34,786
Tintic, Utah	18,666	16,602	14,660	11,020	19,589	18,158	23,646	38,906	40,674
Park City region, Utah	15,780	16,015	11,552	10,123	12,223	8,846	16,120	26,220	33,348
Leadville, Colo	10,755	8,922	11,187	5,038	4,279	1,762	2,742	2,804	4,796
San Juan Mountains, Colo	9,486	11,178	10,252	8,003	13,522	5,323	5,332	13,157	13,149
Aspen, Colo	8,760	7,176	5,833	2,055	2,235	1,198	1,778	1,486	453
Ophir, Utah	6,109	4,551	4,340	3,984	3,628	480	2,921	3,443	1,414
Butte, Mont	4,308	4,917	10,804	9,048	8,356	6,614	10,070	12,746	13,048
Upper Mississippi Valley region (Iowa, northern Illinois, and Wisconsin)	3,449	4,072	5,827	5,703	3,384	1,506	1,259	948	1,639
	529,351	543,989	490,903	380,831	446,697	391,034	438,980	493,733	542,080
Percentage of United States total mine production	88	87	88	90	90	94	92	90	91

COMPARISON OF MINE AND SMELTER TOTALS

The Geological Survey published annually from 1907 to 1920 the statistics of lead output by mines, but because of lack of knowledge of the average smelting loss for the whole country, the total was, in general, given as lead content of ore mined, not as recoverable lead. Beginning with 1921, the lead output of the mines has been expressed as recoverable lead by estimating as closely as possible the losses in smelting and refining. For the sake of the following comparison the mine totals for 1906 to 1920 have likewise been calculated as recoverable lead. In addition to the domestic lead recovered at smelters as refined desilverized lead from argentiferous ores, as soft lead from Mississippi Valley ores, and as lead in antimonial lead and in pigments, considerable lead has been recovered at Canadian smelters from lead ores exported from the United States. This is included in the recovered lead given in the table below, which balances the primary lead recovered in all forms against the estimated recoverable lead in the ore mined for 18 years, the whole period for which such data are available.

Domestic primary lead balance sheet, 1907–1924, in short tons

Year	Recoverable lead (mine production)	Recovered lead (smelter production)	Mine excess (+) or smelter excess (−)	Year	Recoverable lead (mine production)	Recovered lead (smelter production)	Mine excess (+) or smelter excess (−)
1907	364,715	365,506	−791	1917	628,464	578,925	+49,539
1908	330,237	326,657	+3,580	1918	562,402	563,606	−1,204
1909	385,113	367,393	+17,720	1919	429,589	443,954	−14,365
1910	382,602	391,543	−8,851	1920	496,814	500,093	−3,279
1911	426,585	407,767	+18,818	1921	414,491	414,886	−395
1912	442,126	410,228	+31,898	1922	477,633	488,448	−10,815
1913	483,113	435,474	+47,639	1923	547,217	567,247	−20,030
1914	504,769	537,096	−32,927	1924	596,068	593,486	+2,582
1915	542,098	536,355	+5,743				
1916	601,392	582,180	+19,212		8,615,518	8,511,444	+104,074

SUPPLY OF LEAD

The future of the lead industry depends on the
latter on supply and demand, and the supply in t
new and old fields as well as on higher recovery th
metallurgical methods; these of course have always
ing factors in the industry, although imaginary fa
their part in speculative movements. Relief from
may therefore be afforded by discovery of new ore
ment in separation and concentration, by which gr
unworkable are added to the country's or worl
methods in reduction, which accomplish the same
ing the cost of reduction or by effecting a separati
process of reduction; and lessening of demand ei
cessation or by substitution of other metals.

The price of lead has fluctuated greatly in t
owing to the opportunity for speculation offered
spot lead at times. These fluctuations have u
producing and the consuming branches of the
have aroused fears for the adequacy of the futu
the country. Of course, a temporary shortage o
indicates that the lead reserves of the country
partial failure of the wheat or corn crop indicate
of the soil is waning. When production runs be
however, and a greater supply is necessary, it tak
to find and open new deposits and to reopen old
constancy of price only the experienced, farseeing
companies will undertake such work. The smaller
will remember that though lead averaged 8 cent
and has averaged 6.8 cents for 1916 to 1924, inclus
for 1921 was 4.5 cents, the same as the pre-war
1915. Many promising prospects and mines mus
down and the operating companies wiped out i
receipts for their product and high postwar cost
there is yet hope that some of them will be reopene

If the price of lead could remain steadily at th
no one need doubt that our production would s
of a scarcity of spot lead. If lead had no more
price with the average of metals and metal proc
would have sold in 1924 for about 6.9 cents.[3]
with the average of all commodities it would have
of 6.6 cents in 1924; if with agricultural produc
with nonagricultural products, at 7.2 cents; an
living, at 7.6 cents. It would seem, therefore,
with other commodities (except, of course, coppe
a pound, the average for 1924, is not unfair.

The present situation with regard to the lea
this: The United States and Mexico produced
than ever before. Canada has quadrupled he
war and is still expanding her capacity. Austra
two years been well up toward her large war-tim
chief reserves upon which Australia and Canad

[3] Bureau of Labor Statistics, Monthly Labor Review, Department of Labo

been recently said to be equal to about 20 years' draft at the present rate. Moreover, a new field is under development in Queensland, and a concentrating method is being sought for the extensive Read-Rosebery complex ores of Tasmania. The Burma output has nearly trebled since the war and the reserves are equal to nearly 20 years' output at the present rate, disregarding current additions to reserves by mine operations. The output from other sources of lead in Africa, Asia, and South America remains about stationary, but Europe is approximately 220,000 tons short of her pre-war production, chiefly because of the lessened output of Spain, Germany, and Poland. Apparently, the Old World misses the efficient ore-gathering machine of the German metal companies. The world's production in 1924 was the largest in history by over 125,000 metric tons, according to the American Bureau of Metal Statistics.

Residence and business building has been extremely active in this country ever since the World War, and has required supplies of plumbing and other lead material. Such construction was needed not only to accommodate the great expansion of business immediately after the war but also to catch up with current needs and with arrears in residence building. Dow's Agency recently noted that apartment building is threatened with overproduction in certain directions, and continuing the erection of business buildings is, of course, contingent upon continued business prosperity. The automobile industry consumes much lead, but the saturation point in that industry must be reached eventually, and then the salvaged lead will practically equal the consumption of new lead. There is, moreover, a pronounced trend toward the use of less lead. A substitute for lead in underground cable coverings will probably be found. Moreover, encouraging experiments are under way on reduction in the size of individual cable wires as well as in the amount of insulating material, which will permit many more wires in the same space and reduce the consumption of lead for cable covering. Recently a radio tube has been put on the market which uses alternating current, where that is available, instead of the more usual storage battery or the occasional step-down transformer on external direct-current supply. Transformers and rectifiers which eliminate "B" batteries (some of which are lead storage-batteries) have been in use for some time. There is now a tendency to make the ordinary tube set more portable by replacing lead storage-batteries with dry batteries which use no lead.

According to the American Bureau of Metal Statistics, storage batteries (all kinds, of course) consumed the largest amount, about 170,000 short tons, of lead in 1924; white lead took 150,000 tons; and cable covering, 138,000 tons. France, Soviet Russia, and Argentina have legislation, not yet in effect, restricting the use of white lead, hence legal measures or economic necessity might force substitution of other white pigments for part of the lead used in white lead. The examples of lead conservation cited show that the rapidly increasing consumption of lead in the immediate past may not continue indefinitely. Lastly, attention is again called to the 100,000 tons of lead in ore, matte, and bullion in bonded warehouse, December 31, 1924.

METALLURGY

ADVANCE IN METALLUR

Recent advances in the separation and co
ores have been made possible mainly by r
especially differential flotation, but also by va
roasting and leaching or volatilization. These
to be important to the lead industry because
ment will increase the supply of lead by allo
lead from ore, and especially by making avail
of complex sulphides or mixed sulphide and c
unworkable, some because of the penalty exac
which may thus become an asset.[3]

The present movement for more effective c
started at the Sullivan mine in British Col
solidated Mining & Smelting Co. after much e
by differential flotation in overcoming the ob
tion and saving of the lead and zinc in the or
be the largest sulphide ore body in North
success in treating the ores the company
capacity of the lead smelter and the elect
constructed a custom plant which pays miner
complex ores. A plant accomplishing the
by the International Smelting Co. at Tooele
has been started by the United States Sme
Utah; and still others have been built by i
panies. Operation of such plants increase
because greater quantities of the lower-gra
market.

No attempt will be made to discuss the adv
of the proposed roasting, leaching, or volatil
seems advisable to review a few processes wh
commercially.

The Coolbaugh process, now operated by
& Refining Co. in connection with its lead sm
by a closely controlled roast renders a high
blende leachable as zinc sulphate; the residue
ment in the lead smelter. It has not yet be
market outlet for the zinc sulphate will be as
pone, lead-free zinc oxide, or electrolytic zinc

At Harold, Utah, the Tintic Standard Mi
Dern process for an oxidized silver-lead ore.
with salt and coal dust and leached with br
finally lead are precipitated separately. T
melted into refined lead bars in a suitable f
initial output in 1924.

The Combined Metals Reduction Co., a su
Lead Co., is using the Snyder-Christensen p
The finely ground unroasted lead concentrat
acid brine, silver is precipitated by lead, and

[3] The following papers will be found useful in reviewing this met
"Hydrometallurgy of lead": Trans. Am. Inst. Min. and Met. Eng.,
G. L., "Present tendencies in treatment of complex ores": Trans. Am
1924, pp. 471–485. Parsons, A. B., "Progress in hydrometallurgy of l
Press, vol. 119, 1925, pp. 55–61.

cooling the liquor and is reduced to bars by melting with a mixture of lime and coal dust. As the ore is worked at Bauer the zinc is mainly floated in concentration, but any zinc remaining in solution is precipitated by H_2S and filtered off for electrolytic reduction or shipment to zinc smelters.

At the Bunker Hill & Sullivan Mining & Concentrating Co., U. G. Tainton and others have developed a process for the treatment of the zinc-lead ore from the Star mine. The ore is roasted and leached, the zinc recovered by Tainton's "high-acid" process, and the leady residues leached with brine and precipitated electrolytically. The contracting of the Star mine's zinc concentrates to Belgian smelters, as recently announced, may delay the construction of a commercial plant employing these Tainton processes.

It is to be noted that these methods of brine leaching are applicable not only to the complex ores, both sulphide and oxidized, from the mines and to tailings and middlings from their concentrating plants, but also to tailings from electrolytic zinc plants, to leady flue dusts, and to leady sludges from sulphuric acid chambers, and the like. In this adaptability lies much of their promise.

LEAD SMELTERS AND REFINERIES

UNITED STATES

California:
- Selby—Selby plant, American Smelting & Refining Co. Refinery also.

Colorado:
- Durango—Durango plant, American Smelting & Refining Co.
- Leadville—Arkansas Valley plant, American Smelting & Refining Co.

Idaho:
- Kellogg—Bunker Hill & Sullivan smelter. Refinery also.

Illinois:
- Chicago—Goldsmith Bros.' Smelting & Refining Co.[4]
- Chicago—Great Western Smelting & Refining Co.[4]
- Chicago—Illinois Smelting & Refining Co.[4]
- Chicago—U. S. Reduction Co.[4]
- Collinsville—St. Louis Smelting & Refining Works of National Lead Co. Refinery also.
- Federal—American Smelting & Refining Co. (Formerly Federal Lead Co.)

Indiana:
- East Chicago—International Lead Refining Co.[5] Refinery only.
- Grasselli—U. S. S. Lead Refinery (Inc.).[6] Refinery only. Betts electrolytic process.

Kansas:
- Galena—Galena plant, Eagle-Picher Lead Co.

Missouri:
- Granby—American Zinc, Lead & Smelting Co.
- Herculaneum—St. Joseph Lead Co.
- Joplin—Eagle-Picher Lead Co.

Montana:
- East Helena—East Helena plant, American Smelting & Refining Co.

Nebraska:
- Omaha—Omaha plant, American Smelting & Refining Co. Refinery only. Betts electrolytic process.

New Jersey:
- Irvington—Irvington Smelting & Refining Co.[4]
- Newark—Balbach Smelting & Refining Co.
- Perth Amboy—Perth Amboy plant, American Smelting & Refining Co.

Oklahoma:
- St. Louis—Ontario smelter, Eagle-Picher Lead Co.

[4] Smelters of secondary materials but treating some lead ores.
[5] Subsidiary of Anaconda Copper Mining Co.
[6] Subsidiary of the United States Smelting, Refining & Mining Co.

Pennsylvania:
- Carnegie—Pennsylvania Smelting Co. Refine

Texas:
- El Paso—Kansas City Consolidated Smelting

Utah:
- Harold—Tintic Standard Mining Co.
- International—International Smelting Co.[8]
- Midvale—United States Smelting, Refining &
- Murray—Murray plant, American Smelting &

CANADA

British Columbia:
- Trail—Consolidated Mining & Smelting Co. also. Betts electrolytic process.

Ontario:
- Galetta—Estate of Jas. Robertson.

MEXICO

Aguascalientes:
- Aguascalientes—American Smelting & Refinir

Chihuahua:
- Chihuahua—American Smelting & Refining

Coahuila:
- Saltillo—Mazapil Copper Co. (Ltd.).
- Torreón—American Metal Co. (Ltd.). (Cia.

Durango:
- Asarco (Velardeña)—American Smelting & Asarco.)

Guerrero:
- Campo Morado—Reforma Mining & Milling

Nuevo Leon:
- Monterrey—American Metal Co. (Ltd.). Refinery also.
- Monterrey—American Smelting & Refining

San Luis Potosi:
- Matehuala—American Smelting & Refining
- San Luis Potosi—American Smelting & Refini

TRADE CONDITI

WORLD'S SMELTER PRO

In the following table, prepared by W. I of Mines, the figures in italic type are take of the countries named; those in ordinary yearbook of the American Bureau of Meta sources regarded as reliable. However, t substituted when they are available, as i official set of statistics of world production set like that of the American Bureau of M

There is always a possibility of dupli world's production, for some countries s bullion to other countries for refining. F antimonial lead are often included in the production, so that to put the United State statistics it would be necessary to include i tic output of secondary lead and antimo the United States represent refined lead th try, whatever the source of the ore.

[7] Subsidiary of American Smelting & Refining Co.
[8] Subsidiary of Anaconda Copper Mining Co.

World's production of lead, 1918–1924

[In metric tons, by countries where smelted, but not necessarily refined. Figures in italic type are official]

Country	1918	1919	1920	1921	1922	1923	1924
Australia	*163,378*	*83,408*	*5,474*	*51,402*	*105,126*	*132,185*	127,600
Austria	*4,743*	*1,764*	*3,973*	*3,347*	*5,560*	*4,255*	*4,985*
Belgium	*20,850*	*4,228*	*16,040*	*29,760*	*43,680*	*51,100*	*53,700*
Canada	*17,006*	*16,143*	*15,733*	*28,274*	*40,191*	*46,801*	*75,987*
Chosen	*264*	*663*	*555*	(a)	(a)	(a)	(a)
Czechoslovakia	(a)	*2,963*	*2,006*	*2,388*	*2,228*	*2,452*	*2,264*
France	*12,778*	*10,988*	*15,060*	*15,475*	*13,944*	17,413	21,000
Germany:							
Upper Silesia	*23,960*	*18,580*	*18,008*	*13,743*	[b] *6,188*	(a)	(a)
Other Germany	*40,617*	*39,006*	*52,495*	*70,487*	59,100	35,000	46,000
Great Britain	11,083	10,441	11,136	2,474	5,036	6,815	5,388
Greece	*4,095*	*3,841*	*5,016*	*5,575*	*4,408*	*4,255*	*5,106*
India (Burma)	*19,380*	*19,398*	*24,203*	*34,268*	*39,843*	*40,799*	*51,370*
Italy	*18,352*	*16,630*	*15,947*	*12,494*	*10,710*	*17,131*	*22,068*
Japan	*10,684*	*5,771*	*4,167*	*3,138*	*3,239*	*2,700*	*2,941*
Mexico	83,705	70,384	82,480	58,586	114,235	121,607	131,113
Norway						*242*	*648*
Poland:							
Upper Silesia	(d)	(d)	(d)	(d)	[c] *8,325*	*16,256*	*16,205*
Other Poland	(e)	*656*	1,500	*1,010*	*60*		(e)
Rhodesia	*9,936*	*12,869*	*14,836*	*17,969*	*20,829*	*11,197*	*5,999*
Rumania	(e)	*644*	*601*	*582*	*477*	(e)	*433*
Russia	(e)	(e)	(e)	(e)	*394*	*555*	[f] *625*
South America	*4,781*	*6,565*	*6,264*	*4,604*	*5,039*	*5,081*	*11,612*
Spain	*169,709*	*125,721*	*175,196*	*136,881*	*118,461*	*127,514*	*141,849*
Sweden	*2,241*	*827*	*863*	*513*	[e] *316*	*225*	*588*
Tunisia	*16,555*	*5,800*	*11,407*	*12,225*	*14,552*	*14,090*	*14,291*
Turkey	2,500	1,000	1,000	8,345	5,400	1,400	*5,104*
United States (refined)	*505,702*	*391,982*	*440,221*	*367,718*	*437,845*	*515,395*	*555,913*
Yugoslavia	(e)	*5,727*	*5,099*	*4,828*	*8,497*	*9,260*	*11,487*
Known production	1,140,000	802,000	927,000	885,000	1,073,000	1,190,000	1,313,000

[a] Data not available.
[b] First six months; for second six months, see Poland.
[c] See Poland.
[d] See Germany.
[e] Second six months; for first six months, see Germany.
[f] Data for operating year Oct. 1, 1923, to Sept. 30, 1924.

IMPORTS AND EXPORTS

The following tables were compiled from the records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, of the Bureau of Mines.

Lead remaining in warehouse in the United States, December 31, 1920–1924, in pounds

[Stated in the form in which the material was entered for warehouse]

	1920	1921	1922	1923	1924
Ore	32,923,299	13,679,465	10,470,144	76,031,259	103,474,370
Base bullion	69,517,026	24,692,350	7,076,544	80,306,856	95,007,016
Pigs, bars, and old	2,644,576	693,440		5,234,475	10,090,668

Lead imported for consumption in the United States, 1920–1924

Year	Lead in ore [a]		Base bullion		Pigs, bars, and old [b]		Sheets, pipe, and shot		Not otherwise specified	Total value
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value		
1920	13,700,499	$908,619	66,816,820	$3,340,600	68,901,959	$3,887,821	81,396	$5,483	$21,328	$8,163,851
1921	6,842,807	327,046	56,819,980	1,668,410	61,909,094	1,972,716	3,087	140	11,204	3,979,516
1922	[c]23,649,851	812,603	55,859,422	1,815,142	[d] 8,563,110	[d] 335,924	6,018	697	12,286	2,976,552
1923	[c]22,420,046	1,190,414	11,124,151	626,201	[d]42,925,265	[d]2,510,466	19,525	4,495	90,027	4,421,603
1924	[c]65,147,976	3,145,791	28,796,402	1,542,167	[d]27,362,392	[d]1,850,862	11,666	4,384	138,037	6,681,841

[a] Includes also lead in matte beginning Sept. 22, 1922.
[b] Includes also imports of antimonial lead, antimonial scrap lead, babbitt metal, solder, etc., beginning Sept. 22, 1922.

Type metal imported for consumption in the

Year	Type m	
	Pounds	
1920	29,887,353	
1921	38,971,361	
1922	44,895,120	
1923	(a)	
1924	(a)	

[a] Figures not available.

General imports of lead into the United States, 19

Year	Lead in ore	L
1920	29,488,816	
1921	14,234,039	
1922	24,474,481	
1923	66,882,860	
1924	95,320,168	

General imports of lead into the United States, in ore 1924, by sources, in po

Year	Canada	Mexico	South America	
1920	8,199,234	131,815,278	7,085,351	
1921	8,127,158	106,406,238	2,381,365	
1922	8,663,236	141,216,136	3,803,478	
1923	11,399,671	242,352,788	5,300,161	
1924	11,022,091	243,161,069	15,820,867	

The high price of lead shortly before a made it profitable to export domestic le 1914, the exports soon reached large qua rapidly after the war.

Refined lead, made from domestic ores, exported fro

Year	Short tons	Value	
1915	88,306	$7,928,518	1920
1916	100,500	13,494,065	1921
1917	53,688	9,560,598	1922
1918	41,831	5,889,381	1923
1919	10,510	1,471,256	1924

The lead of foreign origin which has manufactured in this country and then in the following tables.

Foreign lead exported from the United States, 1920–1924

Year	Exported from warehouse			Exported in manufactures with benefit of drawback (pounds)
	Pigs, bars, and old *		All other manufactures	
	Pounds	Value		
1920	34,725,501	$2,570,535	$35,146	12,360,794
1921	50,000,259	2,284,107	613	18,738,927
1922	64,709,305	3,177,360	146	11,354,070
1923	97,471,326	5,195,256	(b)	25,052,107
1924	153,515,863	9,685,619	(b)	30,549,116

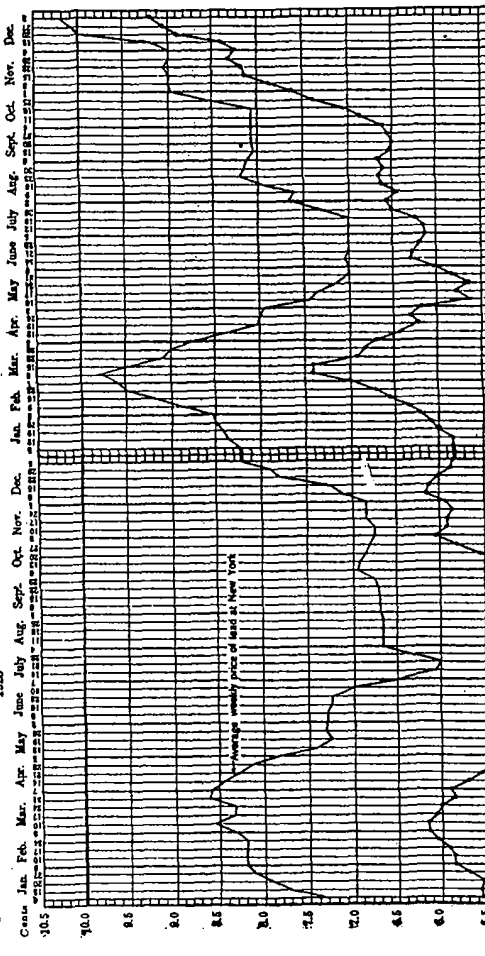
* Since July 1, 1915, the Bureau of Foreign and Domestic Commerce has classed all foreign lead smelted or refined in this country and exported as "domestic exports of pigs, bars, etc., produced from foreign ore." The above figures include also the exports of foreign lead imported in the form of pigs and bars.
b Not separately classified after 1922.

Domestic and foreign pig lead exported from the United States, 1923–24, by destinations

[Figures in parentheses are not duplicated in the totals]

Destination	Domestic		Foreign	
	Short tons	Value	Short tons	Value
1923				
Asia	124	$12,950	2	$144
Japan	(112)	(10,976)		
Philippine Islands	(8)	(1,104)	(2)	(144)
Canada	126	23,594	1	128
Cuba	104	15,313	62	6,725
Europe	690	80,852	45,547	4,843,650
Denmark			(224)	(24,034)
France	(336)	(36,964)	(10,335)	(1,078,051)
Germany	(*)	(17)	(6,611)	(685,831)
Great Britain	(185)	(25,171)	(21,248)	(2,316,482)
Netherlands	(112)	(12,322)	(4,348)	(460,457)
Mexico	96	17,821	48	6,047
South America	743	90,669	3,074	338,329
Argentina	(384)	(41,002)	(843)	(94,665)
Brazil	(257)	(32,323)	(1,942)	(211,433)
Uruguay	(34)	(3,829)	(284)	(31,553)
Panama	58	9,254	(*)	42
Other countries	58	10,034	2	182
	1,009	260,487	48,736	5,195,256
1924				
Asia	33	5,650	2,353	287,397
Japan			(2,072)	(256,427)
Philippine Islands	(30)	(5,037)	(1)	(158)
Canada	120	23,476	(*)	56
Cuba	105	17,308	126	16,220
Europe	3,870	483,571	70,271	8,870,351
France	(1,116)	(130,350)	(10,899)	(1,400,908)
Germany			(10,069)	(1,210,009)
Great Britain	(2,090)	(274,902)	(38,063)	(4,887,487)
Netherlands	(588)	(69,893)	(2,340)	(288,780)
Mexico	45	10,509	35	4,077
South America	1,008	153,217	3,958	504,084
Argentina	(695)	(87,584)	(1,327)	(164,065)
Brazil	(250)	(43,030)	(2,418)	(312,471)
Uruguay	(3)	(571)	(140)	(17,547)
Panama	39	6,477		
Other countries	54	10,879	15	2,834
	5,332	711,147	76,758	9,685,619

* Less than 1 ton.



CONSUMPTION

Apparent consumption of refined primary lead in the United States, refinery stocks disregarded, 1920–1924, in short tons

	1920	1921	1922	1923	1924
Supply:					
Stock in bonded warehouse Jan. 1	234	1,322	347	----------	2,617
Imports of pigs, bars, and old	35,719	31,301	3,551	21,099	12,247
Production	529,657	448,589	532,662	618,322	690,493
	565,610	481,212	536,560	639,421	705,357
Withdrawn:					
Exports of foreign lead—					
From warehouse	17,363	25,000	32,355	48,736	76,758
In manufactures, with benefit of drawback	6,175	9,360	5,677	12,520	15,275
Exports of domestic lead	2,730	1,024	5,823	1,999	5,332
Stock in bonded warehouse Dec. 31	1,322	347	----------	2,017	5,045
	27,590	36,340	43,855	65,878	102,410
Apparent consumption	538,020	444,872	492,705	573,543	602,947

PRICES AND VALUE

The accompanying graph (fig. 5) shows the trend in the quoted price of lead for prompt delivery in the New York market in 1923–24. The price rose from 8.3 cents a pound at the beginning of the year to 9.87 cents the last of February, and then declined to 7 cents in June. A decided upward trend through the remainder of the year culminated in a quotation of 10.2 cents at the end of December. The average quoted price for the year was 8.3 cents, compared with 7.4 cents in 1923. A graph of the lead prices quoted in London is shown for comparison; in it fluctuations in exchange have been taken into account.

The following are prices quoted on lead throughout 1924 by the American Smelting & Refining Co., in cents a pound:

Jan.	2 7.75	Apr.	9 8.50	Oct.	20 8.25
	10 7.90		11 8.25		23 8.40
	18 8.00		24 8.00		25 8.50
Feb.	1 8.15	May	5 7.75		27 8.65
	7 8.25		7 7.50	Dec.	8 8.75
	14 8.40		15 7.25		10 8.90
	15 8.50		22 7.00		11 9.00
	21 8.70	July	23 7.25		15 9.25
	27 8.90		29 7.50		18 9.35
	28 9.00	Aug.	11 7.75		23 9.50
Apr.	3 8.75		15 8.00		26 9.60

The average selling price, based on total sales, was 8 cents a pound in 1924, compared with 7 cents in 1923. The value of the refined lead produced in the United States from domestic ores, based on the average selling price a pound, was $90,625,000 in 1924, compared with $76,138,000 in 1923.

GOLD, SILVER, COPPER, AND L

(MINE REPORT)

By V. C. HEIKES

PRODUCTION

The mines of Arizona produced in 1924 lead valued at $99,610,379. Compared wit of the output decreased $4,690,821, or 4 Cornelia, Miami Copper, Calumet & Arizo ion, United Verde, United Eastern, Arizon and mining companies paid dividends amou Phelps Dodge Corporation, operating mine Ariz., and also in Mexico and New Mexic is not included in the total given above.

Although the quantity of copper increa less. This decrease in value formed the gre in the State total, though there were als silver, and no zinc was reported. The a and tailings decreased from $6.13 in 1923 value in gold and silver decreased from 71

Mine production of gold, silver, copper, and

	Number of producers	Ore and tailings	Gold •	Silver •	Co
		Short tons		*Fine ounces*	*Po*
1924	275	19,820,505	$4,878,465	6,649,276	677,
Increase or decrease from 1923	−60	+2,805,327	−1,242,650	−694,406	+58,

• Includes placer production.

ORE

Copper ore led in quantity the ores mine and siliceous gold ores and lead ore followe metals in the ores and tailings were as $2,171,505; dry gold and silver ore, $177,70 copper ore, $94,575,415; lead ore, $2,308,9 $65,182. In addition the placers produced $3,157. Thus the State total was $99,610,3

Zinc dust sold by producers in the United States, 1919–1924

Year	Prepared "blue powder"			Zinc dust "atomized"			Primary zinc recovered as zinc dust (short tons)
	Short tons	Value		Short tons	Value		
		Total	Average per pound		Total	Average per pound	
1919	4,083	$801,366	$0.098	2,715	$566,294	$0.104	3,420
1920	9,006	2,009,117	.111	2,463	555,773	.113	6,426
1921	2,006	333,390	.083	999	152,151	.076	1,380
1922	3,394	531,225	.078	3,859	573,220	.074	2,113
1923	3,676	643,766	.088	4,376	702,923	.080	2,450
1924	3,894	620,078	.080	4,063	621,221	.076	1,861

The average price of zinc dust, "blue powder," as calculated from sales during the year, was 8 cents a pound; "atomized" zinc dust brought 7.6 cents a pound. "Blue powder" brought a higher average price than "atomized" dust, because much of it was sold in the far West, where higher prices prevailed. The weekly fluctuation in the quoted price of zinc dust is shown in Figure 7 (p. 253).

The following operators reported the production of zinc dust in 1924:

Bartlesville Zinc Co., Bartlesville, Okla.
John Finn Metal Works, San Francisco, Calif.
Grasselli Chemical Co., Clarksburg, W. Va.
The Merrill Co., San Francisco, Calif.
New Jersey Zinc Co., Palmerton, Pa.
United States Zinc Co., Sand Springs, Okla.

ZINC PIGMENTS AND SALTS

Zinc forms the base, either in whole or in part, of three white pigments—zinc oxide, leaded zinc oxide, and lithopone. Two zinc salts, the chloride and the sulphate, are likewise made in part from ore and in part from secondary zinc. Details of the production of zinc pigments and salts and of market conditions are given in the chapter on lead and zinc pigments and salts.

The zinc content of the pigments and salts made in the United States from ore, both domestic and foreign, for the period 1919–1924, is given in the table below. Statistics of the secondary zinc recovered in the form of pigments and salts are given under the next heading.

Primary zinc content of zinc pigments and salts made in the United States, 1919–1924, in short tons

Year	Salts	Pigments	Year	Salts	Pigments
1919	3,393	96,817	1922	1,801	93,112
1920	6,284	110,695	1923	1,573	115,970
1921	3,749	53,480	1924	1,075	108,282

SECONDARY ZIN

Secondary zinc recovered in the United States,

condary zinc, redistilled
condary zinc, remelted
covered zinc in alloys, excluding old brass remelted
covered zinc in remelted brass (estimated)
Secondary zinc recovered as metal
condary zinc recovered in zinc dust
condary zinc recovered in pigments
condary zinc recovered in zinc salts
Total secondary zinc

See p. 235 for definition of secondary zinc.

BY-PRODUCT SULPHU

An important by-product of zinc-smel phuric acid made from the sulphur gases ulphide ores preparatory to their distill xide or to zinc salts. Sulphur gases fro tilized by Matthiessen & Hegeler, at La here are numerous acid plants using thes ay be at zinc smelters and zinc oxide p netic separating plants, at the mines, o he roasted concentrates being shipped inc plants.

The following table gives the outpu cid made at or in association with zin 1919, 1921, and 1923, as collected by the in 1924, as collected by the Bureau of M utput of zinc smelters:

By-product sulphuric acid produced at zinc-blen States, 1919, 1921, 1923,

	191
Number of establishments	
Acid reported as 50°–60° B.:	
Produced ..... short tons	39
Consumed at works ..... do	
Sold ..... do	38
Value of acid sold:	
Total	$4,69
Average	$
Acid reported as 66° B. and stronger:	
Produced ..... short tons	7
Consumed at works ..... do	
Sold ..... do	7
Value of acid sold:	
Total	$1,46
Average	$
Total acid sold, equivalent in 60° B.:	
Quantity ..... short tons	50
Value	$6,16
Consumed at works (60° B.) ..... short tons	1

• Expressed as 60° B.

† Expressed as 66° B.

TANTALUM

Tantalum and its close associate, columbium, are still among the experimental metals—those possessing attractive properties but not shown to have wide uses that some other and cheaper metal or alloy will not fill as well or better. Inasmuch, however, as constant experimentation is developing numberless new uses for the elements and their alloys and compounds, other uses than those now known—uses they will be particularly adapted to fill—will probably be found for these metals.

To obtain these metals in a pure state, or a state of purity comparable to that of the iron, aluminum, or copper of ordinary commerce, is difficult and tedious, though not impracticable. Like vanadium, however, they can be converted into ferroalloys with comparative ease. Several patents have been taken out for their use in steel, but the steels have been made only in experimental lots. So far as is known the steels made have all contained both tantalum and columbium, and the effect of either metal alone is therefore not known.

The only known output of ores of these metals made in the United States for several years has been that shipped by Dr. A. T. Roos, Rapid City, S. Dak., who states that the production of columbite in 1924 was 1,197 pounds, [15] valued at about $598. The columbite has come from pegmatite dikes near Keystone and Hill City, in the southern part of the Black Hills, and all the ore is thought to have been used for experimental purposes, most of it in ferro-tantalum-columbium, without separation of the two metals.

Columbite, mined in the United States, shipped in 1918–1924

Year	Pounds	Value	Year	Pounds	Value
1918	4,500	$2,250	1922	600	$240
1919	300	90	1923	1,350	540
1920	4,000	1,450	1924	1,197	598
1921	3,400	1,150			

No imports of tantalum ores were recorded in 1922. The records of the Bureau of Foreign and Domestic Commerce show that 5,600 pounds of "tantalum steel-hardening ores," valued at $3,031, were imported for consumption in 1923, but none were imported in 1924. American ores are not sufficiently free from columbium to make them suitable for the manufacture of tantalum under present processes.

The Fansteel Products Co., of North Chicago, Ill., markets a charger for storage batteries in which tantalum is used as an electronic valve. The use of tantalum in stellite has been patented.[16] Columbium has been found more difficult to isolate than tantalum, and is not known to have been put to practical use.

TITANIUM

So far as the Bureau of Mines knows the only titanium mineral produced in the United States during 1924 was ilmenite mined from

[15] Figures are published with the express permission of Doctor Roos.
[16] McCurdy, Frederick T., Tool alloy containing cobalt, tantalum, and a chromium-group metal. United States Patent 1440338, Mar. 20, 1923.

the beach sands about 4 miles south of Pablo
man & Pritchard (Inc.), a subsidiary of the T
(Inc.), which in turn is controlled by the U
During the year 4,769 short tons of ilmenite,
about 52 per cent TiO_2, were shipped from
plant of the Titanium Pigment Co. at St. L
also shipped from the same deposit 281 short

Titanium minerals produced in the United S

Year	Rutile conce	
	Short tons	P
1920	277	
1921	310	
1922	270	
1923		
1924		

• Bureau of Mines not at liberty to publish values.

The Titanium Pigment Co. formerly ha
Falls, N. Y., but during 1924 erected a new
with a considerably increased capacity.

On the shore of Monterey Bay, near Apt
southeast of Santa Cruz, Calif., the Trium
to work titanium-bearing sands of the beac
100 or 200 feet long and as much as 50 feet
detrital bluffs carry layers of black sand from
board to as much as 5 or 6 inches, separated
through a thickness of several feet. The san
is said to carry 5 per cent of black sand, thou
the eye.

The sand is said to be mostly magnetite,
16 per cent of TiO_2 in the form of ilmenite.
part is said to carry 40 per cent of TiO_2. T
to use the magnetite and martite for making
without melting, and to save the ilmenite
treatment. The sand was used by another c
facture of pigment.

During the year the Bureau of Standards
specifications for outside white titanium zinc
the following ingredients for pigment:

Specifications for white titanium zinc pai

Ingredients
Titanium pigment
Zinc oxide
Extending pigments
Matter soluble in water
Lead
Sulphide sulphur

In no case shall the sum of the titanium pigment and zinc oxide be less than 90 per cent. The titanium pigment shall contain 25 per cent titanium oxide, the remainder to be blanc fixe (precipitated barium sulphate).

Many patents covering the use of titanium in alloys have been granted during recent years, but many seem to cover efforts to forestall discoveries by some one else rather than discoveries that have been tested. Ferrotitanium for use in steel, like the titanium white pigment, is made from ilmenite.

For paint only very high grade ilmenite is desired; otherwise the consumption of chemicals is increased, more iron has to be removed, and obtaining a white pigment is more difficult.

The various titaniferous iron deposits of the country, such as those of the Adirondacks,[17] Iron Mountain, Wyo.,[18] and western North Carolina,[19] are magnetites containing only intergrowths of ilmenite plates, so that they are very much leaner in TiO_2 than the Florida beach sands. The richest and best supplies of ilmenite yet found are the beach sorted materials that have been derived from weathered gneisses extensively intruded by pegmatites. Such was the origin of the ilmenite sands of Florida, Brazil, Travancore (southwest India),[20] and Ceylon.[21]

A new use for ilmenite-bearing iron ores is covered by a patent in which E. C. Eckel [22] describes the manufacture of a quick-hardening chemically resistant cement by smelting in a blast furnace titaniferous iron ore with enough lime and aluminous material to form a titanium-calcium-aluminum-iron slag, which consists essentially of calcium titanate (TiO_2.CaO) with subordinate quantities of ferrites, aluminates, and calcium silicate, and contains 2 to 10 per cent of iron oxide. The remainder of the iron is reduced to metal and drawn out below as in ordinary smelting. The slag, finely ground, forms "titan cement." It is claimed that if the lime is kept below 50 per cent, preferably about 30 to 40 per cent, the cement hardens rapidly after a normal set, attaining high strength in 24 to 48 hours; that at all periods it is stronger than Portland or alumina cements; and that its resistance to chemical attack is higher than that of either Portland or alumina cement. The specific gravity is given as 3.35 to 3.55.

Rutile, the natural titanium oxide, is used mostly for arc-light electrodes and for potassium-titanium oxalate to be used in dyeing and in the manufacture of leather, but the demand is small. There can not be said to be a market price for titanium minerals, as the buyers are so few. Ilmenite may, perhaps, be said to be worth $10 to $25 per short ton for material carrying about 52 per cent TiO_2, if a buyer can be found. Concentrated rutile sells at 10 to

[17] Kemp, J. F., "The titaniferous ores of the Adirondacks": U. S. Geol. Survey 19th Ann. Rept., 1897, pp. 377–422.
[18] Bull, S. H., Titaniferous Iron Ore of Iron Mountain, Wyo.: U. S. Geol. Survey Bull. 315, 1907, pp. 206–212.
[19] Nitze, H. B. C., Iron Ores of North Carolina; a Preliminary Report: North Carolina Geol. Survey Bull. 1, 1893, 239 pp.
[20] Masillimani, E., and Chacko, C. I., Report Travancore Geological Survey, 1907–1910. Tipper, G. H., The monazite sands of Travancore: Recs. Geol. Surv. India, vol. 44, 1914, pp. 186–195.
[21] Imperial Institute, London, Recent work on monazite and other thorium minerals in Ceylon: Vol. 14, 1916, pp. 321–309.
[22] Eckel, E. C., Cement and Iron. United States Patent 1511323, Oct. 14, 1924.

25 cents per pound, depending on quality, quantity, f
ing, and above all, on the needs of the buyer and
Imports of "titanium-potassium oxalate and all
mixtures containing titanium" in 1924 amounted t
valued at $3,639. In 1923 they were 39,763 pounds,
In 1922, after September 22, when the new tariff
the imports were 82,544 pounds, valued at $20,596.
separately recorded prior to the new tariff.

The tariff act of 1922 provides duties (par. 91) t
potassium oxalate, and all compounds and mixt
titanium, 30 per centum ad valorem." Paragraph 3
duty on many ores, concentrates, and alloys, among
25 per cent ad valorem on ferrotitanium and titaniu

TUNGSTEN

The year 1924 saw a considerable increase in the c
sten ore produced in the United States over other
since the Great War, but the tonnage was still smal
that of the 10 years preceding the close of the war,
only 374 short tons, which sold for $200,000. Besi
duced during the year, 191 tons of ore that had b
years was sold for $87,000.

The table that follows shows the production c
since 1900, which practically marked the beginning
ing in this country, and the average price per un
prices are surprisingly low in view of the great fl
market quotations. Thus in 1907 $15 per unit wa
ore, in 1917 more than $100 per unit, and in 191
quantity of ore was sold at $75 per unit. On th
1900 and 1901, some ores sold for less than $2 per un

Concentrated tungsten ores (reduced to an equivalent of produced in the United States, sold in 1900–1924, with th unit

Year	Short tons	Value	Average price per unit	Year	Short tons
1900	46	$11,040	$4.00	1913	1,5
1901	• 179	27,720	2.58	1914	9
1902	• 184	34,040	3.08	1915	2,3
1903	• 202	43,639	2.49	1916	5,9
1904	• 740	184,000	4.12	1917	6,1
1905	• 803	268,676	5.57	1918	5,0
1906	928	348,867	6.26	1919	3
1907	1,040	890,048	9.04	1920	2
1908	671	229,955	5.71	1921	
1909	1,019	614,370	6.32	1922	
1910	1,821	832,992	7.68	1923	2
1911	1,139	407,985	5.97	1924	• 5
1912	1,330	502,158	6.27		

• For the years 1901 to 1905 the tungsten content of the concentrates is estim
• The output of 1923 was made by one company only, which sold to its ow
ably above the market.
• Includes 191 tons produced in 1919, sold in 1924 for $87,000.

In 1924 the Wolf Tongue Mining Co., the only
tungsten in Colorado, worked the Cold Spring m
land, but conditions were not encouraging. All c