U. S. DEPARTMENT OF COM
R. P. LAMONT, Secretary
BUREAU OF MINES
SCOTT TURNER, Director

MINERAL RESOU

OF THE

UNITED STA

1928

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PART I—METALS

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BIBLIOGRAPHY

The following articles are among those on tantalum that appear or became available during 1928.

CHEMICAL ENGINEERING AND MINING REVIEW. Tantalite in Australia. V. 20, 1928, p. 384.

"The Pilbara field, Western Australia, is the principal producing center tantalite in Australia. Messrs. Young and Moulden, of Adelaide, work lea at Wodgina and also purchase any small lots raised. The production in 192 was 19.45 tons, valued at £2,357. In 1927 the output fell to 15.28 tons, b the value was higher, viz, £3,808. The output is regulated by the deman The firm mentioned is under contract to sell the whole output to an Americ concern. Tantalite also occurs in association with tin in the same district a at Greenbushes, but the separation is a difficult matter. It has also b reported from Coolgardie.

"In the Northern Territory Messrs. James Gitsham and A. J. Johnson a developing a find of tantalite on the Finnis River, about 65 miles from B Darwin. They have a contract for the supply of 20 tons to the Fansteel C of New York [North Chicago]. Inquiries are reaching Australia from Gre Britain, America, and Europe, and the price offered has increased from 30s. p unit for 60 per cent ore to 80s. Some buyers offer to accept concentrates co taining as low as 45 per cent Ta_2O_5."

INDUSTRIAL AUSTRALIAN AND MINING STANDARD. Tantalite mining in Weste Australia. Vol. 80, 1928, p. 303.

"Since June last there has been increased activity in the mining of the miner tantalite in Western Australia. Prior to 1923 the total value of this produ mined in the State was £18,092. Last year the yield was worth £3,746, and 1926, £5,751. For the months of May, June, July of this year about 7¼ to were obtained at a value of £1,814. The tantalite mines at Wodgina are bei worked by a company in which Lady Hacket Moulden, of Adelaide, and former of Western Australia, is chiefly interested. Whilst in America recently La Moulden was able to arrange a contract for several years ahead with certa interests in the United States."

KIEHL, S. J., and HART, DAVID. The reduction of columbic acid. Jour. Am Chem. Soc., vol. 50, 1928, pp. 1608–1620.

M-O VALVE CO. (Ltd.) and STOFFORD, C. W. Thermionic valves. Britis Patent 277754, June 25, 1926. Chem. Abs., vol. 22, July 20, 1928, p. 249

"The filament is secured to its supports by a solder consisting of a mixture powdered form, of C, a metal such as molybdenum, tungsten, or tantali having a higher melting point than the normal temperature of the joint, and metal such as copper having a lower melting point. Various structural deta also are specified."

SAW, W. W. Tantalum and niobium. Chem. Eng. and Min. Rev., vol. 1 1927, pp. 468–469.

A general article covering the occurrence of Ta and Cb in Western Austral It also gives the properties of the minerals and their constituents.

SCRIVENOR, J. B. The geology of Malayan ore deposits. London, 1928, 216 p. Briefly describes tantalum deposits in the Malayan Peninsula.

THUT, HENRIQUE G. (Rare-metal deposits in Brazil.) Chim. Ind., vol. 1, 192 pp. 349–354; vol. 2, 1927, pp. 383–384, 403–404.

WELLS, R. C. Note on the J. Lawrence Smith method for the analysis samarskite. Jour. Am. Chem. Soc., vol. 50, April, 1928, pp. 1017–1022.

TITANIUM

DOMESTIC PRODUCTION

During 1928, as in preceding years, the principal interest in titanium was in its use in pigments. As rutile is comparatively rare, only ilmenite has been used for this purpose, and the production of titanium has been mostly in that form.

Rutile was produced in 1928 at the plant of ... at Roseland, Nelson County, Va., with abo... ilmenite. Ilmenite and rutile were also shipp... Pritchard (Inc.) operation 4 miles south o... A little ilmenite was produced in Los Ang... the Minerals Conversion Co., of Los Angeles. There were only two shippers each of ilmen... United States in 1928, and the Bureau of Min... publish the figures. The production of titaniu... last 10 years, so far as data are available to th... on, is shown in the following table; the qua... shipments rather than direct production.

Titanium minerals produced in the United Sta...

Year	Rutile concentrates			Sh...
	Short tons	Percentage of TiO_2	Value	
...	102	94–96	$20,400	
...	277	94–96	(3)	
...	310	95	(3)	
...	270	95	(3)	
...	46	95	[4] 11,000	
...	30	95	[4] 7,500	
...	(2)	(2)	(2)	
...	(2)	(2)	(2)	

[1] Virginia production only; information regarding Florida not availa...
[2] Bureau of Mines not at liberty to publish figures.
[3] Arbitrary value.
[4] Figures for Florida only. Bureau of Mines not at liberty to publis...

IMPORTS

During 1928 a considerable quantity of ilmen... the United States—13,305 short tons from Ind... ($3.61 per ton); 2,240 tons from Senegal, valu... per ton); and 1,679 tons from the Netherlan... ($3.63 per ton); a total of 17,224 short ton... imports of ilmenite for earlier years are not se... the Bureau of Foreign and Domestic Comme... comes from Travancore and is said to carry 53... TiO_2; the high percentage is due to tiny particl... with the ilmenite. No figures are at hand to sh... ...es were imported from Canada during 1928, ... 15 to 18 per cent of TiO_2 has been shipped at... States from Ivry and St. Urbain, Canada, fo... ferrotitanium. The St. Urbain deposit carries ...

GENERAL CONDITIONS

C. O. Terwilliger, the National Lead Co., an... poration of America did some drilling and other ... County, Va., but the only production known t... that of the American Rutile Co.

All three of the new operations are reported to be on nelsonite, a dike rock composed typically of rutile and apatite, although in some dikes other rock-forming minerals, such as feldspar and quartz, are also found.

If operations actually begin a quantity of apatite about equal in quantity to the ilmenite and of comparatively high purity will be produced. There is at present no known market for this phosphate, but it seems probable that some use may be found for it. Apatite is said to be less soluble in sulphuric acid and therefore more difficult to make into commercial fertilizers than the phosphates of the sedimentary rocks; when produced in a comparatively pure crushed form, however, it may form a profitable by-product.

Many bauxites carry considerable titanium dioxide, and Indian bauxite is reported to carry as much as 11 per cent of TiO_2. At the East St. Louis plant of the Aluminum Ore Co., a subsidiary of the Aluminum Co. of America, the waste sludge daily discharged from the treatment of bauxite contains more than 75,000 pounds of TiO_2. The results of experiments (see reference in bibliography on page 119) carried out by W. H. Coghill, of the U. S. Bureau of Mines, on deslimed sands carrying 24.33 per cent of TiO_2 encourage further work on gravity separation of the titanium dioxide.

The market for titanium minerals is very limited; sales are all at prices which are more or less a matter of bargaining. Ilmenite containing 50 per cent of TiO_2 was quoted by the Engineering and Mining Journal at $9.50 to $11 per long ton. Rutile in carload lots was quoted at 9½ cents per pound. The best artificial titanium dioxide was quoted at the beginning of 1928 at 44 cents per pound in 300-pound barrels and on June 1 at 35 cents.

WORLD PRODUCTION

The world production of titanium minerals in 1927 and 1928, as gathered from Government reports and other available sources, is shown in the following table.

World production of titanium minerals, 1927 and 1928, in metric tons

Mineral and country	1927			1928		
	Ore produced	Content of TiO_2	Value[1]	Ore produced	Content of TiO_2	Value[1]
Ilmenite:	*Metric tons*	*Per cent*		*Metric tons*	*Per cent*	
Brazil[2]	1,307	[3] 63	$25,737			
Canada (Quebec)	1,841	[3] 35	8,977	2,036	(4)	$6,726
India (Travancore)	18,095	[3] 54	162,567	(4)	(4)	(4)
Norway	5,733	43.6	44,802	(4)	(4)	(4)
Portugal	703	(4)	3,181	(4)	(4)	(4)
Senegal	5,200	[3] 50	16,323	2,110	[3] 50	6,624
United States	3,175	50	44,000	(5)	(5)	(5)
Rutile:						
Norway	45	90–93	14,006	(4)	(4)	(4)
United States	(5)	(5)	(5)	(5)	(5)	(5)

[1] Values as officially reported, converted to United States currency at the annual average rate of exchange as published by the Federal Reserve Board.
[2] Exports.
[3] Estimated.
[4] Data not available.
[5] Bureau of Mines not at liberty to publish figures.

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recently appeared.

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August 14, 1928.

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November 10, 1928, p. 4260.
"Lithopone production is now over 175,000 to
white lead and zinc oxide. Recent improvement
are reviewed. Texture is defined as freedom fr
aggregates, etc. Three tests for hiding power i
indirect tinting strength, cryptometer, and paint-o
and a method given. Relative hiding powers so
100 are as follows: American process ZnO 85–90
ZnS lithopone 135–140; ZnS and TiO_2 run betwe
testing texture and ease of mixing are given."

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lated density is 5.536. The data seem to indic
tronized."

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laboratory process. Chem. and Met. Eng.,
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Canadian Mining Journal. Canadian titanium

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Ind. (London), vol. 47, April 27, 1928, p. 301.
"The alloy (0.5–10 g.) is dissolved in aqua reg
with 5–20 c. c. of sulphuric acid (d 1.8) until cop
solution is cooled, diluted with 100 c. c. of cold w
carbonate, treated with 2 c. c. of sulphuric acid
thiosulphate, and poured slowly into 400 c. c. of b
1 to 2 minutes the liquid is cooled, filter pulp adde
washed with hot water, and ignited to titania. T
phate is stated to prevent precipitation of part of

Coghill, W. H. Titanium in bauxite ores and slu
Serial 2867, Bureau of Mines, 1928, 4 pp. Ch
p. 2341.
"Specific gravity (float and sink) fractionati
indicates that titanium oxide distribution is no
concentrate by gravity methods. Table concen
titanium was in a mixture of clay and bauxite, v
indicating its presence in minerals such as leucoxe
is a whitish, granular, flocculent mineral indist
amorphous $Al(OH)_3$, and xanthitane (a hydrous tit
earthy substance. A general distribution of tita
to accord with the well-known statistical informa
tenor of 0.77 per cent TiO_2. Much of it is too di

d'Ans, Jean and Sommer, Fritz. Titanium o
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"A titanium ore containing iron is reacted on wi
double the quantity of the ore and the reaction
about equal in quantity to the ore treated; the
to the action of a reducing agent such as iron
reduce $Fe_2(SO_4)_3$ to $FeSO_4$ and the latter is remov
tallization. The mother liquor is then heated t
under pressure to precipitate titanium oxide."

DITMAR, R. Titanium dioxide rubber enamels. Chem. Ztg., vol. 52, 1928, pp. 506–507. Chem. and Ind. (London), vol. 47, August 17, 1928, p. 614.

"Fine-grained titanium dioxide is very suitable for the production of snow-white and highly luminous, colored rubber enamels, since it has a better white-coloring power than, for example, zinc oxide, improves the rubber material, and, unlike coloring agents containing zinc, is nonpoisonous. Such enamels may be produced from vulcanized rubber, since the latter is rendered very plastic and adhesive by the titanium oxide. By the use of sulphur monochloride vapor the enamels may be vulcanized in 6 minutes instead of the usual 34–44, giving well-aged and more durable products."

EVENSON, O. L., and MCCUTCHEN, D. T. Use of buffers in the determination of color by means of titanium trichloride. Ind. and Eng. Chem., vol. 20, 1928, p. 861.

"The color content of Amaranth may be determined by titration with titanium trichloride in the presence of sodium citrate, sodium bicarbonate, or potassium antimony tartrate. That of Ponceau 3R may be determined by titration with titanium trichloride in the presence of sodium citrate or sodium bicarbonate. Orange I may be titrated in the presence of sodium citrate, sodium bicarbonate, or the tartrates, except potassium antimony tartrate. The correct buffer salt must be determined for each dye."

GARDNER, D. Paints, enamels, japans, etc. U. S. Patent 1662741, March 13, 1928. Chem. Abs., vol. 22, April 20, 1928, p. 1485.

"An anhydrous colloidal lead-free paint, enamel, japan or like composition, contains a pigment (such as TiO_2 and titanium 'trioxide') comprising a base constituent and at least one filler constituent in which the oxide of the base constituent is positively charged relatively to the charge carried by the oxide or oxides forming the filler; all the constituents introduced into the vehicle may be compounds of the same metal as that in the case. Titanium borate may be used as a drier."

GESTETNER, D. Stencil sheet. U. S. Patent 1664675, April 3, 1928. Chem. Abs., vol. 22, May 20, 1928, p. 1832.

"A white titanium pigment is used in the coating applied to yoshino or similar paper, the coating may also contain gellatin and glycerol."

GILMORE, L. E. Effect of various elements on malleable cast iron. Trans. Am. Foundrymen's Assoc., vol. 36, 1928, pp. 287–292. Chem. Abs., vol. 22, July 20, 1928, p. 2535.

"The elements present in ordinary malleable iron are: Iron, phosphorus, manganese, sulphur, silicon and oxygen. In solution phosphorus is harmless, but iron phosphide causes brittleness and loss of strength. The manganese-sulphur ratio must be carefully controlled with manganese in slight excess, but the absolute amounts are not so important. Low carbon with high silicon makes the strongest and most ductile iron. Titanium, nickel, uranium and zirconium act like silicon in precipitating carbon. Inhibitors of graphitization are abnormal amounts of sulphur or manganese and antimony, boron, cerium, chromium, molybdenum, selenium, tellurium, tin and vanadium. Malleable iron should be regarded as a mixture of compounds and interacting elements which, when properly balanced, determine the quality of the iron."

INDUSTRIAL AUSTRALIAN AND MINING STANDARD. Tasmania's mineral industry. IX. Paint materials. Vol. 80, 1928, p. 227.

As in most countries, rutile and ilmenite are found in small quantity at various places. The principal deposit is that at Naracoopa, King Island, at the mouth of the Fraser River. The sea sand here contains ilmenite, SnO_2, gold, monazite, molybdenite, etc., ilmenite and SnO_2 being most plentiful. The enriched portion appears to be about half a chain in width, lessening toward the seashore. The depth of the deposit varies slightly, its average being about 8 feet. The surface is but 6 feet above high-water mark. The highest assay in TiO_2 from the most finely divided material of the magnetic product of the sand is 44.88 per cent. The results of some tests carried out on the black sand are appended below:

	Magnetic product, per cent	TiO_2, per cent	Fe, per cent.
On 60 mesh	3.12	11.80	6.
On 80 mesh	20.08	30.16	14.
On 100 mesh	31.37	43.52	21.
On 120 mesh	20.32	44.56	26.
Through 120 mesh	12.51	44.88	33.

The land is held under lease 9620/M at p
Bowling.

The Arthurs Lake deposit consists of ilmenit
floor of the upper lake. An analysis of a cl
25.75 per cent of titanium.

———. Vol. 79, 1928, p. 512.

"A substantial deposit of ilmenite, assaying 4
reported to have been discovered within 40 m
is endeavoring to secure its commercial exploit

JOHNSON, J. Y. Destructive hydrogenation of
Patent 300703, 1928. Chem. Age (Lond
p. 589.

"Catalysts for the hydrogenation of coal, tar
tion, and conversion products at high tempera
silicon, titanium, vanadium, tantalum, molybc
combined, or cobalt in a combined state, togeth
of copper and zinc (or cadmium) either in a fr
sure is above 50 atmospheres and the temperat
of hydrogen is employed or mixtures or compo
used. The apparatus is preferably composed o
alloys. The carbonaceous material is exposed
through which the hydrogenating gas passes
sprayed into the gas."

LEHMANN, K. B., and HERGET, L. Hygienic p
"titanium white." Chem. Ztg., vol. 51,
Ind. (London), vol. 47, February 3, 1928,

Titanium dioxide proved harmless when a
over periods up to 16 months, and titanium wh
nonpoisonous pigment. Methods for the ana
are described.

LUBOWSKY, SIMON J., assignor to Metal & T
transforming titanium-dioxide or rutile
Patent 1640952, August 30, 1927.

"Rutile, ground to 150 mesh, is intimately
magnesium oxide, preferably dead-burned m
The mixture is then transferred to a kiln, f
approximately Seger cone 18, until a hard sen
calcined mass is then ground to about 150 mes
to approximately 90° C. with sulphuric acid
parts acid to 1 part of the calcined product by
stirred or agitated. This produces an exoth
product combines with the sulphuric acid a
added in the proportions of about 2 parts by
acid employed and the whole stirred until a cl
which solution contains the titanium values in
whatever titanium compound may be desire
solution and boiling the filtrate, a brilliant whi
is obtained, which, when calcined, is converte
extremely fine texture and excellent covering

MEIER, C. Ferrous alloy. U. S. Patent 1662
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"An alloy adapted for casting in permanent e
with carbon 2–4, silicon 2.5, 60 per cent chrom
0.5–1.0, manganese 0.5–3.0 and phosphorus 0.

OSBORNE, F. F. Certain magmatic titaniferou
Geol., vol. 23, 1928, pp. 741–745.

PILLING, N. B., and SCHOENER, J. G., assign
(Inc.). Welding rod. U. S. Patent 167
Ind. (London), vol. 47, October 12, 1928,

"A welding electrode comprises a nickel rod r
of an alkaline-earth metal and coated with a
and a calcium alloy in such proportions tha
0.1–10 per cent and the calcium 0.1–8 per cen

RUDGE, ERNEST A., and ARNALL, FRANCIS. "Titanium cyanonitride" and the titanium oxychlorides. Chem. and Ind. (London), vol. 47, 1928, pp. 376T–380T.

"The copper-colored crystalline compound of titanium produced during the blast-furnace process for the manufacture of iron is titanium nitride, of the empirical formula TiN. It is intimately admixed with graphite, a circumstance which has probably given rise to the fact that it has been regarded as a cyanonitride of the formula $Ti(CN)_2.3Ti_3N_2$ (Wöhler, 1850).

"The crystalline compound obtained by the action of chlorine on this substance is an oxychloride of titanium and not a cyanochloride, $2TiCl_4$, CNCl. The constitution of the oxychloride is correctly represented by the formula $3TiCl_4$, TiO_2."

SPENCE & SONS (LTD.). Preparation of titanium compounds and pigments. British Patents 290683 and 290684, November 17, 1926. Chem. and Ind. (London), vol. 47, August 3, 1928, p. 568.

"Titanium phosphate is prepared by addition of a soluble phosphate to a solution of a titanium salt containing more than 10 per cent of titania and more than 15 per cent of free sulphuric acid or its equivalent. To obtain a precipitate that filters readily, a temperature of 50° must not be exceeded. Titanium phosphate is converted into hydroxide or oxide by heating with alkali carbonates or hydroxides either in aqueous solution or in powder form. The soluble alkali phosphate is removed by leaching. To obtain colored pigments, the titanium phosphate may be calcined with salts of a colored base with a volatile acid—e. g., ferrous sulphate for red pigments or barium sulphate and ammonium dichromate for green pigments."

STANSFIELD, ALFRED. Smelting titaniferous ores of iron. Emp. M. & M. Cong. Proc., 1927, pp. 552–569.

VINASSA, PAOLO. Molecular number. Gazz. chim. ital., vol. 58, 1928, pp. 178–180. Chem. Abs., vol. 22, July 20, 1928, p. 2499.

"In drawing the general conclusion that nearly all compounds, whether natural or synthetic, organic or inorganic, have even molecular numbers, certain important exceptions must be recognized. Among inorganic compounds with uneven molecular numbers, compounds of manganese, cobalt, chromium, copper, cerium, molybdenum and iron predominate, with a few compounds of titanium, iridium, mercury, chlorine, phosphorus, nitrogen, tin, nickel, ruthenium, vanadium, tungsten, uranium, gallium, neodymium, and praseodymium. Only a small proportion of the elements form compounds with uneven molecular numbers. Extremely few organic compounds have uneven molecular numbers."

TUNGSTEN

UNITED STATES

In 1928 tungsten miners of the United States sold an equivalent of 1,208 short tons of concentrates carrying 60 per cent of tungsten trioxide (WO_3) for $753,900, and of these sales, 180 tons came from stocks. Very little stock was held at the end of 1928, and the production for the year was somewhat less than the sales in 1927, which amounted to 1,164 tons, valued at $724,000. Tungsten ore was produced and sold in 1928 by 12 companies. Eight of these companies, employing 210 men, produced 93 per cent of the total output.

The tungsten production of the United States during the last 10 years has been as follows:

Concentrated tungsten ores (reduced to equivalent of 60 per cent WO_3) produced in the United States, sold in 1919–1928, and average price per unit

Year	Short tons	Value	Average price per unit	Year	Short tons	Value	Average price per unit
1919	327	$353,900	$18.02	1924	[1]505	[2]$287,000	$8.47
1920	216	101,800	7.86	1925	1,191	765,500	10.57
1921				1926	1,382	920,400	11.10
1922				1927	1,164	724,000	10.37
1923	241	144,600	[1]10.00	1928	1,208	753,900	10.40

[1] The output of 1923 was made by one company only, which sold to its owners at a price considerably above the market.
[2] Includes 191 tons produced in 1919, sold in 1924 for $87,000.

Prices in the United States ranged between $10
centrates of good quality. Many tons of concentr
28 to 55 per cent of WO_3, and prices for the lower g
$4.25 per short ton unit (20 pounds of WO_3). V
from $3.25 to $4 per long ton unit (22.4 pounds
trates carrying 65 per cent or more of tungsten t

Arizona.—In Arizona the Minerals Conversion
erected a small mill in the Tip Top district, and
was produced; the Tungsten Production Co. (Inc
did some prospecting for scheelite in the Huachu
Edward C. O'Brien & Co. erected a small mill at
tungsten ores of the region.

California.—The Atolia Mining Co. worked th
placer deposits and the dumps from the East Un
The placers carry only about 2 pounds of concentr
and the East Union dumps yield about 10 pounds
ton. Such material, of course, can be made to
operation. During the year the Capitola Mining
work near Atolia. Cooper Shapley was in cha
tactite deposits at Round Valley, near Bishop, a
of scheelite was made. Beauregard Bros. prospect
in the Chedago district, 20 miles north of Bishop

Colorado.—Near Nederland, Boulder County,
duction Co. (Inc.), the Wolf Tongue Mining Co., t
Co., the Molybdenum Corporation of America, C
the Ferberite Tungsten Mines (Inc.) all operat
the year. It is probably fair to say that mos
during the year was prospecting for new ore bo
the known ore bodies have been worked out,
bodies have been found.

Missouri.—The Ozark Tungsten Co. and Edwa
mined a little wolframite in sec. 23, T. 33, R. 5 E
about 10 miles west of Fredericktown.

Nevada.—The Nevada-Massachusetts Co., in
tains 12 miles northwest of Mill City, was the
tungsten concentrate in the United States in 192
several years past. The ore is tactite (a cont
limestone) carrying scheelite. The concentrate
and carry about 70 per cent of WO_3. About 50 m
the mine and 12 around the mill. Alex Ranson
mined in 1927 from a vein, the Silver Dyke, 9
Mina. As the water supply was inadequate to
he moved to a deposit near Quartz Mountain in
Massachusetts Co. is also interested; this deposi
gray scheelite replacing limestone. The compa
are reported to have purchased from Garrett
deposit on Jew Mountain, 43 miles northeast of
The Tungsten Production Co. (Inc.), of Boul
work on the tactite on the east side of the Nig
which follow the east shore of Lake Winnemucc

South Dakota.—The Homestake Mining Co. c
wolframite deposits at Lead until November 1,
exhausted. Prospecting in the vicinity of the o
on Yellow Creek, 2 miles south of Lead, is unde
little encouragement.

Among the other countries producing small amounts of tin in 1928 or developing tin deposits are Portugal, Spain, Japan, French Indo-China, Canada, Mexico, Russsia, Germany, Czechoslovakia, Argentina, and France.

WORLD'S TIN SMELTERS

Name, location, control, and capacity of the world's tin smelters in 1928

Smelter	Location	Control	Capacity (long tons) [1]
Straits Trading Co.	Singapore and Butterworth, Straits Settlements.	British	65,000
Williams-Harvey	Liverpool, England	Bolivian	45,000
Eastern Smelting Co.	Penang, Straits Settlements	British	25,000
----------	Netherland East Indies	Dutch	25,000
----------	Redruth, Cornwall	British	15,000
----------	----------	German and others	8,000

[1] Annual production of pig tin as reported in Mining Magazine (London), vol. 39, August, 1928, p. 86.

LEAD AND ZINC PIGMENTS 'A

By Elmer W. Pehrson [1]

SUMMARY

The value of lead and zinc pigments and zin
ducers in 1928 amounted to $98,000,000, or 1
1927. Lead pigments accounted for 54.5 per cen
zinc pigments 43.5 per cent, and zinc salts 2 per
lead pigments sold in 1928 decreased 6 per cen
pigments increased 6 per cent, and the value of
1 per cent.

The quantity of lead pigments sold by produce
to 297,734 short tons, an increase of about 1
Sales of litharge, dry white lead, basic lead sul
increased substantially; sales of white lead in
cent and accounted for 38 per cent of the tot
pigments sold; and sales of orange mineral de
but represented an unimportant part of the tota

The quantity of zinc pigments sold in 1928 a
tons, an increase of 9 per cent over 1927. Sales o
13 per cent, zinc oxide increased 6 per cent, wh
decreased 7 per cent.

Sales of zinc chloride (50° Baumé) amoun
tons, an increase of 8 per cent; sales of zinc su
2,293 tons as compared with 3,211 tons in 1927.

Quoted prices of white lead in oil and basic
constant throughout the year at figures equal to
price ranges. The quotation on dry white lead
first 10 months of the year and then dropped
per pound, notwithstanding a general upward
of lead during most of the year. Litharge, re
mineral fluctuated with the price of lead, and
quotations at the same level as at the beginning
of zinc oxide was constant throughout the yea
The price of lithopone was steady but sligh
quotation.

Imports of lead pigments decreased in 1928
unimportant. Exports, however, increased in
value and amounted to 3 per cent of the total
domestic producers. The principal exports w
red lead.

[1] The statistics in this report were prepared (unless otherwise indicated) on imports and exports were compiled from records of the Bureau of Fo by J. A. Dorsey, both of the Bureau of Mines.

Imports and exports of zinc pigments as a whole increased in both quantity and value. Imports were equivalent to 3 per cent and exports 5 per cent of the domestic sales. Lithopone was the principal import and ranked second in exports, while zinc oxide was the principal export and ranked second in imports.

An outstanding feature of the lead and zinc pigment industry during the last few years has been the severe competition between white lead and other pigments for the paint trade. The effect of this is roughly indicated in the comparative sales of the pigments concerned. Sales of white lead in oil decreased from 153,000 tons in 1922 to 112,000 tons in 1928. During the same period the combined sales of zinc oxide and lithopone increased from 212,000 tons to 361,000 tons. As three-fourths of the lithopone and about one-third of the zinc oxide produced in the United States are used in the manufacture of paints, these figures indicate the marked degree to which the zinc pigments have invaded the paint industry at the expense of white lead.

The rapid expansion in the use of nitrocellulose paints in recent years has not materially altered the quantity of pigments consumed. The average nitrocellulose paint contains considerably less pigment per gallon than oil paints, but a heavy pigment priming coat and more finishing coats are used to offset the low pigment content. White lead is seldom used in these paints owing to its chemical instability in contact with nitrocellulose products. Zinc oxide and lithopone are the pigments generally used in nitrocellulose paints at the present time, but as a low pigment content is desirable an increased use of high hiding-power pigments, such as titanium oxide and zinc sulphide, is a possibility for the future.

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. The total value of lead and zinc pigments and zinc salts sold by domestic producers in 1928 was approximately $97,974,000, as compared with $99,026,000 in 1927 and $106,253,000 in 1926. The following tables show the production of lead and zinc pigments and zinc salts as reported to the Bureau of Mines:

Lead pigments sold by domestic manufacturers in the United States, 1919–1928, in short tons

Year	White lead		Basic lead sulphate or sublimed lead		Red lead	Orange mineral	Litharge
	Dry	In oil	White	Blue			
1919	30,085	109,005	9,068	1,350	[1] 32,362	(1)	46,739
1920	33,078	112,017	12,412	928	[1] 34,431	(1)	62,329
1921	26,738	143,545	11,568	463	21,805	381	41,909
1922	41,598	153,393	13,765	972	30,509	370	58,261
1923	37,786	125,087	11,949	800	38,037	646	75,107
1924	42,622	144,872	14,572	1,088	36,813	331	74,724
1925	43,420	120,479	14,096	1,090	41,669	840	86,546
1926	37,068	111,845	12,271	1,236	42,550	813	82,640
1927	38,669	119,026	13,482	1,061	39,073	709	81,055
1928	42,049	111,923	16,002	1,234	40,497	459	85,570

[1] Figures for red lead include orange mineral prior to 1921.

Lead pigments sold by domestic manufacturers in the United

	1927			
	Short tons	Value (at plant, exclusive of container)		Short tons
		Total	Average	
Basic lead sulphate or sublimed lead:				
White	13,482	$2,027,333	$150	16,
Blue	1,061	168,410	159	1,
Red lead	39,073	6,980,042	179	40,
Orange mineral	709	178,467	252	
Litharge	81,655	13,064,046	160	85,
White lead:				
Dry	38,669	6,767,385	175	42,
In oil	119,026	27,770,000	233	111,

Zinc pigments and salts sold by domestic manufacturers in th 1928, in short tons

Year	Zinc oxide	Leaded zinc oxide	Lithop
1919	117,639	27,591	78,
1920	99,444	30,460	89,
1921	74,329	16,103	55,
1922	128,466	19,613	83,
1923	126,987	23,504	98,
1924	131,470	26,729	109,
1925	151,354	31,750	145,
1926	146,923	23,859	159,
1927	151,246	20,064	176,
1928	160,904	24,223	200,

[1] Figures cover production, not sales.

Zinc pigments and salts sold by domestic manufacturers in and 1928

	1927			
	Short tons	Value (at plant, exclusive of container)		Sh to
		Total	Average	
Zinc oxide [1]	151,246	$19,887,212	$131	160
Leaded zinc oxide [1]	20,064	3,193,014	123	24
Lithopone	176,994	17,163,620	97	200
Zinc chloride, 50° Baumé	36,096	1,640,446	45	38
Zinc sulphate	3,211	185,865	58	2

[1] Zinc oxide containing 5 per cent or more of lead is classed as leaded zinc

Statistics for lead arsenate, lead acetate, zinc stearate, and other lead and zinc salts and compounds are collected biennially by the Bureau of the Census for odd years. The following tables show the production (exclusive of pigments) during the past few years.

Lead acetate, lead arsenate, and other lead salts (exclusive of lead pigments) produced in the United States, 1919, 1921, 1923, 1925, and 1927

Year	Lead acetate			Lead arsenate		Other salts
	Total production	Produced for sale				
	Short tons	Short tons	Value	Produced for sale (short tons)	Value	Value
1919	2,566	2,092	$552,435	5,733	$2,000,341	$335,900
1921	1,408	372	90,305	4,615	1,629,446	120,327
1923	2,753	616	160,133	5,378	2,229,431	388,868
1925	3,432	1,251	359,686	5,969	1,777,552	192,995
1927	(1)	1,508	395,122	[2] 10,764	[2] 3,100,257	254,809

[1] Not given.
[2] The statistics for 1927 are not comparable with those for preceding years as the figures prior to 1927 do not include data for the production reported by establishments engaged primarily in the manufacture of patent and proprietary medicines and compounds.

Zinc stearate and other salts and compounds of zinc (exclusive of zinc pigments, zinc chloride, and zinc sulphate) produced in the United States, 1923, 1926, and 1927

Year	Zinc stearate		Other salts and compounds, value
	Short tons	Value	
1923	227	$107,319	$410,913
1926	393	169,051	420,944
1927	391	164,927	376,666

COMPETITION BETWEEN PIGMENTS

Throughout the nineteenth century white lead was used almost exclusively as the pigment base in the manufacture of paints, but during the last 25 years its dominant position has been challenged by the competition of zinc oxide and lithopone. The increasing use of these two pigments, particularly lithopone, is due to their lower first cost and to the constantly improved properties that have been attained as a result of scientific research on the part of the producers. Production of lithopone has increased from less than 30,000 tons in 1913 to more than 200,000 tons in 1928, three-fourths of which is used in the manufacture of paint.

Another influencing factor in the pigment industry has been the development of nitrocellulose paint, lacquer, and enamels. Nitrocellulose paint was developed for use in the automotive industry, in which the practice of mass production required a satisfactory paint that would dry quickly and thus assist in speeding up the production process. During the past few years, however, its use has extended to many other branches of industry; in 1927 more than 11,000,000 gallons of nitrocellulose paint, lacquer, and enamels were produced. This represents between 10 and 15 per cent of the total volume of

paint and varnish produced in the United States 40 per cent over 1926. Although it is impossibl the effect of this product on the mineral pigment of interest may be noted. First, the growing paint is limiting the field of white lead, which is on account of its chemical instability in contac products. Lithopone, zinc oxide, and titanox ar titanox being a recent development. The seco is that, notwithstanding the lower pigment co nitrocellulose paint, there probably will be no m quantity of pigment used per unit of painted surf pigment base coat and more finishing coats are r

Titanium pigments have been increasing in especially since the development of titanox. T per cent of titanium oxide and 75 per cent of ba claimed that this pigment excels the lead and zin power and inertness; consequently, it is finding with the nitrocellulose paint manufacturers. In chiefly in interior enamels and mixed with zi paints. Used alone in exterior paints it has not a tory. Extensive development of titanium pigm been retarded by limited sources of raw materi production; recently, however, new sources and developed, and it now appears that titanium wi lead and zinc pigments. The fact is significan Lead Co., one of the most important pigment pro States, has secured a commanding position in field.

The poisonous qualities of white lead have lon much discussion which at times has resulted in against its use, particularly in France and Bel 1928, a royal decree was issued in Spain which November, 1928, the use of paints containing mo lead for interiors would be prohibited except authorized by the Ministry of Labor. It also pr preparations containing lead must be labele legislation of this nature has as yet developed in

In the lead and zinc pigment industry white le ized as competing against the field. Although th competition on the consumption of white lead i can not be accurately gaged, undoubtedly the pr lead industry has been seriously hampered. T and lithopone will probably increase with further paint, in which white lead is seldom used. Leg tending to restrict the use of lead paints on acc ous qualities. Further development of tita probably provide competition for both lead and pigments bearing the brunt on account of their h

A red pigment known as minium of alumin factured in France by dehydrating, grinding, an grades of bauxite. This pigment has been used the railways of France as a substitute for red le with oil it is said to have a greater covering powe

Zinc sulphide has long been noted for its excellent pigment qualities and is one of the principal constituents of lithopone. Its use unmixed as a pigment, however, has been very limited in the past owing to its comparatively high cost, but recently it has been used in increasing amounts. In 1928 the production of zinc sulphide for market was reported, but the amount produced can not be disclosed as disclosure would divulge confidential information. Imports increased from 132,000 pounds in 1927 to 338,000 pounds in 1928.

CONSUMPTION OF LITHOPONE

Through the cooperation of the producers of lithopone the Bureau of Mines is able to show the distribution of lithopone sales in 1927 and 1928.

Distribution of lithopone sales by industries, 1927 and 1928

	1927		1928	
	Short tons	Per cent	Short tons	Per cent
Paints, varnish, lacquers	131,145	74.1	149,122	74.4
Floor coverings and textiles	31,186	17.6	35,416	17.7
Rubber	7,653	4.3	6,898	3.4
Other uses	7,010	4.0	9,032	4.5
	176,994	100.0	200,468	100.0

Lithopone producers reported an annual productive capacity of 202,000 tons at the end of 1927 and 227,000 tons at the end of 1928.

SOURCE

The following table gives the quantity and source of the lead and zinc contained in the pigments and salts produced in the United States in 1927 and 1928. It shows that in 1928, 96 per cent of the lead in lead pigments was derived from pig lead, 4 per cent from ore, and less than ½ per cent from secondary material. For zinc pigments the proportions were 70 per cent from ore, 21 per cent from metal, and 9 per cent from secondary material. The zinc in zinc salts is derived largely from secondary material.

Metal content of lead pigments and zinc pigments and salts produced by domestic manufacturers, 1927 and 1928, by sources, in short tons

Source	1927			1928		
	Lead in pigments [1]	Zinc in—		Lead in pigments [1]	Zinc in—	
		Pigments	Salts		Pigments	Salts
Domestic ore	13,136	121,899	47	10,465	123,904	126
Metal	242,713	34,008	4	242,914	37,584	4
Secondary material [2]	1,246	13,972	9,544	654	14,890	10,463
	257,095	169,879	9,595	254,033	176,438	10,593

[1] Includes also lead recovered in zinc oxide and leaded zinc oxide. The metal content of lead acetate and lead arsenate is not available, as no canvass of their production is made by the Bureau of Mines. Moreover, these salts are derived from pig lead, and their metal content has already been taken into statistical account in the figures covering lead production.
[2] Zinc ashes, skimmings, drosses, and old metal.

The American Bureau of Metal Statistics repor
ing quantities of zinc materials were used in
lithopone in 1928: Roasted ore, 35,805 tons; galva
tons; and zinc oxide and fume, 8,000 tons. I
amount of slab zinc was used which was omitt
accounting to avoid disclosing confidential informa

PREPARATION AND USE

WHITE LEAD

White lead is the basic carbonate of lead an
most important of the white pigments used in oi
erties of white lead that contribute to its usefuln
very great hiding power and the facility with wh
can be worked with a brush. Owing to its relat
and the fact that white-lead paints are blackened
taining sulphur, the use of less-expensive zinc oxi
paint pigments has increased during recent yea
retarded expansion of the white-lead industry.

The largest part of the white lead manufact
States is produced by the "stack" or old Dut
perforated disks of high-grade metallic lead, call
inches in diameter, are placed in small clay pots,
well in the bottom containing dilute acetic ac
arranged in tiers within a large room. Each t
boards and a layer of spent tanbark. The lead
basic carbonate by the action of acetic acid va
CO_2 and the heat necessary to vaporize the aceti
by the fermentation of the tanbark. The pro
three to four months for completion. The cor
are washed, crushed, screened, and ground in wa
either dried to form dry white lead or ground wit
to form the oil pigment. In the United States
of the product is ground in oil.

Some white lead is also made by the Carter pro
lytic process. In the former metallic lead is fin
of steam and is then treated with dilute acetic aci
in slowly rotating wooden cylinders. The proc
about 12 days.

In the electrolytic process a lead anode and
used, each of which has an independent conti
electrolyte kept separate by a porous diaphragm
are solutions of sodium acetate containing sodiu
anolyte contains the exact amount of carbonate
itate the basic lead carbonate, whereas the catho
tively large amount of carbonate. During elect
solves at the anode surface and is immediately
basic carbonate in suspension in the anolyte. A
is generated at the cathode, passes through t
replaces the CO_2 precipitated with the lead, th
anolyte at a constant concentration. The catho
a carbon-dioxide absorption tower where it is res
strength. The basic lead carbonate is filtered
washed, dried, and barreled.

It is estimated that more than 85 per cent of the white lead produced in the United States is used in the manufacture of paint. It is the only important white pigment that is used unmixed with other pigments in oil paints; it is also used in varying proportions in many mixed pigments. The dry white lead is used in paints, as a constituent of the glaze used in the finer grades of pottery, and to some extent in the manufacture of rubber.

The United States produces an export surplus of about 6,000 tons annually, most of which is manufactured in bond from foreign lead.

BASIC LEAD SULPHATE

Basic lead sulphate is also known as sublimed lead and is marketed in two forms, "white" and "blue." The white variety is usually made by vaporizing powdered galena at a high temperature in the presence of air, which oxidizes it to the basic sulphate. The resultant fume is collected in bags, and owing to the zinc content of the ore used it usually contains about 5 per cent of zinc oxide. This product is usually not as white as basic carbonate white lead but has a more stable color in the presence of sulphur gases. It is used chiefly in the manufacture of prepared paints and mixed pigments. A small amount is used in the manufacture of rubber. Some sublimed lead is made from pig lead.

The blue variety is generally a by-product of the smelting of pig lead and is collected from the fumes leaving the smelting furnaces. Its color is due to small amounts of carbon and lead sulphide. Paints made from blue lead are especially useful as protective coatings on metallic surfaces. Some blue lead is also used in the manufacture of rubber.

LITHARGE

Litharge is the monoxide of lead and is produced by the oxidation of molten lead at a moderate temperature in a reverberatory furnace. The oxide forms on the surface of the molten metal and is raked off into iron pots. The texture and color of the litharge, which affect its use in the various industries, are controlled by the temperature of the furnace and the method of cooling. The chief use of litharge is in the manufacture of storage-battery plates. The negative plates are usually made of straight litharge, whereas the positive plates are a mixture of red lead and litharge. It is estimated that more than half the litharge produced in the United States is used in the battery industry. The second largest use of litharge is in the rubber industry where it acts as a cure accelerator and toughener in the production of mechanical rubber goods and rubber clothing. Other uses are in the manufacture of lead-chromate color pigment, in the refining of petroleum products, in the manufacture of insecticides, pottery glaze, and enamel ware, in making glass, and as a drier in the manufacture of varnish and linoleum.

RED LEAD

Red lead is the tetroxide of lead and is made by heating powdered litharge at a moderate temperature in a "coloring oven." The marketed product varies in composition, averaging about 85 per cent pure red lead and 15 per cent litharge; the latter is unchanged

in the process of manufacture. About two
duction is used in the manufacture of stora
an important pigment in paints used as a pr
surfaces and accounts for the familiar orange
all steel construction. Red lead is the mos
compounds used in the production of flint
also used in potter's glaze, enamel ware, and
facture of varnish.

ORANGE MINERAL

Orange mineral is a form of red lead; it
composition but differs in physical properties
gravity and lighter color. It is usually mad
under a process that requires great care a
the price is higher than that for any of t
Orange mineral is used chiefly in the man
vermilion color pigment known as eosin la
production of printer's inks and enamels.

ZINC OXIDE

Zinc oxide, the monoxide of zinc, is made
United States—the French and the America
lic zinc is heated in a current of air, and th
collected in long chambers. The product is
fineness and is labeled "white seal," "gre
The white-seal variety is the finest and wh
gravity is much lower than the specific gravi
It is used chiefly in high-grade enamel pai
seal are the intermediate and heavy grades,

American process zinc oxide is made by h
ore and anthracite coal to produce a meta
turn is treated with air to form the oxide. T
in bag houses. As lead is usually present
oxide contains some lead compounds. It
white as French oxide but in other respec
American process of making zinc oxide pre
States.

Zinc oxide has been used as a paint pigm
for several centuries, but the increase in p
States during the twentieth century has been
of the rubber industry. In an estimate ma
use of zinc oxide in the various industries v

	Per cent		
Rubber	53	Ceramics	
Paints and enamels	33	Miscellan	
Oilcloth and linoleum	5		
Exports	4		

Zinc oxide is used in the manufacture of ru
ficial properties it imparts to rubber. It inc
and the resistance to abrasion and tear
qualities by counteracting the tendency of ru

[1] Chemical and Metallurgical Engineering, vol. 33, January, 192

under action of light and heat. All of these properties are essential in making automobile tires, tubes, and accessories, which represent about 75 per cent of the entire rubber industry.

Zinc oxide is seldom used alone as a paint pigment as it dries to a hard smooth surface which on aging tends to crack and peel off, leaving an unsatisfactory surface for repainting. It has a more stable color and costs less than white lead, has excellent white color and covering properties, and is durable. These many advantages make zinc oxide a useful constituent of mixed paints, in which it finds a large usage. It is generally mixed with lithopone, white lead, and inert pigments.

Zinc oxide is also used in the manufacture of oilcloth and linoleum, pottery glazes and glass, celluloid, druggists' supplies, printer's inks, leather finishes, and for many other purposes.

The United States produces an exportable surplus of about 13,000 tons annually.

LEADED ZINC OXIDE

Leaded zinc oxide is made by a method similar to the American process of making zinc oxide. The ore used contains lead in varying proportions, and the finished product may contain from 5 to 35 per cent of basic lead sulphate. The properties of this pigment are similar to those of zinc oxide and basic lead sulphate. It has fair hiding power but is not so white as American process zinc oxide. Leaded zinc oxide is used chiefly in the manufacture of paint.

LITHOPONE

Lithopone is the newest of the important white pigments, and its introduction into the United States dates back to the close of the nineteenth century. It contains about 70 per cent of barium sulphate and about 30 per cent of zinc sulphide. The latter, a powerful pigment, is responsible for the useful pigment qualities of lithopone. The process of manufacture consists in mixing proper proportions of solutions of barium sulphide and zinc sulphate. The resulting precipitate is heated to a red heat and plunged into cold water, after which it is ground, dried, and powdered.

The use of lithopone in the United States has increased rapidly and has spread to many industries. Its chief use is in paint manufacture, in which it is favored on account of its low cost and many good qualities. Formerly the use of lithopone was confined to interior paint, as the pigment would discolor in sunlight. In recent years, however, the refining process has been changed, and it is claimed that lithopone with a stable color suitable for exterior paints is now being produced. It is generally mixed with other pigments, notably zinc oxide.

A large quantity of lithopone is used in the manufacture of oilcloth and linoleum, artificial leather finishes, window shades, and printer's inks. The distribution of the 1927 and 1928 sales of lithopone is given on page 352.

The United States has a small excess of lithopone imports over exports.

ZINC SALTS

Zinc sulphate, sometimes known as white vit
by treating secondary zinc material with di
which upon evaporation yields the white crysta
to some extent in calico printing and in dyeing,
oil, as a disinfectant and astringent, and as a si
to painting. In addition to these uses, severa
used yearly in the manufacture of lithopone, b
an intermediate product it is not separately rec
of Mines.

Zinc chloride may be prepared by treating
chlorine or with hydrochloric acid, the latter
used. Practically all zinc chloride produced i
is made from scrap metal or secondary materi
ashes, skimmings, and galvanizer's scrap. Owi
properties it is usually marketed in solution, alt
may be obtained in air-tight containers. Zi
chiefly as a preservative of timber but is also
and disinfectant, in the refining of petroleum, in
in the manufacture of hard fiber, for medic
dentistry.

PRODUCERS AND PLANT

The following companies reported sales of lea
and zinc salts of their own production in 1928.

White lead:

Anaconda Lead Products Co. (electrolytic process)	East
Carter White Lead Co	Wes
E. I. du Pont de Nemours & Co	Phil
Eagle-Picher Lead Co	East
Do	Cinc
Euston Lead Co	Scra
W. P. Fuller & Co	Sout
John T. Lewis & Bros. Co	Phil
National Lead Co. of California	Mel
National Lead Co	Chic
Do	St. I
Do	Broo
Do	Port
Do	Cinc
National Lead & Oil Co. of Pennsylvania	New
Sherwin-Williams Co	Chic
United Lead Co	Perth
Wetherill & Bro	Phil

Basic lead sulphate, or sublimed lead:

Eagle-Picher Lead Co	Gale
Do	Jopli
St. Louis Smelting & Refining Works of National Lead Co	Colli

Red lead, orange mineral, and litharge:

Eagle-Picher Lead Co	East
Do	Jopli
Do	New
Do	Cinc
Evans Lead Co	Char
Franklin Lead Oxide Co	Fran
W. P. Fuller & Co	Sout
Grasselli Chemical Co	East

Red lead, orange mineral, and litharge—Continued.	
Harshaw Chemical Co	Cleveland, Ohio.
John T. Lewis & Bros. Co	Philadelphia, Pa.
Metals Refining Co	Hammond, Ind.
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.
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.
Eagle-Picher Lead Co	Hillsboro, Ill.
Empire Zinc Co	Canon City, Colo.
Grasselli Chemical Co	East Chicago, 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.
Lithopone:	
Chemical & Pigment Co. (Inc.)	Oakland, Calif.
Do	Collinsville, Ill.
Do	St. Helena, Md.
E. I. du Pont de Nemours & Co	Newark, N. J.
Do	Philadelphia, Pa.
Eagle-Picher Lead Co	Argo, Ill.
Grasselli Chemical Co	Grasselli, N. J.
Krebs Pigment & Chemical Co	Newport, Del.
Mineral Point Zinc Co	Depue, Ill.
New Jersey Zinc Co. (of Pennsylvania)	Palmerton, Pa.
Sherwin-Williams Co	Chicago, Ill.
United Color & Pigment Co	Newark, N. J.
Zinc salts:	
Arkansas Preservative Co	North Little Rock, Ark.
Charles Cooper & Co	Newark, N. J.
General Chemical Co	Chicago, Ill.
Grasselli Chemical Co	East Chicago, Ind.
Do	Grasselli, N. J.
Do	Cleveland, Ohio.
Do	Weirton, W. Va.
Harshaw Chemical Co	Cleveland, Ohio.
Charles Lennig & Co. (Inc.)	Philadelphia, Pa.
Merrimac Chemical Co	Everett, Mass.
Monsanto Chemical Works	Monsanto, Ill.
Ozark Smelting & Mining Co	Coffeyville, Kans.

IMPORTS AND EXPORTS

Lead pigments.—Imports of lead pigments into the United States are relatively insignificant. In 1928 imports of white lead and red lead decreased, while imports of litharge and orange mineral increased. Exports of white-lead pigments increased 7 per cent in 1928 and amounted to 4 per cent of the total domestic output of basic carbonate white lead. United Kingdom took 66 per cent of the white-lead pigments exported in 1928. Combined exports of red lead and litharge increased 46 per cent and amounted to 2 per cent of the total domestic production of these two pigments.

Basic carbonate white lead, red lead, litharge, and orange consumption in the United States, 1919–

Year	Basic carbonate white lead		Red lead		Litha	
	Pounds	Value	Pounds	Value	Pounds	
1919	21,213	$2,490	7,199	$1,136		
1920	150,077	19,449	23,076	1,780	21,002	
1921	124,176	12,598	12,236	680	100	
1922	222,465	21,335	1,405	94	1,770	
1923	336,892	31,386	3,600	220	22,525	
1924	141,150	13,478	1,874	156	1,838	
1925	213,028	21,535	3,452	268	2,417	
1926	297,667	31,690	9,591	817	122	
1927	330,421	29,901	51,088	4,403	1,182	
1928	166,236	15,889	24,676	1,510	2,100	

White lead and red lead exported from the United St

Year	White lead [1]	
	Short tons	Val
1919	14,017	$3,037
1920	14,901	3,195
1921	5,161	993
1922	4,598	710
1923	[1] 5,172	836
1924	[1] 5,055	853
1925	[1] 6,832	1,293
1926	[1] 6,239	1,119
1927	[1] 6,047	947
1928	[1] 6,476	962

[1] Exports of white lead and basic lead sulphate or sublimed lead not class
figures for 1923–1928 may include an unknown quantity of basic lead sulphat
[2] Exports of red lead and litharge not classified separately for 1923–24 and
years may include an unknown quantity of litharge. Figures for other years

White lead [1] exported from the United States, 1927–2

Destination	1927	
	Short tons	Val
North America:		
Canada	61	$10
Cuba	48	10
Mexico	105	25
Panama	356	67
Other	88	20
	658	134
South America:		
Brazil	(2)	
Colombia	30	6
Uruguay	48	7
Venezuela	29	6
Other	535	92
	642	113
Europe:		
Netherlands	579	77
United Kingdom	4,007	580
Other	2	
	4,588	658
Asia:		
Philippine Islands	144	35
Other	4	
	148	36
Africa	1	
Oceania, including Australia	10	3
	6,047	947

[1] White lead and basic lead sulphate or sublimed lead not classified separat
include an unknown quantity of basic lead sulphate or sublimed lead.
[2] Less than 1 ton.

Zinc pigments and salts.—Lithopone is the principal zinc pigment imported into the United States. Imports of lithopone increased 24 per cent in 1928 and were equivalent to 5 per cent of the domestic output. Imports of zinc oxide did not change materially in 1928; they were equivalent to less than 1 per cent of the domestic production. Imports of zinc sulphide have increased from about 8,000 pounds in 1926 to 338,000 pounds in 1928. Imports of zinc chloride and zinc sulphate increased substantially in 1928. The Netherlands supplies about 75 per cent of the zinc pigments imported into the United States.

Zinc oxide is the principal zinc pigment exported from the United States; in 1928 there was a slight increase in the quantity shipped abroad. Exports amounted to 9 per cent of the domestic output. Canada took 43 per cent of the total, and United Kingdom took 29 per cent. Exports of lithopone increased 58 per cent; imports, however, exceeded exports by 6,600 tons, or the equivalent of 3 per cent of the United States output.

Zinc oxide, lithopone, zinc sulphide (white), zinc chloride, and zinc sulphate imported for consumption in the United States, 1919–1928

Year	Zinc oxide				Lithopone	
	Dry		In oil			
	Short tons	Value	Short tons	Value	Short tons	Value
1919	105	$44,338	3	$1,351	739	$122,708
1920	1,431	289,890	14	3,590	1,714	203,240
1921	1,286	145,071	57	17,549	5,247	432,019
1922	2,712	301,599	42	8,595	10,763	885,671
1923	1,036	109,415	89	21,934	10,440	776,383
1924	1,703	220,629	110	25,874	6,830	543,025
1925	1,274	205,582	132	31,187	6,330	478,395
1926	1,127	198,807	94	23,103	8,686	661,700
1927	1,399	220,427	77	18,619	7,979	656,166
1928	1,348	208,557	107	25,620	9,885	808,200

Year	Zinc sulphide [1]		Zinc chloride		Zinc sulphate	
	Pounds [1]	Value	Short tons	Value	Short tons	Value
1919	10,035	$4,413	1	$192	(2)	$152
1920	45,482	15,027	585	76,495	60	3,038
1921	93,537	8,330	2,109	213,905	17	820
1922	27,150	8,453	1,374	87,509	17	1,004
1923	11,844	5,403	551	44,104	20	3,466
1924	9,078	5,727	319	28,011	13	1,265
1925	14,604	5,589	409	50,712	17	1,368
1926	7,800	4,125	568	51,605	66	4,590
1927	132,223	22,984	470	40,089	205	9,390
1928	338,030	47,235	563	47,185	683	28,866

[1] Zinc sulphide is stated in pounds rather than tons because of its high value and smaller quantities.
[2] Less than 1 ton.

Zinc oxide and lithopone exported from the United Stat

Year	Zinc oxide	
	Short tons	Value
1919	14,703	$3,059,27
1920	11,164	2,161,64
1921	2,511	426,25
1922	3,977	503,12
1923	5,024	743,57
1924	3,927	605,63
1925	10,855	1,503,56
1926	14,601	1,917,42
1927	14,494	1,821,78
1928	14,799	1,849,88

[1] Not classified separately prior to 1922.

Zinc oxide exported from the United States, 1927 and 192

Destination	1927	
	Short tons	Value
North America:		
Canada	5,544	$763,7
Cuba	45	7,5
Mexico	87	16,5
Panama	73	13,9
Other	36	7,4
	5,785	809,3
South America:		
Brazil	14	2,6
Other	131	26,3
	145	29,0
Europe:		
France	1,708	189,1
Italy	685	77,8
United Kingdom	3,410	390,7
Other	1,835	206,0
	7,638	869,7
Asia:		
Philippine Islands	99	12,7
Other	711	84,3
	810	97,0
Africa	5	8
Oceania, including Australia	111	15,7
	14,494	1,821,7

[1] Less than 1 ton.

PRICES AND VALUE

The total value and the average price received by producers from sales of lead and zinc pigments and salts are given on preceding pages of this chapter. The range of market quotations as reported by the Oil, Paint and Drug Reporter is shown in the following table.

Range of quotations on lead pigments and zinc pigments and salts at New York, 1926–1928, in cents a pound

Product	1926	1927	1928
Basic lead sulphate, or sublimed lead, dry, in casks	9.00–10.00	7.75–9.00	7.75
White lead, or basic lead carbonate:			
Dry, in casks	9.75–10.75	8.50–9.75	8.25–8.50
In oil, carload lots	12.15–12.30	10.73–12.15	10.73
Litharge, American, commercial powdered, casks	10.50–11.75	8.75–10.75	8.50–9.00
Red lead, dry, in casks	11.00–12.25	9.75–11.25	9.50–10.00
Orange mineral, American, casks	13.25–14.50	11.75–13.50	11.50–12.00
Lead acetate, brown, broken, barrels	13.00–14.50	12.00–13.50	12.00–12.50
Lead arsenate, powdered, drums	[1] 10.00–12.00	13.50–15.00	13.00–15.00
Zinc oxide:			
American process, lead-free, bags, car lots	6.50–7.25	6.50	6.50
American process, leaded, barrels, car lots	6.50–8.00	6.75–6.88	6.88
French process, red seal, bags, car lots	9.38–10.13	9.38	9.38
French process, green seal, bags, car lots	10.38–11.13	10.38	10.38
French process, white seal, barrels, car lots	11.63–12.38	11.63	11.63
Lithopone, American, bags, car lots	5.38–5.63	5.38	5.25
Zinc chloride:			
Solution,[2] drums	3.00–4.25	2.75–4.00	2.75–3.25
Fused	5.25–6.00	5.25	5.25
Zinc sulphate, barrels	3.00–4.00	3.00–3.75	3.50–3.75

[1] Reported as "paste, barrels," in 1926. [2] At works.

Quotations on basic lead sulphate and white lead in oil were constant throughout the year, notwithstanding an upward trend in the price of lead during most of the year. Dry white lead was quoted at 8½ cents during the first 10 months, but in November it was cut to 8¼ cents. Quotations on litharge, red lead, and orange mineral fluctuated with the lead market and were the same at the end of the year as at the beginning. The range of quotations on lead acetate and lead arsenate was lower in 1928.

Quotations on zinc oxide and lithopone were constant throughout the year, although the price of zinc increased steadily from February to December. The price range of zinc chloride was lower in 1928, while that of zinc sulphate was somewhat higher.

ZINC[1]

By Elmer W. Peh

GENERAL SUMI

Salient figures of the zinc industry in th

Production of primary zinc:	
From domestic ores	
From foreign ores	
Apparent consumption of primary zinc	
Stocks of zinc on hand at smelters Dec. 31	
Ratio of electrolytic zinc to total primary zinc production	
Recovery of unalloyed secondary zinc	
Prices per pound of prime western zinc at St. Louis:	
Average for year	
Highest monthly average	
Lowest monthly average	
Mine production of recoverable zinc	
Tri-State district (Joplin region)	
Western States	
Other	
World smelter production of zinc	

From a statistical point of view the
of the United States, which began in th
to a definite end early in 1928, and duri
definite improvement was noted in the b
The price, although considerably under th
consistently after February. The St.
cents per pound at the beginning of the
cents the latter part of February, and t
of 6.35 cents, which was maintained th
yearly average was 6.03 cents, as compar

The production of primary zinc in th
to 602,581 tons, as compared to 592,51
from domestic ores having increased 2.
foreign ores decreased 29 per cent. In 192
to nearly 27 per cent of the total produc
cent in 1927. Coincident with this, M
as the leading producer of metallic zinc.
zinc increased 7 per cent.

The apparent consumption of primary
for all time and was 12 per cent greate
industry showed the largest tonnage in
while die casting exhibited the largest perc
ing used considerably more zinc in 1928,
slight decrease.

[1] Work on manuscript completed October, 1929.
[2] The statistics in this report were prepared (unless otherwise
on imports and exports were compiled from records of the Bu
by J. A. Dorsey, both of the Bureau of Mines.

perature below its melting point and that the vapor forms an alloy on the surface of the metals to be coated. The process is especially adapted to the coating of quantities of small articles and threaded hardware, such as screws, bolts, and nuts. Zinc dust is also used as a reducing agent in the manufacture of dyes, as a precipitant of gold in the cyanide process, and as a pigment in paints, especially marine paints.

The following companies reported the production and sale of zinc dust in 1928:

Producers of zinc dust in the United States in 1928

	Location of plant
The Alloys Co	San Francisco, Calif.
Federated Metals Corporation	Trenton, N. J.
John Finn Metals Works	San Francisco, Calif.
Grasselli Chemical Co	Meadowbrook, W. Va.
New Jersey Zinc Co	Palmerton, Pa.
Superior Zinc Corporation	Philadelphia, Pa.
United States Zinc Co	Sand Springs, Okla.

ZINC PIGMENTS AND SALTS

Zinc oxide, leaded zinc oxide, and lithopone are the principal pigments of zinc, and the chloride and sulphate are the principal salts. These products are manufactured from various zinciferous materials, such as ores, metal, and secondary substances. In 1928 the total zinc content of all zinc pigments and salts produced and sold amounted to 187,031 tons, an increase of 4 per cent over 1927. This was derived from the following sources:

	Short tons
Domestic ores	124, 090
Metal	37, 588
Secondary material	25, 353

The following table gives the primary zinc content (that is, zinc derived directly from ores) of zinc pigments and salts produced for market in the United States during the last 10 years.

Primary zinc content of zinc pigments and salts made in the United States, 1919–1928, in short tons [1]

Year	Pigments	Salts	Year	Pigments	Salts
1919	96, 817	3, 393	1924	108, 282	1, 075
1920	110, 605	6, 284	1925	110, 554	673
1921	53, 480	3, 749	1926	127, 085	2, 106
1922	93, 112	1, 801	1927	121, 899	47
1923	116, 970	1, 573	1928	123, 964	126

[1] Includes some zinc derived from primary drosses from zinc-reduction plants.

The direct use of zinc ore in the manufacture of pigments and salts increased 2 per cent in 1928, while the use of metallic zinc and secondary material increased 11 and 8 per cent, respectively.

Ore was used in the following products in 1928; the percentages represent proportion of the total zinc, recoverable from the ore, entering the various pigments:

	Per cent
American process zinc oxide	70
Lithopone	21
Leaded zinc oxide	9

The metallic zinc was practically all used in the ma
French process zinc oxide. The secondary zinc was d
follows:

Lithopone
Zinc salts
Leaded zinc oxide

Further details of the production of zinc pigments
given in the Mineral Resources chapter on lead and zin

SECONDARY ZINC

The accompanying table shows the amount of se
recovered in the United States as metal and in zinc d
ments, and zinc salts, 1925 to 1928.

Secondary zinc recovered in the United States, 1925–1928, in

	1925	1926
Secondary zinc, redistilled	39, 181	40, 709
Secondary zinc, remelted	22, 249	23, 771
Total zinc recovered unalloyed	61, 430	64, 570
Recovered zinc in alloys, excluding old brass remelted	13, 300	13, 430
Recovered zinc in remelted brass (estimated)	53, 300	63, 000
Secondary zinc recovered as metal	128, 000	141, 000
Secondary zinc recovered in zinc dust	6, 232	4, 400
Secondary zinc recovered in pigments	11, 714	12, 480
Secondary zinc recovered in zinc salts	10, 928	10, 084
Total secondary zinc	156, 000	168, 000

The recovery of secondary zinc increased 7 per cen
exceeded all previous records. The production of
increased only 2 per cent.

Secondary zinc recovered in the form of metal increa
due to increases of 14 per cent in redistilled secondary
cent in remelted brass. That recovered in dust, pigme
increased 11 per cent, all three products having co
stantially to the increase.

Since 1910, the first year for which satisfactory data
production of secondary zinc has increased steadily, exc
postwar period. Since the production of primary zinc
at about the same rate, however, there has been little
ratio of secondary to primary zinc. From 1910 to 191
of secondary zinc as metal was equivalent to 23 per cent
zinc output. During the war and postwar periods the
by extraordinary conditions, but during the last five
averaged 24 per cent. In 1928 the ratio was 25 per
ratios for copper and lead were 43 and 40 per cent, resp
relatively advantageous position of zinc is probably d
percentage consumed in dissipative uses, such as zinc
dust, pigments, and salts which yield little secondary
estimated that less than 35 per cent of all the zinc min
ever available for secondary usage.

The Magnolia property owned by the Anaconda Copper Mining Co. was worked by lessees, and 4,086 tons of silver-lead-zinc ore was shipped to the flotation plant of the Timber Butte Milling Co. The Eveline mine was operated by a lessee who shipped nearly 1,000 tons of lead-zinc ore to Butte for milling and 2 cars of first-class siliceous silver ore to Anaconda for smelting. The Badger State property of the Anaconda Copper Mining Co. was reopened and produced 1,637 tons of lead-zinc ore of milling grade. Other producers of lead-zinc ore were the Minnie Jane, Moulton, Lizzie, Goldsmith, Curry, Garfield-Salvador, Magna Charta, Elba, and Venus. The Moulton, Goldsmith, and Venus also produced first-class siliceous silver ore. The Right Bower mine of the Anaconda Copper Mining Co. was worked by a lessee who shipped about 1,300 tons of first-class oxidized copper ore to Anaconda for smelting. The Lizzie mine also produced a little first-class copper ore, and small lots of similar material came from the Butte-Bullwhacker, Rose O'Malley, and B & B properties. Small lots of first-class silver ore were shipped from the Little Darling, West Olive Branch, Alice, French Joe Fraction, I. X. L., and Unexpected Williamsburg claims. A small lot of slag containing a little copper was shipped from the old Bell smelter dump, and more than 1,500 tons of low-grade copper ore containing more than 6 ounces of silver to the ton was shipped from the East Butte dump to Anaconda for smelting.

LEAD[1]

By Elmer W. Pehrson[2]

GENERAL SUMMARY

Salient figures of the lead industry in the United Sta

Production of refined primary lead:	
From domestic ores	short
From foreign ores and base bullion	
Recovery of secondary lead:	
As pig lead	
In alloys	
Total production of pig lead (primary and secondary)	
Imports (general):	
Lead in base bullion	
Lead in ore	
Exports:	
Refined pig lead from domestic ores	
Refined pig lead from foreign materials	
Apparent consumption of refined primary lead	
Estimated consumption of primary and secondary lead	
Prices per pound of refined lead at New York:	
Highest monthly average	c
Lowest monthly average	
Average for year	
Quotation at end of year	
Mine production of recoverable lead	short
Southeastern Missouri district	per cent of t
Utah	
Coeur d'Alene region	
Joplin (tri-State) region	
All other	
World smeltor production of lead	short
United States	per cent of t
Mexico	
Australia	
Canada	
All other	

[1] Revised figures.
[2] Exclusive of the output from Virginia, figures for which the Bureau publish.

The depression in the primary lead industry, w steadily during the past few years, appeared to l in 1928, and a slight but definite upward trend the latter part of the year. Although the pro refined lead in the United States was 2 per cent le the decline was due largely to curtailment during year. The American Bureau of Metal Statistics

[1] Work on manuscript completed December, 1929.
[2] The statistics in this report were prepared (unless otherwise indicated) on imports and exports were compiled from records of the Bureau of Foreig J. A. Dorsey, both of the Bureau of Mines.

monthly output as in July, after which there was a definite upward trend. Outstanding features in the production of refined primary lead in 1928 were the 6 per cent decrease from domestic ores and the 21 per cent increase from foreign materials. The latter was the net result of the 34 per cent increase in the refined lead produced from foreign base bullion and the 18 per cent decrease in the amount obtained from smelting foreign ore.

The downward trend in the price of lead, so apparent in 1927, continued during the first part of 1928, reaching the low point of the year early in March; during the remainder of the year the trend was definitely upward. The New York monthly average was 6.50 cents for January. The low average for the year was 6.02 cents for March. By October the average was again 6.50 cents. There was a slight recession in November, but the price again averaged 6.50 cents for December. The average for the year was 6.31 cents in 1928, as compared to 6.75 cents in 1927. Owing to the depressed London market in 1928 the New York price exceeded the St. Louis average by only 0.17 cent per pound, as compared to 0.23 cent in 1927. The New York price was 1.73 cents above the London average in 1928, as compared to 1.50 cents in 1927.

The recovery of secondary lead in pig lead and in alloys in 1928 broke all previous records; it amounted to 308,600 tons or the equivalent of 49 per cent of the primary lead produced from domestic ores. Secondary lead recovered as pig lead amounted to 138,000 tons or 45 per cent of the total secondary lead recovered in 1928.

The total consumption of lead in the United States, as estimated by the American Bureau of Metal Statistics, amounted to 930,500 tons in 1928, an increase of 11 per cent over 1927 and surpassing all previous records. Storage batteries ranked first among the consumers of lead in 1928 and showed a 26 per cent increase over 1927 in the quantity of lead used. Cable covering was next in importance and used 12 per cent more lead in 1928 than in 1927. White lead was the third largest consumer in 1928, but showed a slight decrease in the quantity of lead used. This industry, which consumed 23 per cent of the total lead used in 1922, took only 13 per cent of the total in 1928. Owing to the large increase in the recovery of secondary lead there was a decrease of 1 per cent in the apparent consumption of primary lead.

Mine production of lead in the United States showed a 6 per cent decrease in 1928, fairly general throughout the States—production in the Western States having been curtailed 6 per cent and that in the Mississippi Valley States, 5 per cent. Oklahoma suffered the largest tonnage cut, and Virginia was the only State in which there was a substantial increase.

General imports of lead in base bullion increased about 10,000 tons or 9 per cent, largely as a result of importations from Peru, where an American copper company began lead-smelting operations. Imports of lead in ore decreased nearly 15,000 tons, or 36 per cent, largely as a result of smaller shipments from Mexico. Exports of refined pig lead from domestic ores were nearly 12,000 tons (461 per cent) greater in 1928 than in 1927; at the same time exports of foreign pig lead decreased nearly 21,000 tons, or 17 per cent.

An important development in the United States lead industry in 1928 was the organization, on November 14, of the Lead Industries

Association, comprising both producers and co
purposes are to promote service among lead in
munity at large, disseminate accurate informati
of lead products, collect statistics on marketing
lead and its products, and develop methods to i
those in the lead industries. Its membership i
engaged in mining, smelting, and manufacturin
States, Mexico, Canada, and South America. E
ciation began distributing weekly reports on the
stocks of pig lead and white lead in the United

World smelter production of lead in 1928 a
short tons, a decrease of about 1 per cent as
Production outside of the United States increased
output, which ranked second to that of the Uni
to 13 per cent of the world total; it was 6 per cen
Australia was third, with 9 per cent of the wor
6 per cent less than in 1927. Canada ranked fo
it increased its output 2 per cent. Spain fell off
fifth, with slightly less than 8 per cent of the w
and Belgium followed in order, with little change i
increased its output 19 per cent, and Peru and
their production considerably.

The London price of lead in 1928 averaged £
or 4.58 cents per pound, a decrease from 1927 o
pared with a decrease of 7 per cent in the Ne
low price prevailing in Europe caused European
curtailment of output along the lines of the Zinc
was held in London in September, 1928, but
negative. Arrangements were made for collect
tistical data, but it was concluded that worl
inconsiderable, that production was about kee
sumption, and that curtailment of output was
time. Later in the year it was announced t
would be held in March, 1929.

During the past few years some important o
large quantities of lead have been developed.
is the Mount Isa deposit in Queensland, Austral
to have ore reserves as follows: 3,500,000 tons of
ing 9 per cent lead and 3.6 ounces of silver per
of sulphide ore containing 6.1 per cent lead, 8.2
ounces of silver; and an additional 500,000 to
much higher grade. Production is expected in 1
of the plant is to be eventually 2,000 tons of ore
there was considerable development of lead-zinc
in British Columbia, from which an increased out
Buchans mine in Newfoundland is reported to ha
000 tons of ore averaging 7.65 per cent lead, 17.8
ounce of gold, 3.25 ounces of silver, and 1.4 per c
tion at the rate of 300 tons of ore per day was be
of the year, and an increase to 500 or possibly 1,0
soon. In France, Russo-Asiatic Consolidated
ore bodies at Villemagne and St. Sebastien w
promising futures. No substantial discoverie
reported in the United States in 1928.

PRODUCTION

GENERAL

Pig lead produced in the United States for domestic market and export is derived from three main sources—domestic ore, foreign ore and base bullion, and secondary materials. The following table shows the quantity of pig lead produced from each of these sources from 1919 to 1928.

Pig lead produced in the United States, 1919–1928, in short tons

Year	From domestic ores and base bullion	From foreign ores and base bullion	From secondary materials	Total
1919	424,433	57,787	55,684	537,904
1920	476,849	52,808	56,350	586,007
1921	398,222	50,367	46,370	494,959
1922	468,746	63,916	75,480	608,142
1923	543,841	74,481	96,430	714,752
1924	566,407	124,086	90,400	780,893
1925	654,921	112,048	112,420	879,389
1926	680,685	118,256	125,000	923,941
1927	668,320	128,210	119,000	915,530
1928	626,202	154,869	138,000	919,071

The total production of pig lead for domestic market and export in 1928 increased 3,541 tons, or less than one-half of 1 per cent. The production of pig lead from domestic ore and base bullion decreased 6 per cent, whereas that from foreign ore and base bullion and from secondary materials increased 21 and 16 per cent, respectively.

PRIMARY LEAD

REFINERY PRODUCTION

Pig lead is classified by the Bureau of Mines as primary or secondary, according to whether it is derived directly from the smelting of ores and from base bullion or is reclaimed from industrial lead scrap. Some plants that ordinarily smelt ore frequently add lead scrap to the charge, so that the resulting product is an inseparable mixture of lead from both sources and is all marketed as refined pig lead. Nevertheless, the smelter calculates the quantity of secondary lead so produced, thus enabling the Bureau of Mines to obtain a consecutive record of the amount of primary lead being supplied to the trade each year.

Primary lead may be produced from domestic ore or foreign ore and from base bullion. The smelting of lead-bearing ores from the Western States yields an impure pig lead (base bullion) that contains valuable amounts of silver and gold, in addition to objectionable impurities such as copper, arsenic, and antimony. This base bullion is given further treatment for the removal of the impurities and finally emerges for the market as refined pig lead. The smelting of lead-bearing ores from the Mississippi Valley and Southern States yields soft lead pure enough for marketing, but some of it is desilverized and is designated in this report as desilverized soft lead. Foreign ore is first smelted into base bullion and then refined for market. Foreign base bullion imported into the United States is also refined before marketing. All of these products for market are referred to as refined lead. The following table gives a summary of the refined primary lead produced in the United States from 1720 to 1928.

Refined primary lead produced in the United States, 1

Year	Short tons						
	Desilverized lead [1]	Desilverized soft lead	Soft lead [2]	Total production [1]	From domestic ores and base bullion	From foreign ores	Fro fore bas bull
1720–1912	7,176,497	326,991	2,929,180	10,432,668	8,545,383	1,887	285
1913	301,160	29,433	131,867	462,460	411,878	13,223	37
1914	340,397	43,506	153,219	542,122	512,794	7,639	21
1915	344,593	44,001	161,461	550,055	507,026	9,581	33
1916	335,375	68,244	167,515	571,134	552,228	6,085	12
1917	365,998	55,268	188,503	610,769	548,450	15,872	46
1918	382,314	47,418	210,463	640,195	539,905	15,334	84
1919	266,538	67,938	147,744	482,220	424,433	7,656	50
1920	273,135	66,668	189,854	529,657	476,849	8,414	44
1921	238,329	52,747	157,513	448,589	398,222	7,120	43
1922	249,107	74,805	209,250	532,662	468,746	13,898	50
1923	366,241	61,332	190,749	618,322	543,841	24,288	50
1924	423,429	63,440	203,615	690,493	566,407	46,332	77
1925	457,477	48,932	260,560	766,969	654,921	47,024	65
1926	484,609	55,707	258,565	798,941	680,685	48,210	70
1927	507,099	55,487	233,944	796,530	668,320	32,369	95
1928	506,603	40,465	225,003	781,071	626,202	26,632	128
	13,018,961	1,211,891	6,024,005	20,254,857	17,126,200	3,128,562	

[1] The lead content of antimonial lead is excluded; see p. 615. [2] Desilverized

The total production of refined primary lead in t
in 1928 was 1.9 per cent less than the 1927 output
per cent less than the 1926 production, the maximu
to date. The greater relative decrease in total valu
marked decline in the average price of lead. The to
was 10 per cent less than that for 1927 and 29 per ce
for 1926, and amounted to only 68 per cent of that f
annual value up to the end of 1928.

Two outstanding features in the production of pr
United States in 1928 were the increased output fro
and the decreased production from domestic ores.
of lead from ore and base bullion of foreign origin am
tons, an increase of 21 per cent over 1927. Foreig
cent of the total output in 1928, whereas it amoun
of the total in 1927. This increase was all due to
tion of refined lead from foreign base bullion, whic
cent in 1928; refined lead derived from the smelti
decreased 18 per cent in 1928. The production of
domestic ores in 1928 was 42,118 tons, or 6 per ce
in 1927 and was lower than in any year since 1924.
of refined lead of domestic origin in 1928 was lowe
since 1922 and amounted to only 64 per cent of
1925. The following table shows the quantity an
lead produced in the United States from domestic
1928.

Refined lead produced in the United States from domesti

Year	Short tons	Value	Year	Short tons
1919	424,433	$44,990,000	1924	
1920	476,849	76,296,000	1925	
1921	398,222	35,840,000	1926	
1922	468,746	51,562,000	1927	
1923	543,841	76,138,000	1928	

GEOGRAPHICAL SOURCE OF LEAD RAW MATERIALS SMELTED OR REFINED IN THE UNITED STATES

The following table shows the source of the ore and foreign base bullion from which refined lead was produced in the United States from 1919 to 1928. Most of the base bullion produced in the Western States is shipped to the Mississippi Valley and Eastern States for refining. In reporting the production of lead by sources most of the refiners make the distribution on the basis of base bullion, so that the total lead given in this table as from domestic ore includes both base bullion and refined lead and thus contains a large part of the antimonial lead produced from domestic ores. The total here given for 1928 exceeds the total production of refined lead from domestic ores, as shown on page 611, by 16,495 tons. The production of antimonial lead from domestic ores in 1928 amounted to 17,930 tons.

Primary lead smelted or refined in the United States, 1919–1928, by sources, in short tons

Source of ore	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Domestic ore:										
Alaska	645	591	773	324	400	582	699	1,018	1,010	962
Arizona	5,407	5,987	3,313	7,218	8,828	9,372	10,231	10,646	7,918	8,144
California	2,004	2,260	614	3,018	5,168	2,805	4,148	4,044	1,232	637
Colorado	18,867	17,752	12,104	11,108	23,885	25,491	31,855	37,653	37,040	28,533
Idaho	89,091	117,191	99,707	91,487	127,797	123,709	128,363	132,564	150,618	141,748
Illinois[1]	977	948	271	750	1,286	1,089	474	357	222	396
Kansas[1]	7,951	8,421	10,939	10,900	20,207	12,895	15,001	20,884	[2]7,530	20,889
Kentucky[1]	63	114	41	73	66	201	96	27	139	268
Missouri[1]	150,341	171,999	151,028	202,245	169,323	191,501	208,547	218,083	210,366	192,739
Montana	17,518	13,231	11,565	14,551	18,345	21,226	22,008	26,350	23,041	20,470
Nevada	5,958	5,650	3,553	4,264	8,044	8,070	10,978	11,379	8,680	6,823
New Hampshire	16									
New Mexico	1,418	1,123	384	1,230	1,638	2,263	3,782	4,383	3,377	3,469
Oklahoma[1]	49,984	68,494	46,902	67,436	59,602	56,017	78,487	70,004	[3]65,790	52,817
Oregon				37	47		6	5	2	7
South Dakota	18	6	2	2		2	2	1	79	37
Tennessee[1]	2,371	2,705		751	1,020	985	436	770	19	
Texas	8	1	1	5	40	27	31	102	275	437
Utah	65,102	64,006	51,872	63,130	104,678	119,318	166,844	151,127	156,199	151,724
Virginia[1]						1,582	2,179	1,714	2,214	4,944
Washington	1,090	2,460	325	478	2,008	2,057	2,802	2,262	442	537
Wisconsin[1]	3,975	3,841	1,079	1,323	601	1,973	2,889	2,052	2,067	1,812
Undistributed	119	201	101	75	691	15	2			
Zinc residues	4,887	4,366	713	1,284	362	1,320	1,541	505	1,905	102
	427,825	494,347	395,287	481,689	564,036	582,000	686,451	695,830	684,165	642,697
Foreign ore:										
Africa	644	1,171			99	6		6	12	
Australia	69	450							2	2
Canada	1,895	1,186	2,877	3,604	3,632	4,633	10,676	5,885	4,138	10,123
Central America	12	22	6	14	18	30	6		18	3
Europe	122	19	17	519	139	328	470	233	19	67
Mexico	2,261	2,729	1,912	7,260	18,867	33,328	31,107	32,693	22,844	14,839
South America	2,537	2,747	2,235	2,458	1,461	7,663	4,496	9,893	5,506	1,568
Other foreign	116	90	73	43	72	397	269			30
Foreign base bullion:										
Canada	567	1,919	1,599	2,900						
Mexico	49,564	42,421	41,648	47,118	50,103	77,701	65,024	70,046	95,841	117,193
South America		54								11,044
	57,787	52,808	50,367	63,916	74,481	124,086	112,048	118,256	128,380	154,869
Grand total	485,612	547,155	445,654	545,605	638,517	706,086	798,499	814,086	812,545	797,566

[1] 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.

[2] Mine production figures for Kansas are 27,497 short tons and for Oklahoma, 51,680 tons. In view of the great discrepancy between mine and smelter figures for these States, it is reasonable to assume that some Kansas ore was shipped to the smelters from Oklahoma points.

Fifty-seven per cent of the lead produced in 1928 fr
ores was from Western States ore, and nearly 43 per c
ore mined in the Central and Eastern States. Small a
derived from Alaska ore and from residues from zinc sr
creased production was the general rule in the impo
Virginia showed the greatest increase; Arizona and
made slight increases.

Refined lead produced from foreign ore amounted to
Mexican ores supplied 56 per cent of it, Canadian ores
and South American ores nearly 6 per cent. Lead
Mexican ore decreased 35 per cent in 1928 and that
American ore decreased 72 per cent, while that from
increased 145 per cent.

Mexico supplied 91 per cent and South America
of the foreign base bullion refined in the United St
Refined lead from Mexican base bullion increased 22 pe
production from South American base bullion was the
in several years; all of it came from Peru, where an Am
company began large-scale lead-smelting operations.

SPECIFICATIONS FOR PIG LEAD

The American Society for Testing Materials classif
three grades—corroding, chemical, and common. The
as to chemical composition are shown in the following

Allowable chemical composition of the various grades of pig lead, a American Society for Testing Materials

	Corroding lead,[1] not over—	Chemical lead[2]	D (z no
	Per cent	*Per cent*	
Silver	0.0015	0.005–0.015	
Copper	.0015	.04– .08	
Copper and silver together	.0025	(3)	
Arsenic	.0015	(3)	
Antimony and tin together	.0095	(3)	
Zinc	.0015	(3)	
Iron	.002	(3)	
Bismuth	.05	(3)	
Lead, by difference	99.9300	(3)	

[1] The maximum limits for bismuth, copper, and silver have been given, but it any delivery will contain the maximum of all three.

[2] Chemical lead is a designation that has been used for many years in the trade silverized lead produced from Southeastern Missouri ores.

[3] Not given.

[4] Less than 0.005 per cent.

[5] Not specified.

SOFT LEAD

A large part (44 per cent in 1928) of the lead produced in the Uni... States from domestic ores is derived from the nonargentiferous le... ores of the Mississippi River Basin. The two principal ore-produci... areas are the Southeastern Missouri district and the tri-State distri... (Joplin) at the junction of Missouri, Kansas, and Oklahoma. Th... former district produced about 71 per cent and the latter 26 per ce... of the total soft lead in ore mined in 1928.

Eighty-two per cent of the soft pig lead produced in 1928 w... marketed without desilverizing, and 18 per cent was desilverized. The former, which is known in the trade as chemical lead, contain... 1 to 4 ounces of silver to the ton and 0.04 to 0.08 per cent copper; it is used chiefly in the manufacture of cable, pipe, and sheets. Desil... verized soft lead is used largely in the manufacture of white lead where a very pure product is required.

A substantial quantity of high-grade lead concentrates from the Mississippi Valley is used each year in the manufacture of lead pig... ments, principally basic lead sulphate (white sublimed lead) and leaded zinc oxide. In 1928 more than 10,000 tons of soft lead wa... recovered in this manner.

The following table summarizes the production of soft lead from... 1922 to 1928.

Soft lead produced in the United States from domestic ores, 1922–1928, in short to...

Year	Soft pig lead			Soft lead recovered in pigments	Total soft lead	Total domestic lead[1]	Soft lead per... centage of do... mestic lead
	Undesilverized	Desilverized	Total				
1922	209,250	74,305	283,555	13,892	297,447	488,448	61
1923	190,740	61,332	252,081	13,612	265,693	567,247	47
1924	203,615	63,449	267,064	15,338	282,402	593,486	48
1925	260,560	48,932	309,492	17,547	327,039	684,668	48
1926	258,565	55,707	314,272	13,685	327,957	710,990	46
1927	233,944	55,487	289,431	13,136	302,567	695,500	44
1928	226,003	49,405	274,408	10,405	284,933	652,402	44

[1] Includes domestic refined lead, domestic lead in antimonial lead, and domestic lead in pigments.

ANTIMONIAL LEAD

Antimonial lead is an important by-product of the refining of base bullion. In 1928, 33,058 tons of primary antimonial lead was pro... duced, which contained 29,626 tons of lead, an increase of 36 per cent over the 1927 output of antimonial lead and equivalent to 6.5 per cent of the total refined lead produced from base bullion. The principal uses of antimonial lead are in the manufacture of storage batteries, bearing metal, and type metal. The consumption of antimonial lead in storage batteries increased nearly 40 per cent in 1928. The fol... lowing table shows the production of primary antimonial lead from 1919 to 1928.

...product primary antimonial lead produced in the United Sta...

...ar	Total lead refined from base bullion (short tons)	By-product antimonial lead (percentage of total)	Antimonial lead				
			From domestic ore (short tons)	From foreign ore (short tons)	Total		
					Short tons	Value	Antimon...
							Short tons
...0	266,538	5.2	9,674	4,200	13,874	$1,513,968	1,943
...9	273,135	4.6	9,604	2,931	12,535	1,963,255	2,033
...8	238,329	4.2	7,881	2,183	10,064	870,059	1,589
...7	249,107	3.2	7,068	1,007	8,075	844,993	1,441
...6	366,241	3.9	11,636	2,555	14,190	1,960,870	2,170
...5	423,429	4.9	13,593	7,194	20,787	3,876,713	2,763
...4	457,477	4.3	14,472	5,195	19,667	3,785,547	2,624
...3	484,669	4.6	18,909	3,615	22,524	3,916,714	2,603
...2	507,099	4.8	16,040	8,807	24,847	3,277,043	2,736
...1	506,603	6.5	17,930	15,128	33,058	3,978,318	3,482
Average.		4.7					

SECONDARY LEAD

Much of the lead consumed in the United States manufacture of articles from which there is a large ret... ary metal. This is particularly true of the storage-ba... which is the leading single consumer of lead and in wh... large and rapid return of secondary metal. This indu... sible for much of the increase in the ratio of secondary l... to domestic primary lead production. In 1914 the sec... was equivalent to only 12 per cent of the primary outpu... tic ores; in 1928 the ratio was 49 per cent, an increase fr... in 1927 and the record to date. Other important l... industries in which there is a large return of secondary cable manufacture, building, bearing metal, and type Fifty-five per cent of the secondary lead output in 1... ered in the form of alloys, principally alloys of lead, tin, and 45 per cent was recovered as pig lead.

The following tables show the recovery of secondar... ratio to the refined primary lead produced in the Unit... domestic ores. Further details of the secondary lead be found in the Mineral Resources chapter on seconda...

Secondary lead recovered in the United States, 1922–1928, i...

Year	Pig lead	Lead in alloys	
1922	75,480	84,060	
1923	96,430	98,060	
1924	90,400	114,100	
1925	112,420	114,460	
1926	125,000	152,300	
1927	119,000	157,000	
1928	138,000	170,600	

Ratio of secondary lead recovered to refined primary lead produced in the United States from domestic ores, 1913–1928

Year	Refined primary lead		Secondary lead	
	Short tons	Average price per pound (cents)	Short tons	Ratio to refined primary lead (per cent)
1913	411,878	4.4	72,834	18
1914	512,794	3.9	61,002	12
1915	507,026	4.7	78,900	16
1916	552,228	6.9	96,300	17
1917	548,450	8.6	93,500	17
1918	539,905	7.1	97,100	18
1919	424,433	5.3	122,100	29
1920	476,849	8.0	124,650	26
1921	398,222	4.5	103,780	26
1922	468,746	5.5	159,560	34
1923	543,841	7.0	194,490	36
1924	566,407	8.0	204,500	36
1925	654,921	8.7	226,880	35
1926	680,685	8.0	277,300	41
1927	668,320	6.3	276,000	41
1928	626,202	5.8	308,600	49

PIGMENTS

Lead pigments manufactured in 1928 contained 254,000 tons of lead derived from the sources shown in the following table. Refined pig lead is used in the manufacture of white lead, litharge, red lead, sublimed lead, and orange mineral, and in 1928 about 243,000 tons of the lead contained in lead pigments was derived from refined pig lead; white lead accounted for 52 per cent of it, litharge 32 per cent, red lead 14 per cent, and sublimed lead and orange mineral 2 per cent. Sublimed lead and leaded zinc oxide are the principal pigments in which the lead content is derived from ores.

Further details of the production and value of lead pigments in the United States are given in the Mineral Resources chapter on lead and zinc pigments and salts.

Lead in pigments,[1] 1922–1928, by sources, in short tons

Year	Lead in pigments from—			
	Domestic ore	Foreign ore	Metal	Scrap
1922	13,892	----------	241,096	111
1923	13,612	----------	236,541	----------
1924	15,338	545	250,930	----------
1925	17,547	----------	256,064	----------
1926	13,685	----------	240,902	1,029
1927	13,136	----------	242,713	1,246
1928	10,466	----------	242,914	654

[1] Includes also lead recovered in zinc oxide and leaded zinc oxide.

MINE PRODUCTION

BY STATES

The Bureau of Mines canvasses every mine yielding lead in order to ascertain the quantity and metal content of the ores produced. Allowance is made for metallurgical losses, and the estimates of recoverable lead are combined into State totals. Suc
10-year period 1919 to 1928 are given in the follow
bureau is not at liberty to publish the total for Virgi
would disclose confidential information, so the outp
is excluded from the United States total.

Mine production of recoverable lead, 1919–1928, by State

State	1919	1920	1921	1922	1923	1924	1925
Alaska	687	875	759	377	410	631	789
Arizona	4,847	6,935	3,271	7,535	8,146	9,321	11,938
Arkansas	27	8	21	42	25	20	58
California	1,695	2,407	562	3,156	4,775	2,382	3,283
Colorado	18,535	23,315	9,830	11,739	22,849	23,779	31,483
Georgia		2		4			
Idaho	86,612	118,565	99,235	97,917	121,178	124,478	126,521
Illinois	2,063	1,708	672	1,325	1,381	1,464	1,001
Kansas	11,057	16,452	18,679	23,271	17,598	18,560	22,775
Kentucky	84	120	69	92	53	175	152
Maine	1						
Massachusetts		14				(1)	
Missouri	160,024	161,812	180,085	178,412	169,743	189,929	211,566
Montana	16,358	14,846	10,183	14,884	17,973	19,788	18,765
Nevada	7,291	10,100	3,594	4,695	9,078	10,030	12,238
New Mexico	1,443	1,435	339	1,506	1,916	1,817	3,210
Oklahoma	52,795	64,086	41,552	62,856	66,904	71,358	79,946
Oregon				38	14	(2)	
Pennsylvania		7					
South Dakota	16	6	2				
Tennessee	2,079	1,880		732	1,250	937	448
Texas	7			4	13		
Utah	58,819	66,898	44,594	67,666	101,724	116,655	163,331
Virginia						1,275	2,225
Washington	1,010	2,749	72	691	1,463	1,968	2,814
Wisconsin	4,130	2,594	972	691	734	1,264	1,877
	429,589	496,894	414,491	477,633	547,217	596,068	684,430

[1] It is said that a few tons of lead ore was mined at the old Chipman mine i
treated at a small smelter owned by the mine operators.
[2] 513 pounds.
[3] Bureau of Mines not at liberty to publish figures.
[4] Exclusive of the output from Virginia, figures for which the Bureau of Mines

The foregoing table shows a total production o
recoverable lead in 1928, a decrease of 6 per cent fro
produced nearly 32 per cent of the total and Utah
cent each, a total of 78 per cent for the three St
ranked fourth in production with 7 per cent, and
Colorado and Kansas with about 4 per cent each,
per cent, and Nevada, New Mexico, and Arizona
cent each. The combined output of all other Stat
tion is shown in the table amounted to less than 1 pe

Curtailment of production was fairly general thro
The three largest producers, Missouri, Utah, and Ida
and 4 per cent, respectively. Oklahoma suffered th
cut, its output having been reduced 8,000 tons,
Colorado's output was reduced 6,600 tons, or
Arizona's 2,700 tons, or 28 per cent. The producti
larger in 1928 than in 1927.

Additional details of mine production of lead ma
chapters of Mineral Resources covering the mine p
silver, copper, lead, and zinc in the various States o

BY DISTRICTS

Mine production of recoverable lead in the principal lead-producing districts of the United States, 1921–1928, in short tons

District	State	1921	1922	1923	1924	1925	1926	1927	1928
Southeastern Missouri region	Missouri	178,735	176,708	167,458	187,737	208,915	203,062	196,261	194,270
Coeur d'Alene region	Idaho	94,543	91,216	114,426	118,327	120,856	128,834	141,948	139,276
Joplin region	Kansas, Missouri, Oklahoma	61,581	87,771	80,787	92,110	105,372	102,117	81,080	70,096
Bingham	Utah	12,288	19,348	25,353	34,786	54,082	54,907	55,508	52,378
Tintic	do	18,158	23,646	38,906	40,674	45,889	47,108	46,045	44,906
Park City region	do	8,846	16,129	20,220	33,346	40,656	35,910	41,403	41,427
San Juan Mountains	Colorado	5,323	5,332	13,157	13,148	17,092	19,237	21,739	18,553
Butte	Montana	6,614	10,070	12,745	13,648	12,091	13,678	12,769	12,330
Rush Valley	Utah	607	586	1,284	926	2,406	5,022	7,340	7,222
Willow Creek	New Mexico							4,353	5,103
Leadville	Colorado	1,702	2,742	2,804	4,795	6,931	6,266	6,781	6,163
Bisbee (Warren)	Arizona	2,338	4,187	4,221	5,719	6,657	5,729	5,256	2,917
Jack Rabbit	Nevada	868	791	536	120	224	578	1,266	2,661
Upper Mississippi Valley	Iowa, Northern Illinois, Wisconsin	1,606	1,259	948	1,639	2,365	1,919	2,141	1,700
Montana	Montana	749	775	912	1,241	1,427	2,069	1,806	1,421
Warm Springs	Idaho	2,374	1,758	925	357	355	149	478	1,207
Vulture	Arizona		3		4	26	133	133	1,291
Texas	Idaho	971	2,168	2,417	2,197	1,714	2,882	3,895	1,105
Central	New Mexico	2	176	656	692	1,182	1,306	954	1,180
Pioche	Nevada	668	932	2,697	2,152	2,806	2,420	639	1,167
Yellow Pine	do	93	158	736	3,855	2,644	952	826	1,105
Dome	Idaho	24			226	602	246	1,182	1,074
Inyo County	California	523	3,135	4,744	2,306	3,098	3,278	1,081	872
Aspen	Colorado	1,198	1,778	1,486	455	1,820	1,632	1,203	804
Summit County	do	252	280	1,946	1,105	1,707	1,481	614	786
Eagle County	do	6	161	230	1,145	2,041	1,305	2,059	750
Pend d'Oreille	Idaho	1	238	304	67	113	481	1,048	694
Spruce Mountain	Nevada	458	237	261	508	647	1,099	636	529
Northport	Washington	50	534	1,062	1,232	2,218	1,984	325	503
Magdalena	New Mexico	30	462	753	818	1,217	700	819	496
Banner	Arizona	10	2,140	1,731	160	49	7	13	490
Eureka	Nevada	388	251	673	888	2,163	2,784	1,132	466
Kentucky-Southern Illinois	Kentucky-Illinois	207	849	1,220	1,254	075	440	344	416
Port Hill	Idaho	760	1,440	2,116	2,317	1,606	1,597	468	414
Barker	Montana	856	971	846	1,272	1,420	1,387	412	264
San Francisco	Utah	442	1,118	1,489	1,069	1,999	1,326	420	109
Bryant	Montana	83	158	968	1,743	1,150	730	398	195
Big and Little Cottonwood	Utah	2,230	2,754	3,831	3,128	2,374	1,507	1,099	146
Ophir	do	480	2,921	3,443	1,414	2,945	217	157	101
New Placers	New Mexico				3	125	527	1,100	48
Troy	Montana	377	1,528	1,050	530	259	231	181	28
Mammoth	Nevada	3	8	2	21	331	305	1,195	21
Bell	do		612	1,160		128	455	143	
Embree	Tennessee		732	1,260	937	448	800		
Austinville	Virginia				1,276	782	1,582	2,393	(2)
Boulder	Idaho				(2)	(2)	(2)	(2)	(2)

[1] Not listed according to rank.
[2] Bureau of Mines not at liberty to publish figures.

The foregoing table shows all of the mining districts that have produced 1,000 tons of lead, or more, in any of the 8 years from 1921 to 1928. The Southeastern Missouri district has been the largest producer for many years and in 1928 contributed 31 per cent of the United States total. The Coeur d'Alene region of Idaho ranked second in 1928, with 22 per cent of the total to its credit. The Joplin region (tri-State) at the junction of Missouri, Kansas, and Oklahoma ranked third, with 11 per cent of the total. The Bingham, Tintic, and Park City districts, all in Utah, ranked fourth, fifth, and sixth in 1928, having produced 8, 7, and 6.6 per cent, respectively, of the United States total. The San Juan Mountain district, Colorado, contributed 3 per cent, and Butte district, Montana, 2 per cent. Rush Valley district, Utah, was the only other district that produced more than 1 per cent of the total in 1928.

LEAD BALANCE SHEET OF THE UNITED ST

Most of the lead ore mined in the United States is sm its lead content emerges in marketable form as primary lead and antimonial lead. Some of the ore is used in the m of pigments and some may be exported, but for severa amount exported has been negligible. The total primar lead in the various products in which it is produced for compared in the following table with the estimates of recov in the ore mined. The table begins with 1907, the first yea the mine production of the entire country was determine quantities compared were determined by independent canv producers and consumers of lead-bearing ore, the table gi on the accuracy of the figures.

Comparison of mine production of lead and primary domestic lead ac lead products manufactured in the United States, 1907–1928, in

Year	Mine production	Primary lead accounted for in—			
		Refined lead	Antimonial lead	Pigments made from ore	Tot
1907–1918	5,653,706	5,249,081	124,168	121,756	5,503
1919	429,589	424,433	8,339	11,179	443
1920	496,814	476,849	8,032	15,212	500
1921	414,491	398,222	6,675	9,989	414
1922	477,633	468,746	5,810	13,892	488
1923	547,217	543,841	9,794	13,612	567
1924	596,068	566,407	11,741	15,338	593
1925	684,439	654,921	12,500	17,547	684
1926	693,917	680,685	16,620	13,685	710
1927	665,489	668,320	14,044	13,136	695
1928	[1]627,163	626,202	15,825	10,465	652
1919–1928	5,622,810	5,508,626	109,380	134,055	5,752
1907–1928	11,276,516	10,757,707	233,548	255,811	11,247

[1] Includes 8,325 tons of lead produced from domestic ores smelted outside the country.
[2] Includes 3 tons of lead produced from domestic ores smelted outside the country.
[3] Exclusive of the output from Virginia, figures for which the Bureau of Mines is publish.

The table shows substantial discrepancies for indivi probably due largely to variations in mine and smelter st but in none of the last 10 years has the discrepancy exc cent of the total lead produced. From 1907 to 1918—12 y production exceeded the primary lead accounted for in uets by 150,000 tons, or less than 3 per cent. From 19 there was an excess of 129,000 tons, or 2 per cent, in lead contained in the lead products. For the total period 1907 to 1928, mine production exceeded the primary lead lead products by only 21,000 tons or less than one-fifth of

LEAD SMELTERS AND REFINERIES

A list of lead smelters and refineries in the United States, Canada and Mexico follows.

UNITED STATES

Arizona: Douglas—Phelps Dodge Corporation. (Smelter.)
California: Selby—Selby plant, American Smelting & Refining Co. (Smelter and refinery.)
Colorado:
Durango—Durango plant, American Smelting & Refining Co. (Smelter.)
Leadville—Arkansas Valley plant, American Smelting & Refining Co. (Smelter.)
Idaho: Kellogg—Bunker Hill & Sullivan smelter. (Smelter and refinery.)
Illinois:
Chicago—Federated Metals Corporation.[1] (Smelter.)
Collinsville—St. Louis Smelting & Refining Works of National Lead Co. (Smelter and refinery.)
Federal—Federal plant, American Smelting & Refining Co. (Smelter.)
Indiana:
East Chicago—International Lead Refining Co.[4] (Refinery only.)
East Chicago—U. S. S. Lead Refinery (Inc.).[5] (Refinery only. Betts electrolytic process.)
Kansas: Galena—Galena plant, Eagle-Picher Lead Co. (Smelter.)
Missouri:
Granby—American Zinc, Lead & Smelting Co.[6] (Smelter.)
Herculaneum— St. Joseph Lead Co. (Smelter and refinery.)
Joplin—Eagle-Picher Lead Co. (Smelter.)
Montana: East Helena—East Helena plant, American Smelting & Refining Co. (Smelter.)
Nebraska: Omaha—Omaha plant, American Smelting & Refining Co. (Smelter and refinery.)
New Jersey:
Newark—Balbach plant, U. S. Metals Refining Co. (Smelter and refinery.)
Perth Amboy—Perth Amboy plant, American Smelting & Refining Co. (Smelter and refinery.)
Oklahoma: St Louis—Ontario smelter, Eagle-Picher Lead Co. (Smelter.)
Pennsylvania: Carnegie—Pennsylvania Smelting Co.[5] (Smelter and refinery).
Texas: El Paso—El Paso plant, American Smelting & Refining Co. (Smelter.)
Utah:
International—International Smelting Co.[4] (Smelter.)
Midvale—United States Smelting, Refining & Mining Co. (Smelter.)
Murray—Murray plant, American Smelting & Refining Co. (Smelter.)

CANADA

British Columbia: Trail—Consolidated Mining & Smelting Co. of Canada (Ltd.). (Smelter and refinery. Betts electrolytic process.)
Ontario: Galetta—Kingdon Mining, Smelting & Manufacturing Co. (Ltd.). (Smelter.)

MEXICO

Chihuahua: Chihuahua—American Smelting & Refining Co. (Smelter.)
Coahuila: Torreon—American Metal Co. (Ltd.). (Cia. Metalúrgica de Torreon.) (Smelter.)
Hidalgo: Zimapan—Cia. Min. y Fundidora de Zimapan. (Smelter.)
Nuevo Leon:
Monterrey—American Metal Co. (Ltd.). (Cia. Minera de Peñoles—S. A.) (Smelter and refinery.)
Monterrey—American Smelting & Refining Co. (Smelter and refinery.)

[1] Smelters of secondary materials but treating some lead ores.
[4] Subsidiary of Anaconda Copper Mining Co.
[5] Subsidiary of the United States Smelting, Refining & Mining Co.
[6] Plant idle in 1928.

San Luis Potosi: San Luis Potosi—American Smelting
Minera Asarco.) (Smelter.)
Zacatecas: La Fé—American Metal Co. (Ltd.). (Cia.
A.) (Smelter.)

In the following paragraphs the production by
smelting companies, for which published dat
summarized.

The American Smelting & Refining Co. is the
in the United States and operates several lead s
in various parts of the United States and Mexic
extensive mining operations in North and Soutl
lowing table shows the principal metal products
operations during 1927 and 1928 in all countries

Metals produced by the American Smelting & Refinin

Gold	ounces
Silver	do
Lead	pounds
Zinc	do
Copper	do

An important domestic subsidiary of the A
Refining Co. is the Federal Mining & Smelting
mines in the Coeur d'Alene and tri-State (J
strictly a mining organization, its products be
plants of the American Smelting & Refining Co.
shows its production in 1927 and 1928, and the
1928.

Metals produced by the Federal Mining & Smelting Co., 1

		1927
Ore	short tons	1,187,
Gold	ounces	57,
Silver	do	2,187,
Lead	short tons	43,
Zinc	do	44,

The Bunker Hill & Sullivan Mining & Conce
mines and a lead smelter in the Coeur d'Alen
largest producer in that district. The met
output) in 1927 and 1928 was as follows:

Ore mined and milled	short t
Silver	oun
Lead	pou
Zinc	d

The company also does custom smelting but
on that phase of its operations.

The St. Joseph Lead Co. is the largest operator in the Southeastern Missouri lead district. The company's mine production in this district in 1927 and 1928 was as follows:

		1927	1928
Ore	short tons	4,527,095	4,382,135
Lead concentrates	do	208,381	202,801
Lead content	do	151,045	147,691
Zinc concentrates	do	8,390	6,884

The company smelts part of its ore and ships the balance to custom smelters in the St. Louis district; it also has interests, the chief product of which is zinc, in other parts of the country.

The International Smelting Co., a subsidiary of the Anaconda Copper Mining Co., operates a custom smelter at Tooele, Utah, the production of which in 1927 and 1928 was as follows:

		1927	1928
Lead	pounds	140,073,315	145,613,624
Silver	ounces	8,001,707	8,439,372
Gold	do	56,850	65,117
Copper	pounds	20,119,391	20,654,286

The product of the Tooele smelter is base bullion, which is refined by another subsidiary of the Anaconda company, the International Lead Refining Co., at East Chicago, Ind.

Important smelting companies, which do not publish production statistics, include the Eagle-Picher Lead Co., the St. Louis Smelting & Refining Co. (a subsidiary of the National Lead Co.), and the United States Smelting, Refining & Mining Co.

WORLD ASPECTS

WORLD SMELTER PRODUCTION

The following table shows the world smelter production of lead from 1924 to 1928, so far as statistics are available. Official figures are used wherever possible. For countries for which official data are not yet available the figures are taken from the yearbook of the American Bureau of Metal Statistics and other reliable sources, but in later reports the official statistics will be substituted as received.

There is always a possibility of duplication in figures showing world production, for some countries send "work lead" or base bullion to other countries for refining. Furthermore, secondary and antimonial lead are often included in the figures showing the foreign production, so that to put the United States on an equal footing in the statistics it would be necessary to include in its production the domestic output of secondary lead and antimonial lead. The figures for the United States represent refined lead that was smelted in this country, whatever the source of the ore.

World production of lead, 1924–1928, in me

[Compiled by L. M. Jones, of the Bureau of Mi

Country[1]	1924	1925	19
Argentina	4,536	7,700	
Australia	130,494	151,269	15
Austria	4,986	5,408	
Belgium	77,950	87,480	8
Canada	75,503	104,303	12
Chosen	(2)	485	
Czechoslovakia	2,264	2,212	
France	13,881	20,543	
Germany	67,427	89,458	
Great Britain	5,387	4,811	
Greece	5,106	5,366	
India (Burma)	52,590	48,034	
Indo-China			
Italy	22,662	24,475	
Japan	2,941	3,337	
Mexico	133,440	163,242	
Northern Rhodesia	5,999	3,406	
Norway	642	406	
Peru	149	[3]150	
Poland	21,264	28,637	
Portugal	31	60	
Rumania	433	489	
Russia[4]	685	1,021	
Southwest African Protectorate	[5]813	[5]1,019	
Spain	141,849	153,567	
Sweden	477	723	
Tunisia	14,291	16,013	
Turkey	5,104	4,786	
Union of South Africa	4,609		
United States (refined)	555,913	636,790	
Yugoslavia	11,487	10,956	
	1,367,000	1,677,000	1,6

[1] By countries where smelted but not necessarily refined.
[2] In addition to the countries listed, China smelts lead, but no reliab
Official estimates of production in 1925 range from 1,500 to 3,500 tons.
[3] Approximate production.
[4] Data not available.
[5] Year ended Sept. 30.
[6] Year ended Mar. 31 of year following that stated.
[7] Exports.

The world smelter production of lead in 1928 Bureau of Mines, amounted to 1,705,000 metric under the 1927 output. The American Bureau estimates the 1928 output at 1,675,277 metric to under its estimate of production for 1927. The Frankfort am Main, reports the 1928 world outp tons or about 1.5 per cent under the 1927 outp

In 1928, eight countries produced nearly 90 world's supply of lead, as follows: United States, 13.1 per cent; Australia, 9.2 per cent; Canada, 8 per cent; Germany, 6.5 per cent; Belgium, 5.4 (Burma), 4.7 per cent. Other countries which more of the world total were as follows: Poland, 1.3 per cent; Italy, 1.2 per cent; and Tunisia, 1.0 and Peru each produced 0.8 per cent.

The largest tonnage decrease in 1928 (43,40 cent) was in the United States.

Spain fell off 13,000 tons, or 9 per cent, and or 6 per cent. The 1928 outputs of Germany ap equal to those of 1927. Italy and France show 8 per cent, respectively. The largest tonnage Peru, which for the first time became an import

ment relief has been attempted in the form of reduced taxation of prospecting permits and reduction of transport charges on low-grade ores. Development of new areas has been retarded by lack of adequate transportation.

Tunisia exports some ore to Belgium, France, and Germany.

YUGOSLAVIA

Production of lead in Yugoslavia in 1928 was nearly 14,000 metric tons, or 30 per cent more than that in 1927. Exports were 8,800 tons, of which Austria and Hungary took 96 per cent. The Central European Mines (Ltd.) was the principal producer, its smelter at Mezica having produced 9,734 tons of virgin soft lead.

Trepca Mines (Ltd.), a subsidiary of Selection Trust (Ltd.), was reported as developing the Stantrg lead-zinc-silver deposit near the town of Kosovska Mitrovica. The ore body is a replacement in limestone. Reserves were estimated at 1,750,000 tons, averaging 11.5 per cent lead, 10.5 per cent zinc, and 3 ounces of silver per ton.[11]

IMPORTS

The United States imports much lead in various forms, principally in base bullion and ore. Some of it is entered for immediate consumption; most of it, however, is entered for warehouse, is smelted and refined in bond, and is then reexported as refined pig lead or in manufactured products.

GENERAL IMPORTS

The following table shows the general imports of lead into the United States, by classes, including both imports for immediate consumption and imports for warehouse. Of the total lead imported in 1928, as shown in the table, 82.9 per cent was in base bullion, 16.7 per cent in ore, and 0.4 per cent in pigs, bars, sheets, and old. Imports in base bullion increased 9 per cent in 1928, while imports in ore decreased 36 per cent.

Lead imported into the United States, 1919–1928, by classes, in pounds

[General imports]

Year	Lead in ore	Lead in base bullion	Pigs, bars, sheets, and old	Total lead content
1919	19, 573, 856	112, 024, 518	10, 214, 753	141, 813, 127
1920	29, 488, 816	96, 103, 603	71, 437, 108	197, 029, 527
1921	14, 234, 039	71, 733, 838	62, 602, 534	148, 570, 411
1922	24, 474, 481	124, 074, 465	7, 101, 623	155, 650, 569
1923	66, 882, 850	161, 496, 495	42, 198, 848	270, 578, 193
1924	95, 320, 168	155, 501, 350	24, 493, 746	275, 315, 264
1925	88, 962, 502	141, 253, 559	14, 042, 369	244, 258, 430
1926	116, 232, 669	156, 570, 738	22, 304, 620	295, 108, 027
1927	81, 276, 126	236, 567, 252	4, 934, 749	322, 778, 127
1928	51, 829, 530	256, 936, 461	1, 323, 158	310, 088, 149

General imports of lead by countries of origin are shown in the next table. Mexico supplied nearly 89 per cent of the total, South

[11] Mining Magazine (London), vol. 41, August, 1929, p. 72.

America (principally Peru) nearly 6.6 per cent, C
er cent, and Europe and other countries only sma
orts from Mexico decreased 8 per cent from 1927,
Canada and South America increased 131 and 40 per c

ead imported into the United States, in ore, base bullion, and
by sources, in pounds

[General imports]

Year	Canada	Mexico	South America	Europe
1919	10, 391, 115	125, 541, 614	5, 504, 416	89, 840
1920	8, 199, 234	131, 815, 278	7, 085, 351	38, 766, 504
1921	8, 127, 188	106, 406, 238	2, 381, 366	30, 224, 701
1922	8, 663, 236	141, 216, 136	3, 803, 478	1, 454, 384
1923	11, 399, 671	242, 352, 788	6, 300, 161	11, 004, 938
1924	11, 022, 091	248, 161, 069	15, 820, 867	4, 857, 805
1925	11, 646, 820	218, 873, 800	10, 621, 737	1, 594, 963
1926	12, 316, 740	254, 203, 852	24, 790, 076	3, 224, 504
1927	6, 214, 867	300, 634, 815	14, 583, 513	1, 226, 049
1928	14, 352, 967	275, 184, 287	20, 408, 574	56, 406

The following tables show the imports of lead i
base bullion, by countries.

Lead imported into the United States, in ore and matte, 1924–
short tons

[General imports]

Country	1924	1925	1
Mexico	34, 629	32, 971	4
Canada	4, 383	4, 978	
Peru	387	1, 887	
Chile	7, 516	3, 216	
Other countries	745	1, 429	
	47, 660	44, 481	5

Mexico has supplied a large part of the imported
from this source showed a large decrease in 1928. Im
America also decreased, but those from Canada inc

Lead imported into the United States, in base bullion, 1924–1
short tons

[General imports]

Country	1924	1925	1
Mexico	77, 406	70, 505	7
Peru			
Spain			
Other countries	345	122	
	77, 751	70, 627	7

Mexico supplies the bulk of the imported base
quantity imported in 1928 was the greatest recorde
furnished a substantial tonnage as the result of
large-scale lead-smelting operations in that country
copper company.

IMPORTS FOR CONSUMPTION

Statistics on imports for consumption, as shown in the tables that follow, include imports entered for immediate consumption and withdrawals from warehouse for domestic consumption. As most of the lead imported is smelted and refined in bond and reexported the total imported for consumption is considerably less than general imports. In 1928 imports for consumption were equivalent to only about [illegible] per cent of the general imports of lead.

Lead remaining in warehouse in the United States, December 31, 1919–1928

pounds

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

Year	Ore (lead content)	Base bullion (lead content)	Pigs, bars, and old	Year	Ore (lead content)	Base bullion (lead content)	Pigs, bars, and old
1919	29,843,811	61,408,873	468,164	1924	103,474,370	95,007,016	10,090
1920	32,923,299	66,617,026	2,644,576	1925	105,884,711	91,725,008	[1] 16,563
1921	13,679,465	24,692,350	693,440	1926	114,630,697	107,582,653	[1] 21,820,0
1922	10,470,144	7,076,544		1927	99,526,380	126,009,074	[1] 19,226,0
1923	76,031,289	80,306,856	5,234,475	1928	97,648,207	137,500,524	8,278,1

[1] Includes lead in reclaimed scrap, as follows: 1925, 241,078 pounds; 1926, 397,433 pounds; 1927, 397,7 pounds. Corresponding figures for earlier years and for 1928 are not recorded separately.

Lead imported for consumption in the United States, 1919–1928, by classes

Year	Lead in ore [1]		Lead in base bullion		Pigs, bars, and old [2]		Sheets, pipe, and shot		Not otherwise specified	Total value
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value		
1919	4,106,823	$196,303	31,796,693	$1,130,937	10,174,115	$415,094	8,018	$628	$17,187	$1,760,2
1920	13,700,499	908,619	66,816,820	3,340,600	68,901,959	3,887,821	81,396	5,483	21,328	8,163,8
1921	6,842,807	327,040	50,819,980	1,033,410	61,909,094	1,972,716	3,087	140	11,204	3,979,6
1922	23,640,851	812,603	55,859,422	1,815,142	8,563,110	335,924	6,018	697	12,286	2,976,6
1923	22,420,046	1,190,414	11,124,151	626,201	42,925,265	2,510,466	19,525	4,495	00,027	4,421,6
1924	65,147,976	3,145,791	28,796,402	1,542,167	27,362,392	1,850,802	11,600	4,384	138,637	6,681,8
1925	12,700,508	672,112	24,747,665	1,823,656	15,464,205	1,038,350	27,579	10,429	139,533	3,683,9
1926	58,752,911	3,393,039	13,341,038	972,758	24,365,670	2,191,658	864,342	101,322	62,895	6,721,6
1927	70,200,478	4,203,897	14,629,606	925,328	9,933,679	635,807	988,170	104,800	52,626	5,922,5
1928	46,511,508	2,620,231	12,397,455	560,983	20,488,373	808,359	775,329	67,131	134,995	4,197,6

[1] Includes also lead in matte beginning Sept. 22, 1922.
[2] Includes also imports of antimonial lead, antimonial scrap lead, babbitt metal, solder, etc., beginning with tariff of Sept. 22, 1922, except in 1925, 1926, 1927, and 1928, when antimonial lead is excluded.

Type metal [1] imported for consumption in the United States, 1919–1928

Year	Type metal		Lead content	
	Pounds	Value	Pounds	Percentage
1919	13,394,803	$816,642	11,000,498	82.1
1920	20,857,353	1,349,495	25,761,643	86.2
1921	38,971,351	1,191,553	30,700,845	78.8
1922	44,895,120	1,120,814	33,944,199	75.6
1923			7,353,463	[2]
1924	[2]	[2]	1,288,766	[2]
1925 [1]	[2]	[2]	4,309,549	71.7
1926 [1]	6,009,161	463,134	7,053,849	81.8
1927 [1]	8,021,175	912,331	606,654	76.9
1928 [1]	878,346	65,049	3,986,770	77.4
	3,990,548	103,177		

[1] Classification for 1925 to 1928 is "Type metal and antimonial lead"; separate figures not recorded.
[2] Figures not available.

EXPORTS

The chief lead export of the United States is refined pig [illegible] of which is derived from the smelting of foreign o[illegible]ion. In 1928 there was a large decrease in the expor[illegible] notwithstanding a large increase in the productio[illegible] lead from foreign raw materials. At the same time [illegible] increase in the export of domestic refined lead. [illegible] orted in manufactures (chiefly lead pigments and foil [illegible] of drawback amounted to more than 13,000 tons in 1[illegible] total exports of domestic and foreign pig lead decrease[illegible] 1928. Europe, Asia, and South America, the principa[illegible] 75, 20, and 4 per cent of the total, respectively. [illegible] rope and South America decreased considerably, wh[illegible] a increased. United Kingdom and Germany were [illegible] uropean consumers. Exports to the former increased [illegible] 1928 and those to the latter decreased 28 per cent. [illegible] pan in 1928 were 26 per cent greater than those in 19[illegible] ented 18 per cent of the total United States export. [illegible] exports to South America in 1928 was due largely to [illegible] per cent and 27 per cent in exports to Chile and Argen[illegible] ely. Brazil was the largest South American import[illegible] tates lead in 1928.

Refined lead, from domestic ores, exported from the United State[illegible]

Year	Short tons	Value	Year	Sho[illegible]
1919	10,510	$1,471,256	1924	
1920	2,730	462,223	1925	
1921	1,624	177,926	1926	
1922	5,823	604,005	1927	
1923	1,999	260,487	1928	

Foreign lead exported from the United States, 1919–1[illegible]

Year	Exported from warehouse		All [illegible]
	Pigs, bars, and old [1]		
	Pounds	Value	
1919	81,951,396	$4,536,273	
1920	34,725,501	2,570,535	
1921	50,000,259	2,284,107	
1922	64,709,305	3,177,360	
1923	97,471,326	5,195,256	
1924	153,515,863	9,685,619	
1925	197,128,517	14,910,891	
1926	135,319,321	8,904,603	
1927	245,467,878	12,508,556	
1928	204,134,083	9,060,200	

[1] Since July 1, 1915, the Bureau of Foreign and Domestic Commerce has classed a[illegible] or refined in this country and exported as "domestic exports of pigs, bars, etc., p[illegible] ore." The figures include also the exports of foreign lead imported in the form of [illegible]
[2] Not separately classified after 1922.

Foreign lead exported in manufactures with benefit of drawback, 1927 and 1928, by sources, in pounds

Commodity exported	Foreign lead contained in articles exported and products in which the lead was imported									
	In ore		In bullion		In type metal		Pigs, bars, etc.		Total	
	1927	1928	1927	1928	1927	1928	1927	1928	1927	1928
Lead-covered cable							1,900,653	245,910	1,900,653	245,910
Tin cans							98,082	121,397	98,082	121,397
Lead-headed nails							8,033	28,785	8,033	28,785
Lead seals							19,043	46,966	19,043	46,966
Lead foil							8,225,780	11,620,707	8,225,780	11,620,707
Lead calking	32,636						382,386		415,022	
Type metal			90,823	182,427				532,020	90,823	714,447
Type					295,008				295,008	
Antimonial lead						13,525	203,896	213,999	203,896	227,524
Babbitt							198,930	30,183	198,930	30,183
Shot, sheet pipe		478,564	217,636	90,730			2,126,374	3,638,790	2,344,010	4,208,084
Shot shells							357,853	164,203	357,853	164,203
Lead arsenate		14,211					13,327	209,442	13,327	223,653
Red lead, in oil								69,196		69,196
Red lead and litharge	44,062		160,295	593,690			695,202	908,049	899,559	1,501,739
White lead, dry							4,643,472	6,198,038	4,643,472	6,198,038
White lead, in oil	38,593						4,290,119	1,048,001	4,328,712	1,048,001
	115,291	492,775	468,754	866,847	295,008	13,525	23,129,750	25,076,755	24,008,803	26,448,902

Domestic and foreign pig lead exported from the United States, 1927 and 1928, by destinations

Destination	Domestic		Foreign	
	Short tons	Value	Short tons	Value
1927				
North America:				
Canada	94	$20,018	26	$5,250
Cuba	55	9,017	147	18,629
Mexico	45	9,734	1	93
Panama	16	2,898	50	6,730
Other	35	5,660	22	2,897
	245	47,327	246	33,599
South America:				
Argentina	37	3,408	1,657	173,408
Brazil	6	911	2,415	250,483
Chile	1,248	141,193	2,285	292,300
Colombia	41	7,829	52	7,814
Peru	6	843	84	9,316
Uruguay			395	45,290
Other	16	2,766	282	30,474
	1,354	156,950	7,170	809,083
Europe:				
Belgium			1,495	155,436
France			7,694	725,560
Germany			32,734	3,258,650
Italy			336	35,518
Netherlands			4,765	459,886
Sweden			4,269	428,550
United Kingdom	112	14,000	38,222	3,856,461
Other	1	287	5,320	578,232
	113	14,293	94,825	9,493,293

Domestic and foreign pig lead exported from the United States, by destinations—Continued

Destination	Domestic		Sh
	Short tons	Value	
1927			
Asia:			
China	(1)	$45	
Japan	561	59,222	
Philippine Islands	59	9,155	
Other	201	21,645	
	821	90,067	
Africa	(1)	16	
Oceania, including Australia	(1)	45	
	2,583	308,698	
1928			
North America:			
Canada	132	18,622	
Cuba	56	8,363	
Mexico	37	6,842	
Panama	17	2,430	
Other	42	6,615	
	284	42,872	
South America:			
Argentina	25	3,842	
Brazil	327	30,614	
Chile	222	27,481	
Colombia	68	9,296	
Ecuador	11	1,631	
Peru	5	578	
Uruguay	56	5,500	
Other	88	8,716	
	802	87,658	
Europe:			
Belgium	113	10,111	
Denmark	110	11,108	
France	399	36,018	
Germany	2,971	262,428	
Italy	112	9,860	
Netherlands	538	48,860	
Sweden	964	85,925	
United Kingdom	7,807	692,314	
Other	(1)	33	
	13,020	1,156,657	
Asia:			
China			
Japan	2	393	
Philippine Islands	49	6,287	
Other	45	5,055	
	96	11,735	
Africa	(1)	57	
Oceania, French	(1)	42	
	14,202	1,299,021	

1 Less than 1 ton.

CONSUMPTION

APPARENT CONSUMPTION OF REFINED PRIMARY LEAD

Apparent consumption of refined primary lead in the United States, refinery stocks disregarded, 1923–1928, in short tons

	1923	1924	1925	1926	1927	1928
Supply:						
Stock in bonded warehouse Jan. 1		2,617	5,045	8,162	10,711	9,464
Imports of pigs, bars, and old[1]	21,099	12,247	7,021	11,152	2,467	66[illegible]
Production	618,322	690,493	766,969	798,941	798,530	781,07[illegible]
	639,421	705,357	779,035	818,255	809,708	791,1[illegible]
Withdrawn:						
Exports of foreign lead—						
From warehouse	48,736	76,758	93,504	67,660	122,734	102,067
In manufactures, with benefit of drawback	12,526	15,276	11,699	17,955	12,004	13,22[illegible]
Exports of domestic lead	1,999	5,332	4,955	4,276	2,533	14,20[illegible]
Stock in bonded warehouse Dec. 31	2,617	5,045	8,162	10,711	9,464	4,13[illegible]
	65,878	102,410	123,380	100,602	146,735	133,6[illegible]
Apparent consumption	573,543	602,947	655,655	717,653	[2]662,973	657,[illegible]

[1] Includes 622 tons of "old, reclaimed, and scrap" in 1925 and 1,135 tons in 1926. Corresponding figures for other years not separately recorded.
[2] Revised figures.

The foregoing table is intended to include only primary lead or lead smelted directly from ore. There are, however, some small discrepancies which should be pointed out. Many primary lead smelters produce from secondary materials some lead which is inseparable from the primary lead in the final product. Exports of lead as reported above may therefore contain some secondary lead. There are also some inaccuracies in the statistics of imports, exports, and warehouse transactions. Nevertheless, on the basis of the data available, the table gives approximately the quantity of new refined lead entering into American industry each year.

The apparent consumption of refined primary lead in 1928 amounted to 657,565 tons, a decrease of 1 per cent from 1927. As the use of lead is intimately associated with the uses of other common metals, and as the apparent consumption of primary copper, zinc, and iron increased 13, 12, and 4 per cent, respectively, it is concluded that the decrease in the consumption of primary lead was due largely to increased use of secondary lead, recovery of which increased 12 per cent in 1928 and was equivalent to 47 per cent of the primary lead consumed.

CONSUMPTION BY USES

The American Bureau of Metal Statistics each year estimates the quantity of lead used by the various industries. The following table is quoted in full from the 1928 yearbook of that bureau.

Lead consumed in the United States,[1] 1920–1928, i

Purpose	1920	1921	1922	1923	1924	1928
White lead[2]	116,500	136,000	156,000	130,000	150,000	131,0
Red lead and litharge[3]	45,000	23,500	30,000	46,000	34,000	42,0
Storage batteries[4]	108,000	87,000	130,000	143,000	170,000	180,0
Cable covering[4]	79,000	67,000	93,000	131,000	138,000	156,0
Building[4]	71,000	48,000	71,000	75,000	83,100	88,4
Automobiles[5]	4,750	4,600	7,200	10,400	10,700	12,8
Locomotives[4]	2,000	1,000	850	2,100	1,100	2
Railway cars[4]	2,800	1,800	2,600	6,000	4,500	4,4
Shipbuilding[4]	1,550	850	100	100	200	1
Ammunition[4]	33,600	26,500	38,000	40,000	27,000	31,5
Terneplate[4]	3,100	3,000	4,700	4,600	4,050	4,5
Foil[4]	21,000	23,800	26,800	33,300	35,000	32,5
Bearing metal[4]	26,000	21,000	26,000	28,000	32,000	34,0
Solder[7]	15,000	12,000	20,000	30,000	30,000	35,0
Type metal[7]	7,500	7,500	9,500	12,000	13,000	15,0
Calking[4]	24,000	20,000	20,000	25,000	26,500	30,0
Castings[4]	15,000	12,000	15,000	15,000	15,000	18,0
Other uses[8]	29,000	25,000	32,500	36,500	38,000	40,5
Total[9]	604,800	520,550	683,150	768,000	812,150	856,5

[1] Source: American Bureau of Metal Statistics. These estimates are for th
irrespective of whether its origin be primary or secondary. Antimonial lead is in
of lead for export under drawback provisions is included.
[2] From data of sales reported by U. S. Geological Survey and U. S. Bureau
content at 80 per cent.
[3] Based on data of sales reported by U. S. Geological Survey and U. S. Burea
content of litharge at 92 per cent and red lead at 90 per cent, and from the to
mated as going into storage batteries, this deduction being to eliminate dupli
[4] Based on reports from a large proportion of manufacturers in each industry
of ammunition were not requested to report for 1919–1921 and the estimates for
[5] Based upon estimates of manufacture and the quantity of lead used per u
the head of building is included the lead used in chemical construction and it
[6] Based on the estimated consumption of lead for this purpose by the railw
[7] Estimates of persons engaged in the trades.
[8] Conjectural.
[9] These totals are probably slight understatements.

According to the foregoing table the lead consum
States industry in 1928 amounted to 930,500 tons
all previous records. It exceeded 1927 by 11 per c
previous peak, by 3 per cent. In the following ta
uses of lead have been arranged according to their p
to the total lead consumed in 1928.

Percentage of total lead consumed in the United States, 1

Use	1924	192
Storage batteries	20.93	21.0
Cable coverings	17.00	18.3
White lead	18.47	15.3
Building	10.23	10.3
Ammunition	3.32	3.0
Solder	3.69	4.0
Foil	4.31	3.8
Bearing metal	3.94	3.9
Calking	3.26	3.4
Litharge and red lead	4.19	4.0
Castings	1.85	2.1
Type metal	1.70	1.7
Automobiles	1.32	1.4
Terneplate	.50	.5
Railway cars	.55	.5
Locomotives	.14	.0
Shipbuilding	.02	.0
Miscellaneous	4.68	4.5

For several years storage batteries have been the largest consumer of lead, having taken first place from white lead in 1923. Storage batteries are used chiefly in motor vehicles, and the 26 per cent increase in the quantity of lead used in storage batteries in 1928 is in part a reflection of the 28 per cent increase in the number of automobiles and trucks manufactured in that year. Exports of storage batteries have grown steadily from a total of about 207,000 in 1925 to 338,000 in 1928, an increase of 63 per cent. The expansion of the automobile industry and export trade has more than offset the decreased use of storage batteries in radios which resulted from the introduction of "socket power" sets. In 1928 the use of lead in storage batteries exceeded all previous years. The American Bureau of Metal Statistics has estimated that about 15,000,000 storage batteries were manufactured in 1928.

The second largest use of lead is as a protective coating for copper wire cables used chiefly in telephone and underground transmission lines. The quantity of lead so used was 12 per cent greater in 1928 than in 1927 but was slightly less than in 1926. This use appears to be sure to increase. General expansion of the use of electrical power, such as the large electrification programs announced by some of the railway companies and the development of the Boulder Dam and other great power projects, will require large amounts of lead-covered cable. Increasing civic consciousness will undoubtedly result in placing many of the present unsightly overhead transmission lines underground, as has been the custom in Washington, D. C., for many years. Research work now in progress to determine the causes and remedies of certain defects in lead-covered cable that have limited its use in some industries should yield profitable results in expanding the market for lead-covered cable.

The manufacture of white lead is the third largest use of lead, but one that appears to be on the decline. Prior to 1923 this industry was the largest consumer of lead and in 1922 took 156,000 tons of lead, or 23 per cent of the total estimated lead consumption. In 1928 only 123,000 tons (13 per cent of the total) was so used. The declining use of white lead is due to the substitution in paints of the cheaper pigments, principally lithopone and zinc oxide, and to the increased use of nitrocellulose paints in which white lead is seldom used on account of its chemical instability in contact with nitrocellulose products.

During the war lead-tin-cadmium solders containing more lead and less tin than ordinary lead-tin solders were developed and proved economical under the high prices of tin then prevailing. Research has since been continued and several new substitutes have been developed, but owing to the recent increase in the price of cadmium and decrease in the price of tin the advantage of the lead-tin-cadmium solders from a cost standpoint has practically disappeared.

An interesting and comparatively new use of lead is in the manufacture of tetra-ethyl-lead for use in antiknock gasoline. The company making this product estimates that the consumption of this type of gasoline in 1929 will be 1,145,000,000 gallons and that 2,700 tons of

metallic lead will be used. As this quantity represe
cent of the total gasoline consumed annually in the Uni
appears to be room for a substantial increase in the
this way.

New uses of lead developed in 1928 have been s
Metal Industry as follows:[12]

Some uses of lead have occurred during the year which may be
Molten lead is used in high pressure autoclaves in the Blummer
benzine by cracking from benzine free crude oil. The function
ably to aid in an even distribution of heat and it is said that no
takes place. 'A reduction in the noise made by trolley cars
tially filling the inside of the gear wheels with lead. Lead-thalli
used in very small quantities by the General Electric Co., for
gives way at slightly higher temperatures than either lead or th
inghouse Electric & Manufacturing Co. is using a new solder
It is said to be even better than low tin high lead solders for
peratures than is possible with ordinary solders. The compo
Silver, 2½; copper, ¼; lead, 97¼.

PRICES

The two major markets for lead in the United States
and St. Louis, and a large part of the lead produced in t
is sold at prices based on the quotations in these two
New York quotations are influenced to some extent by
usually prevailing on the London market, so that the
seldom exceeds the St. Louis price by as much as the fr
0.35 cent a pound. The following tables show the
quoted prices of lead at St. Louis, New York, and L
1927, and 1928 and the average yearly prices fro
inclusive.

Average monthly quoted prices of lead at St. Louis, New York, 1928, in cents per pound[a]

Month	1926			1927		
	St. Louis	New York	London	St. Louis	New York	Londo
January	9.14	9.35	7.54	7.41	7.58	5.95
February	9.02	9.17	7.36	7.29	7.48	5.92
March	8.19	8.50	6.86	7.34	7.61	6.03
April	7.76	8.04	6.26	6.84	7.11	5.76
May	7.58	7.81	6.13	6.27	6.60	5.43
June	7.90	8.11	6.51	6.16	6.43	5.30
July	8.46	8.63	6.89	6.13	6.36	5.09
August	8.81	8.91	7.10	6.39	6.68	5.02
September	8.52	8.78	6.95	6.05	6.31	4.66
October	8.13	8.40	6.67	6.01	6.26	4.45
November	7.81	8.00	6.34	6.04	6.28	4.55
December	7.09	7.80	6.27	6.33	6.51	4.83

[a] St. Louis: Metal Statistics, 1929, p. 391. Average daily quotations of soft Mis
(open market), as reported daily in the American Metal Market.
New York: American Metal Market, monthly review section. Pig lead, N
prompt shipment from west.
London: Metal Statistics, 1929, p. 395. Average price of foreign lead. Price pe
Metal Statistics, converted to cents per pound at average exchange rate report
Board.

[12] Metal Industry, New York, vol. 27, January, 1929, p. 12.

Average yearly prices of lead at St. Louis, New York, and London, 1909–1928

Year	St. Louis [1] (per pound)	New York [2] (per pound)	London [3]		New York excess (+) or London excess (−) (per pound) [4]
			Per long ton	Per pound	
	Cents	*Cents*		*Cents*	*Cents*
1909	4.19	4.30	£13.083	2.84	+1.46
1910	4.33	4.49	12.950	2.81	+1.68
1911	4.31	4.46	13.403	2.92	+1.54
1912	4.38	4.48	17.792	3.87	+.61
1913	4.26	4.40	18.308	3.98	+.42
1914	3.74	3.87	18.688	4.09	−.22
1915	4.57	4.67	22.883	4.85	−.18
1916	6.80	6.83	30.975	6.58	+.25
1917	8.92	8.71	30.000	6.37	+2.34
1918	7.25	7.46	30.133	6.40	+1.06
1919	5.55	5.81	28.196	5.57	+.24
1920	7.93	8.08	38.229	6.25	+1.83
1921	4.39	4.55	22.725	3.90	+.65
1922	5.62	5.71	23.742	4.69	+1.02
1923	7.35	7.25	26.817	5.48	+1.77
1924	8.10	8.08	33.600	6.64	+1.44
1925	8.92	9.02	35.863	7.73	+1.29
1926	8.25	8.42	31.075	6.74	+1.68
1927	6.52	6.78	24.192	5.25	+1.60
1928	6.14	6.31	21.058	4.58	+1.73

[1] Compiled from daily quotations in the open market at St. Louis, as published in Metal Statistics, 1929, p 389.
[2] Average prices based on quotations of American Smelting & Refining Co., as published in Metal Statistics, 1929, p. 383.
[3] Prices of foreign lead in London, as published in Metal Statistics, 1929, p. 395, converted to cents per pound on basis of average exchange rates published in the reports of the Federal Reserve Board.
[4] Import duties on refined pig lead have been as follows: Aug. 6, 1909, to Oct. 3, 1913—2½ cents per pound. Oct. 4, 1913, to Sept. 21, 1922—25 per centum ad valorem; average tariff collected—1½₀ cents per pound. Sept. 22, 1922, to date (1928)—2½ cents per pound.

To facilitate the settlement of its buying and selling contracts for lead the American Smelting & Refining Co., which controls a large part of the United States lead production, at frequent intervals publishes an official contract price based on the New York market. The following are the company's quotations for 50-ton lots, f. o. b. New York, in 1927 and 1928, in cents per pound.

1927		1927	
Jan. 6	7.65	Aug. 24	6.60
Jan. 20	7.50	Aug. 30	6.50
Jan. 25	7.40	Sept. 6	6.40
Mar. 2	7.55	Sept. 9	6.25
Mar. 3	7.65	Nov. 28	6.30
Mar. 23	7.55	Nov. 29	6.40
Mar. 25	7.45	Dec. 1	6.50
Mar. 29	7.35		
Apr. 4	7.25	1928	
Apr. 18	7.15		
Apr. 20	7.00	Feb. 10	6.35
Apr. 28	6.85	Feb. 20	6.25
May 2	6.75	Feb. 27	6.15
May 10	6.65	Mar. 1	6.00
May 19	6.50	Apr. 2	6.10
May 26	6.40	May 25	6.20
July 1	6.30	May 29	6.30
July 7	6.20	July 9	6.20
July 20	6.30	Aug. 23	6.30
July 21	6.40	Aug. 27	6.40
July 22	6.50	Sept. 17	6.50
July 29	6.60	Nov. 9	6.35
Aug. 3	6.75	Dec. 3	6.50

The downward trend in the price of lead, which
part of 1925, apparently reached a final low point
and for the balance of that year the trend was d
The average quotation for January, 1928, was 6.50
at New York. By March the monthly average h
6.02 cents, but the low point in daily quotations wa
the first part of the month, so that the trend durin
of the month was slowly upward. This upward
regular thereafter, and in October the monthly ave
reached 6.50 cents, the January quotation. In Nov
slight recession, but in December the average was
The opening quotation on January 2, 1928, was 6.5
closing quotation on December 31, 1928, was also 6

The average New York price for 1928 was 6.31 c
less than the 1927 average, 30 per cent less than
price, and the lowest annual average since 1922.
market averaged 0.17 cent per pound over the St.
1928, as compared with 0.23 cent in 1927.

The average price, including domestic and foreign
lead producers in the United States in 1928, accor
producers to the Bureau of Mines, was 5.8 cents a
it was 6.3 cents.

The London quotation reached the low mo
March, attained the high for the year in October, decl
to less than the January average, and failed to recov
ber. The yearly average was 13 per cent less in 1
it was 1.73 cents cent per pound under the New Y
as compared to 1.50 cents in 1927.