

DEPARTMENT OF COMMERCE

BUREAU OF THE CENSUS

WASHINGTON

FOURTEENTH CENSUS OF THE UNITED STATES

MANUFACTURES: 1919

CHEMICALS

SULPHURIC, NITRIC, AND MIXED ACIDS, AND
COAL-TAR PRODUCTS

TOGETHER WITH

THE COKE AND SALT INDUSTRIES

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EXPLANATION OF TERMS.

Scope of census.—Census statistics of manufactures are compiled primarily for the purpose of showing the absolute and relative magnitude of the different branches of industry covered and their growth or decline. Incidentally, the effort is made to present data throwing light upon character of ownership, size of establishments, and similar subjects. When use is made of the statistics for these purposes it is imperative that due attention be given to their limitations, particularly in connection with any attempt to derive from them figures purporting to show average wages, cost of production, or profits.

The census did not cover establishments which were idle during the entire year or for which products were valued at less than \$500, or the manufacturing done in educational, eleemosynary, and penal institutions.

Period covered.—The returns relate to the calendar year 1919, or the business year which corresponded most nearly to that calendar year, and cover a year's operations, except for establishments which began or discontinued business during the year.

The establishment.—As a rule, the term "establishment" represents a single plant or factory, but in some cases it represents two or more plants which were operated under a common ownership or for which one set of books of account was kept. If, however, the plants constituting an establishment as thus defined were not all located within the same city, county, or state, separate reports were secured in order that the figures for each plant might be included in the statistics for the city, county, or state in which it was located. In some instances separate reports were secured for different industries carried on in the same establishment.

Classification by industries.—The establishments were assigned to the several classes of industries according to their products of chief value. The products reported for a given industry may thus, on the one hand, include minor products different from those covered by the class designation, and, on the other hand, may not represent the total product covered by this designation, because some products of this class may be made in establishments in which it is not the product of chief value.

Influence of increased prices.—In comparing figures for cost of materials, value of products, and value added by manufacture in 1919 with the corresponding figures for earlier censuses, account should be taken of the general increase in the prices of commodities during recent years. To the extent to which this factor has been influential the figures fail to afford an exact measure of the increase in the volume of business.

Persons engaged in the industry.—The following general classes of persons engaged in the manufacturing industries were distinguished: (1) Proprietors and firm members, (2) salaried officers of corporations, (3) superintendents and managers, (4) clerks (including other subordinate salaried employees), and (5) wage earners.

The number of persons engaged in each industry, segregated by sex, and, in the case of wage earners, also by age (whether under 16 or 16 and over), was reported for a single representative day. The 15th of December was selected as representing for most industries normal conditions of employment, but where this date did not portray such conditions, an earlier date was requested.

In the case of employees other than wage earners the number thus reported for the representative date has been treated as equivalent to the average for the year, since the number of employees of this class does not ordinarily vary much from month to month. In the case of wage earners the average has been obtained in the manner explained in the next paragraph.

In addition to the more detailed report by sex and age of the number of wage earners on the representative date, a report was obtained of the number employed on the 15th of each month, by sex, without distinction of age. From these figures the average number of wage earners for the year has been calculated by dividing the sum of the numbers reported for the several months by 12. The importance of the industry as an employer of labor is believed to be more accurately measured by this average than by the number employed at any one time or on a given day.

The number of wage earners reported for the representative day, though given in certain tables for each separate industry, is not totaled for all industries combined, because, in view of the variations of date, such a total is not believed to be significant. It would involve more or less duplication of persons working in different industries at different times, would not represent the total number employed in all industries at any one time, and would give an undue weight to seasonal industries as compared with industries in continual operation.

In order to determine as nearly as possible the age distribution of the average number of wage earners for an industry, the per cent distribution by age of the wage earners for December 15, or the nearest representative day, has been calculated from the actual numbers reported for that date. The percentages thus obtained have been applied to the average number of wage earners for the year to determine the average numbers 16 years and over, and under 16, employed.

Salaries and wages.—Under these heads are given the total payments during the year for salaries and wages, respectively. The Census Bureau has not undertaken to calculate the average annual earnings of either salaried employees or wage earners. Such averages would possess little real value, because they would be based on the earnings of employees of both sexes, of all ages, and of widely varying degrees of skill. Furthermore, so far as wage earners are concerned, it would be impossible to calcu-

late accurately even so simple an average as this, since the number of wage earners fluctuates from month to month in every industry, and in some cases to a very great extent. The Census Bureau's figures for wage earners, as already explained, are averages based on the number employed on the 15th of each month, and while representing the number according to the pay rolls to whom wages were paid on that date, no doubt represent a larger number than would be required to perform the work in any industry if all were continuously employed during the year.

Prevailing hours of labor.—No attempt was made to ascertain the number of wage earners working a given number of hours per week. The inquiry called merely for the prevailing practice followed in each establishment. Occasional variations in hours in an establishment from one part of the year to another were disregarded, and no attention was paid to the fact that a few wage earners might have hours differing from those of the majority. All the wage earners of each establishment are therefore counted in the class within which the establishment itself falls. In most establishments, however, practically all the wage earners work the same number of hours, so that the figures give a substantially correct representation of the hours of labor.

Capital (amount actually invested).—The instructions on the schedule for securing data relating to capital were as follows:

"The answer should show the total amount of capital, both owned and borrowed, on the last day of the business year reported. All the items of fixed and live capital may be taken at the amounts carried on the books. If land or buildings are rented, that fact should be stated and no value given. If a part of the land or buildings is owned, the remainder being rented, that fact should be so stated and only the value of the owned property given. Do not include securities and loans representing investments in other enterprises."

These instructions were identical with those employed at the censuses of 1914 and 1909. The data compiled in respect to capital, however, at both censuses, as well as at all preceding censuses of manufactures, have been so defective as to be of little value except as indicating general conditions. In fact, it has been repeatedly recommended by the census authorities that this inquiry be omitted from the schedule. While there are some establishments whose accounting systems are such that an accurate return for capital could be made, this is not true of the great majority, and the figures therefore do not show the actual amount of capital invested.

Materials.—The statistics as to cost of materials relate to the materials used during the year, which may be more or less than the materials purchased during the year. The term "materials" covers fuel, rent of power and heat, mill supplies, and containers, as well as materials which form a constituent part of the product.

Rent and taxes.—The taxes include certain Federal taxes and state, county, and local taxes. Under "Federal taxes" there are included the internal revenue tax on manufactures (tobacco, beverages, etc.), excise taxes when included in values reported for products, corporation capital stock tax, and corporation income tax, but not the income tax for individuals and partners.

Value of products.—The amounts given under this heading represent the selling value or price at the factory of all products manufactured during the year, which may differ from the value of the products sold.

Value added by manufacture.—The value of products is not always a satisfactory measure of either the absolute or the relative importance of a given industry, because only a part of this value is actually created by the manufacturing processes carried on in the industry itself. Another part, and often by far the larger one, represents the value of the materials used. For many purposes, therefore, the best measure of the importance of an industry, from a manufacturing standpoint, is the value created by the manufacturing operations carried on within the industry. This value is calculated by deducting the cost of the materials used from the value of the products. The figure thus obtained is termed in the census reports "value added by manufacture."

Cost of manufacture and profits.—The census data do not show the entire cost of manufacture, and consequently can not be used for the calculation of profit. No account has been taken of depreciation or interest, rent of offices and buildings other than factory or works, insurance, ordinary repairs, advertising, and other sundry expenses.

Primary horsepower.—This item represents the total primary power equipment of the manufacturing establishments plus the amount of power, principally electric, rented from other concerns. It does not cover the power of electric motors taking their current from dynamos driven by primary power machines operated by the same establishment, because the inclusion of such power would obviously result in duplication. The figures for primary horsepower represent the rated capacity of the engines, motors, etc., and not the amount of power in actual daily use.

Fuel.—Statistics of the quantity of fuel used are shown only for anthracite and bituminous coal, coke, fuel oils, gasoline and other volatile oils, and gas, and represent the quantity used during the year. As only the principal kinds of fuel are shown, comparison as to the total cost of all fuel is impracticable.

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CHEMICALS; SULPHURIC, NITRIC, AND MIXED ACIDS; AND COAL-TAR PRODUCTS;

TOGETHER WITH

THE COKE AND SALT INDUSTRIES.

The statistics for the industries Chemicals; Sulphuric, nitric, and mixed acids; and Coal-tar products are here presented as a group on account of the extensive overlapping of products, and following these industries

are presented the statistics for the Coke and Salt industries, which supply important basic materials for the group.

CHEMICALS.

GENERAL STATISTICS.

General character of the industry.—The industry, "chemicals," according to the census classification, embraces establishments engaged in the manufacture of products grouped under the following heads: I, Acids; II, Ammonium and cyanogen compounds; III, Sodas, sodium, and compounds; IV, Potash, potassium, and compounds; V, Alums, aluminum, and compounds; VI, Bleaching compounds; VII, Coal-tar chemicals; VIII, Plastics; IX, Compressed and liquefied gases; and X, Chemicals, not elsewhere specified.

This classification does not include all chemicals in the broad sense of the word, as some are included under distinctive titles. Establishments engaged primarily in the manufacture of sulphuric acid, nitric acid, or mixed acid are segregated under the title "Sulphuric, nitric, and mixed acids." However, in presenting the statistics for a specific chemical product, the information given, unless otherwise stated, refers to total production, irrespective of the classification of the producing establishment.

Comparative summary.—Table 2 presents the comparative statistics for the census years 1899 to 1919, inclusive, for the chemical industry, with percentages of increase for the respective census periods.

Principal states, ranked by value of products.—Table 3 summarizes the more important statistics for the industry, by states, ranked according to value of products. Though establishments were reported from 38 states, including the District of Columbia, the industry is largely centralized; New York, New Jersey, and Pennsylvania, constituting the Middle Atlantic division, reporting 55.9 per cent of the products, 52.7 per cent of the wage earners, and 222 establishments, or 37.1 per cent of the total number.

Persons engaged in the industry.—The age classification of the average number of wage earners in Table 4, is an estimate obtained by the method described in the "Explanation of terms." Figures for states will be found in Table 36. The female wage earners increased from 4.5 per cent of all wage earners in 1909 to 5.3 per cent in 1914 and to 8.3 per cent in 1919; and in the case of clerks and other subordinate salaried employees, females constituted 34.5 per cent in 1919 as compared with 16.7 per cent in 1909.

Wage earners, by months.—Table 5 is designed to show the regularity of employment, or the reverse, in accordance with the industrial conditions existing during the census year. Females constituted 8.5 per cent of the average number of wage earners in 1919. The statistics show a somewhat greater range between the minimum and maximum months in 1919 than was the case with the earlier censuses, the number reported for the minimum month, May, in 1919, being 84 per cent of the number reported for the maximum month, January. In 1914 the minimum month was 97.1 per cent of the maximum month, and in 1909, 90.2 per cent. Of the states reporting 1,000 or more wage earners, the monthly fluctuation ranged from 66.5 per cent, minimum month of maximum month, for Indiana and Michigan, to 95.2 per cent for Missouri.

Prevailing hours of labor.—The statistics in Table 6 show a very marked movement towards shorter hours of labor. In 1909, 56.2 per cent of the wage earners were employed in establishments where the prevailing hours of labor per week were 60 or more, and in 1914 51.3 per cent were within this class. In 1919, however, the proportion dropped to 13.9 per cent. On the other hand, in 1909 the number employed in establish-

ments where the prevailing hours of labor per week were 48 or less was negligible, only four-tenths of 1 per cent; and in 1914 the number so employed was 2.9 per cent, but in 1919, 38.4 per cent of the wage earners came within this group.

Size of establishments, by average number of wage earners.—In 1914 the establishments averaged 82 wage earners per establishment, and in 1919, 93 wage earners. In 1914 there were 17 establishments each of which employed over 500 wage earners, the number constituting 52.1 per cent of all wage earners in the industry. In 1919 Table 7 shows that the number of establishments of this class had increased to 28, and the wage earners constituted 57.7 per cent of the total.

Size of establishments, by value of products.—The grouping based upon value of products in Table 8 is necessarily affected by the general increase in values since the census of 1914, and this rise is reflected in the changes from lower to higher groups, as well as in the increase in average value of products per establishment. In 1909 the establishments averaged \$328,000 in value of products, in 1914, \$400,000, and in 1919, \$734,000; the increase from 1914 to 1919 being to a considerable extent due to the increase in values, for though the increase in value of products for all establishments for the period 1914-1919 was

177.5 per cent, the increase in average number of wage earners, an index of normal growth, was but 72 per cent.

Character of ownership.—Table 9 presents statistics concerning the character of ownership, or legal organization, of establishments in the industry for 1919, 1914, and 1909, and for the leading states for 1919 and 1914. The figures show growth for the corporation group, and although establishments under other forms of ownership still constitute a considerable number, the corporations account for 98.7 per cent of the products and 99.1 per cent of the wage earners.

Number and horsepower of types of prime movers.—Table 10 presents the power statistics for the industry. There is shown a material increase in electric power. Though the equipment operated with purchased electric current in 1919 is somewhat less in rated capacity than in 1914, yet the motor equipment using current generated by the establishment from prime movers, was materially greater, and in the aggregate the electric power equipment was equal in capacity to 62.6 per cent of the total primary power rating in 1919, as compared with 61.1 per cent in 1914 and 75.1 per cent in 1909.

Fuel consumed.—Table 11 presents the statistics for fuel consumed, by kinds and by states, for 1919 and for 1914. The figures for gas include both natural and manufactured gas.

TABLE 2.—COMPARATIVE SUMMARY: 1919, 1914, 1909, 1904, AND 1899.

	1919	1914	1909	1904	1899	PER CENT OF INCREASE, ¹			
						1914-1919	1909-1914	1904-1909	1899-1904
Number of establishments.....	598	395	359	297	316	51.4	10.0	20.9	-6.0
Persons engaged.....	66,947	37,881	27,817	22,792	(²)	76.7	36.2	22.0	.....
Proprietors and firm members.....	122	99	161	151	(²)	23.2	-38.5	5.6	.....
Salaried employees.....	11,239	5,471	3,927	2,794	1,596	105.0	39.3	40.6	75.1
Wage earners (average number).....	55,586	32,311	23,729	19,847	15,183	72.0	39.2	19.6	30.9
Primary horsepower.....	376,940	282,385	208,657	132,394	(²)	33.5	35.3	57.6	.....
Capital.....	\$484,488,412	\$224,345,921	\$155,198,945	\$96,764,847	\$68,453,931	116.0	44.6	60.4	41.4
Salaries and wages.....	97,188,958	31,086,615	20,236,551	14,873,791	9,717,475	213.0	53.6	35.1	53.1
Salaries.....	24,340,634	9,020,703	6,140,628	4,060,033	2,327,854	170.0	48.9	51.2	74.4
Wages.....	72,848,324	22,066,212	14,095,923	10,813,758	7,389,621	239.0	56.5	30.4	48.3
Paid for contract work.....	1,321,738	375,435	181,011	155,558	(²)	252.0	107.4	15.4	.....
Rent and taxes.....	32,528,130	1,733,251	860,490	860,490	545,204	1,777.0	101.4	.....	.....
Cost of materials.....	216,301,279	89,450,694	64,145,429	42,097,957	27,092,591	142.0	39.4	52.4	55.4
Value of products.....	438,658,869	153,053,602	117,741,103	75,357,495	48,158,261	178.0	34.2	56.2	56.5
Value added by manufacture.....	222,357,590	68,602,908	53,595,674	33,259,538	21,065,670	224.0	28.0	61.1	57.9

¹ A minus sign (-) denotes decrease. ² Figures not available. ³ Exclusive of internal revenue. ⁴ Value of products less cost of materials.

TABLE 3.—PRINCIPAL STATES, RANKED BY VALUE OF PRODUCTS: 1919.

STATE.	Number of establishments.	WAGE EARNERS.			VALUE OF PRODUCTS.			VALUE ADDED BY MANUFACTURE.			STATE.	Number of establishments.	WAGE EARNERS.			VALUE OF PRODUCTS.			VALUE ADDED BY MANUFACTURE.		
		Average number.	Per cent distribution.	Rank.	Amount (expressed in thousands).	Per cent distribution.	Rank.	Amount (expressed in thousands).	Per cent distribution.	Rank.			Average number.	Per cent distribution.	Rank.	Amount (expressed in thousands).	Per cent distribution.	Rank.	Amount (expressed in thousands).	Per cent distribution.	Rank.
United States..	598	55,586	100.0	.....	\$438,650	100.0	.....	\$222,358	100.0	.....	Nebraska.....	12	300	0.5	18	\$2,305	0.5	16	\$1,335	0.6	15
New York.....	88	9,687	17.4	2	88,102	20.0	1	37,230	10.7	3	Wisconsin.....	30	187	0.3	20	2,074	0.5	17	945	0.4	18
New Jersey.....	78	12,472	22.4	1	84,034	19.2	2	38,800	17.5	2	Utah.....	8	454	0.8	16	1,709	0.4	19	922	0.4	19
Pennsylvania.....	56	7,134	12.8	3	75,333	16.7	3	46,552	20.9	4	Minnesota.....	9	162	0.3	21	1,456	0.3	20	832	0.4	20
Michigan.....	36	5,712	10.3	4	37,851	8.6	4	22,107	9.9	5	Rhode Island.....	4	287	0.5	19	1,399	0.3	21	454	0.2	25
Ohio.....	37	3,670	6.6	5	32,719	7.5	5	17,424	7.8	6	Texas.....	9	150	0.3	22	1,394	0.3	22	822	0.4	22
Illinois.....	33	3,004	5.4	6	22,081	5.0	6	10,058	4.5	6	Washington.....	8	90	0.2	25	1,363	0.3	23	828	0.4	21
Massachusetts.....	27	2,483	4.5	7	17,305	4.0	7	9,204	4.1	7	Colorado.....	7	98	0.2	24	1,301	0.3	24	667	0.3	23
Missouri.....	22	1,253	2.3	10	13,538	3.1	8	5,821	2.6	9	Georgia.....	7	107	0.2	23	957	0.2	25	578	0.3	24
Virginia.....	12	1,847	3.3	8	12,765	2.9	9	9,090	4.1	8	Iowa.....	5	72	0.1	27	558	0.1	27	237	0.1	27
California.....	49	1,466	2.6	9	10,539	2.4	10	4,409	2.0	11	Louisiana.....	5	54	0.1	28	313	0.1	29	232	0.1	28
Indiana.....	9	1,026	1.9	12	8,649	2.0	11	4,679	2.1	10	Kentucky.....	4	13	(¹)	33	177	(¹)	33	135	0.1	33
Maryland.....	8	797	1.4	13	5,277	1.2	13	2,079	0.9	13	All other states ²	28	2,527	4.5	.....	14,199	3.3	.....	5,752	2.6	.....
West Virginia.....	7	534	1.0	15	3,281	0.7	14	1,158	0.5	14											

¹ Less than one-tenth of 1 per cent. ² In order of value of products—North Carolina, Tennessee, Kansas, Connecticut, Alabama, Montana, Maine, Arkansas, Oregon, Oklahoma, District of Columbia, Wyoming, and South Dakota.

MANUFACTURES.

TABLE 4.—PERSONS ENGAGED IN THE INDUSTRY: 1919, 1914, AND 1909.

CLASS.	Cen- sus year.	Total.	Male.	Fe- male.	PER CENT OF TOTAL.		CLASS.	Cen- sus year.	Total.	Male.	Fe- male.	PER CENT OF TOTAL.	
					Male.	Fe- male.						Male.	Fe- male.
All classes.....	1919	66,947	59,240	7,707	88.5	11.5	Clerks and other subordinate salaried employees.	1919	8,334	5,460	2,874	65.5	34.5
	1914	37,881	35,349	2,532	93.3	6.7		1914	4,290	3,496	794	81.5	18.5
	1909	27,817	26,239	1,578	94.3	5.7		1909	2,993	2,492	501	83.3	16.7
Proprietors and officials.....	1919	3,027	2,946	81	97.3	2.7	Wage earners (average number).....	1919	55,586	50,834	4,752	91.5	8.5
	1914	1,280	1,256	24	98.1	1.9		1914	32,311	30,597	1,714	94.7	5.3
	1909	1,095	1,081	14	98.7	1.3		1909	23,729	22,666	1,063	95.5	4.5
Proprietors and firm members...	1919	122	111	11	91.0	9.0	16 years of age and over.....	1919	55,420	50,753	4,667	91.6	8.4
	1914	99	89	10	89.9	10.1		1914	32,023	30,411	1,612	95.0	5.0
	1909	161	153	8	95.0	5.0		1909	23,562	22,569	993	95.8	4.2
Salaried officers of corporations...	1919	673	654	19	97.2	2.8	Under 16 years of age.....	1919	166	81	85	48.8	51.2
	1914	473	462	11	97.7	2.3		1914	238	186	102	64.6	35.4
	1909	367	361	6	98.4	1.6		1909	167	97	70	58.1	41.9
Superintendents and managers...	1919	2,232	2,181	51	97.7	2.3							
	1914	708	705	3	99.6	0.4							
	1909	567	567	0	100.0	0.0							

TABLE 5.—WAGE EARNERS, BY MONTHS, FOR STATES: 1919.

[The month of maximum employment is indicated by bold-faced figures and that of minimum employment by *italic* figures.]

STATE.	Aver- age num- ber em- ployed during year.	NUMBER EMPLOYED ON 15TH DAY OF THE MONTH OR NEAREST REPRESENTATIVE DAY.												Per cent min- imum is of max- imum.	
		Janu- ary.	Febru- ary.	March.	April.	May.	June.	July.	August.	Septem- ber.	Octo- ber.	Novem- ber.	Decem- ber.		
United States:															
1919.....	55,586	60,754	57,339	53,281	51,100	<i>51,050</i>	51,651	53,509	55,014	57,089	58,607	59,086	58,552	58,552	84.0
Males.....	50,834	55,865	52,502	48,790	46,393	<i>46,472</i>	47,140	48,906	50,310	52,250	53,077	54,047	53,656	53,656	83.0
Females.....	4,752	4,889	4,837	<i>4,491</i>	4,707	4,578	4,511	4,603	4,704	4,839	5,039	4,896	4,896	89.1	
1914.....	32,311	32,634	32,172	32,681	32,442	31,959	<i>31,878</i>	31,914	32,280	32,813	32,451	32,294	32,216	97.1	
1909.....	23,714	22,609	22,772	22,968	13,241	23,661	23,782	23,747	23,540	23,943	24,355	24,873	25,073	90.2	
California.....	1,466	1,886	1,728	1,622	1,463	1,337	<i>1,273</i>	1,275	1,346	1,392	1,400	1,429	1,441	67.5	
Colorado.....	98	89	92	89	89	89	93	100	100	100	125	107	103	71.2	
Georgia.....	107	90	100	93	101	99	121	126	124	113	111	110	96	71.4	
Illinois.....	3,004	3,039	2,812	2,647	2,670	2,572	<i>2,694</i>	2,831	3,280	3,391	3,544	3,452	3,216	72.5	
Indiana.....	1,026	1,244	1,108	993	994	889	827	913	998	1,105	1,075	1,094	1,072	66.5	
Iowa.....	72	39	36	37	32	38	109	105	102	98	100	105	63	29.4	
Kentucky.....	13	14	14	14	12	12	13	12	11	14	12	14	14	78.6	
Louisiana.....	54	58	62	62	51	52	54	55	55	56	47	40	47	75.8	
Maryland.....	797	651	740	769	710	764	814	771	803	857	926	975	784	66.8	
Massachusetts.....	2,483	2,526	2,415	2,329	2,345	2,367	2,371	2,431	2,463	2,530	2,623	2,666	2,729	85.3	
Michigan.....	5,712	7,494	6,697	5,768	5,042	<i>4,980</i>	5,077	5,083	5,123	5,482	5,720	5,962	6,116	66.5	
Minnesota.....	162	98	140	171	193	188	195	178	153	143	147	180	185	50.3	
Missouri.....	1,253	1,234	1,241	<i>1,218</i>	1,243	1,263	1,280	1,256	1,264	1,264	1,257	1,266	1,250	95.2	
Nebraska.....	300	792	411	87	58	54	51	48	152	428	532	511	476	6.1	
New Jersey.....	12,472	12,911	12,846	11,734	11,277	11,765	11,946	12,469	12,706	12,818	12,988	13,077	13,127	85.4	
New York.....	9,687	11,461	10,829	9,995	9,405	8,926	<i>8,920</i>	9,015	9,152	9,356	9,647	9,775	9,773	77.8	
Ohio.....	3,670	3,901	3,462	3,315	<i>3,022</i>	3,062	3,247	3,569	3,762	4,155	4,210	4,138	4,107	71.8	
Pennsylvania.....	7,134	6,891	6,603	6,602	6,921	6,929	6,998	7,186	7,212	7,470	7,585	7,578	7,633	85.5	
Rhode Island.....	257	256	259	262	278	272	281	318	319	299	305	299	298	80.3	
Texas.....	150	123	137	133	156	154	145	151	146	151	169	168	165	72.8	
Utah.....	454	492	453	547	437	351	<i>342</i>	455	486	496	491	449	449	62.5	
Virginia.....	1,847	1,765	1,769	<i>1,644</i>	1,550	1,745	1,739	1,827	2,004	2,032	2,075	2,118	1,996	72.9	
Washington.....	90	87	89	89	76	76	76	83	99	95	101	103	108	70.4	
West Virgin a.....	534	562	517	480	472	452	478	527	567	624	635	615	479	71.2	
Wisconsin.....	187	219	198	188	174	180	171	169	178	183	197	201	186	77.2	

MANUFACTURES.

TABLE 8.—SIZE OF ESTABLISHMENTS, BY VALUE OF PRODUCTS: 1919, 1914, AND 1909.

VALUE OF PRODUCT.	NUMBER OF ESTABLISHMENTS.			AVERAGE NUMBER OF WAGE EARNERS.			VALUE OF PRODUCTS.			VALUE ADDED BY MANUFACTURE.		
	1919	1914	1909	1919	1914	1909	1919	1914	1909	1919	1914	1909
All classes.....	598	395	359	55,586	32,311	23,729	\$438,658,869	\$158,053,602	\$117,741,103	\$222,357,590	\$68,602,908	\$53,595,674
Less than \$5,000.....	41	53	56	30	69	64	98,181	137,979	124,959	39,026	84,675	57,896
\$5,000 to \$20,000.....	58	51	55	159	171	237	616,212	612,861	596,910	260,719	299,293	268,837
\$20,000 to \$100,000.....	132	103	97	1,044	1,066	1,310	6,881,161	5,719,359	4,985,195	3,582,111	3,102,556	2,746,341
\$100,000 to \$500,000.....	226	110	120	6,559	7,900	6,882	56,121,842	25,668,656	41,227,479	28,589,161	19,017,266	16,870,064
\$500,000 to \$1,000,000.....	58	34	31	4,821	23,105	15,236	39,373,056	23,837,291	70,808,560	18,061,554	46,039,118	33,652,830
\$1,000,000 and over.....	83	44	31	42,973	23,105	15,236	335,568,414	102,077,456	70,808,560	171,825,019	46,039,118	33,652,830
PER CENT DISTRIBUTION.												
All classes.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than \$5,000.....	6.9	13.4	15.6	0.1	0.2	0.3	(¹)	0.1	0.1	(¹)	0.1	0.1
\$5,000 to \$20,000.....	9.7	12.9	15.3	0.3	0.5	1.0	0.1	0.4	0.5	0.1	0.4	0.5
\$20,000 to \$100,000.....	22.1	26.1	27.0	1.9	3.3	5.5	1.6	3.6	4.2	1.6	4.6	5.1
\$100,000 to \$500,000.....	37.8	27.9	33.4	11.8	24.4	29.0	12.8	16.2	35.0	12.9	27.7	31.5
\$500,000 to \$1,000,000.....	9.6	8.6	8.6	8.7	71.5	64.2	9.0	15.1	15.1	8.1	27.7	31.5
\$1,000,000 and over.....	13.9	11.1	8.6	77.3	71.5	64.2	76.5	61.6	60.1	77.3	67.1	62.8

¹ Less than one-tenth of 1 per cent.

TABLE 9.—CHARACTER OF OWNERSHIP, BY STATES: 1919 AND 1914.

STATE.	Cen- sus year.	NUMBER OF ESTABLISHMENTS OWNED BY—			AVERAGE NUMBER OF WAGE EARNERS.						VALUE OF PRODUCTS.							
		Indi- vid- uals.	Cor- pora- tions.	All oth- ers.	Total.	In establishments owned by—			Per cent of total.			Total.	Of establishments owned by—			Per cent of total.		
						Indi- vid- uals.	Cor- pora- tions.	All oth- ers.	Indi- vid- uals.	Cor- pora- tions.	All oth- ers.		Indi- vid- uals.	Cor- pora- tions.	All oth- ers.	Indi- vid- uals.	Cor- pora- tions.	All oth- ers.
United States.....	1919	48	514	36	55,586	201	55,071	314	0.4	99.1	0.6	\$438,658,869	\$1,959,441	\$433,055,446	\$3,643,982	0.4	98.7	0.8
	1914	44	325	26	32,311	147	31,974	190	0.5	98.0	0.6	158,053,602	892,905	155,272,720	1,887,077	0.6	98.2	1.2
	1909	63	270	26	23,729	240	23,283	208	1.0	98.1	0.9	117,741,103	1,107,630	115,321,196	1,222,277	1.0	97.9	1.0
California.....	1919	4	40	5	1,466	5	1,418	43	0.3	96.7	2.9	10,539,416	38,141	10,184,906	317,369	0.4	96.6	3.0
Colorado.....	1919		6	1	98		198			100.0		1,301,141		1,301,141			100.0	
Georgia.....	1919		7		107		107			100.0		957,293		957,293			100.0	
Illinois.....	1919	2	28	3	3,004		2,976	28		99.1	0.9	22,060,803		21,509,109	2 461,694		97.9	2.1
	1914	3	23		1,682	5	1,677		0.3	99.7		8,018,118	18,775	8,590,343		0.2	99.8	
Indiana.....	1919		9		1,023		1,026			100.0		8,649,304		8,649,304			100.0	
Iowa.....	1919		5		72		72			100.0		558,084		558,084			100.0	
Kentucky.....	1919	1	3		13		13			100.0		177,018		177,018			100.0	
Louisiana.....	1919		4	1	54		54			100.0		312,806		312,806			100.0	
Maryland.....	1919		08		797		797			100.0		5,277,426		5,277,426			100.0	
Massachusetts.....	1919	3	20	4	2,483	42	2,404	37	1.7	98.8	1.5	17,305,166	169,189	18,896,495	269,532	1.0	97.5	1.6
	1914	2	17	5	1,395		1,374	21		98.5	1.5	6,684,918		6,524,735	2 100,183		97.6	2.4
Michigan.....	1919	9	25	2	5,712	14	5,708			99.9		37,850,834	1 25,170	37,825,664			99.9	
	1914	11	21	4	4,509	12	4,493	4	0.3	99.6	0.1	13,891,415	26,300	13,855,241	6,874	0.2	99.8	(¹)
Minnesota.....	1919		9		162		162			100.0		1,455,658		1,455,658			100.0	
Missouri.....	1919	2	18	2	1,253		1,211	42		96.6	3.4	13,537,929		12,943,083	2 594,846		95.6	4.4
	1914	3	16	3	842	3	811	28	0.4	96.3	3.3	6,936,122	17,440	6,686,778	231,904	0.3	96.4	3.3
Nebraska.....	1919		11	1	300		300			100.0		2,304,793		2,304,793			100.0	
New Jersey.....	1919	4	72	2	12,472	143	12,429		0.3	99.7		84,033,941	1 394,321	83,639,620		0.5	99.5	
	1914	4	58	2	6,276	121	6,255		0.3	99.7		31,680,865	1 125,248	31,561,617		0.4	99.6	
New York.....	1919	8	76	4	9,687	52	9,613	22	0.5	99.2	0.2	88,101,532	890,247	86,921,539	289,746	0.1	98.7	0.3
	1914	10	57	3	7,780	82	7,613	85	1.1	97.9	1.1	42,876,880	583,446	41,435,938	857,496	1.4	96.6	2.0
Ohio.....	1919	1	36		3,670		3,670			100.0		32,719,466		32,719,466			100.0	
	1914	2	26	1	2,017	15	2,012		0.2	99.8		11,388,860	1 24,280	11,368,860		0.2	99.8	
Pennsylvania.....	1919	2	53	1	7,134		7,116	18		99.7	0.3	73,332,932		72,713,960	2 618,972		99.2	0.8
	1914	2	34	3	4,748		4,732	16		99.7	0.3	22,387,835		22,072,933	2 314,902		98.6	1.4
Rhode Island.....	1919		3	1	287		287			100.0		1,399,346		1,399,346			100.0	
Texas.....	1919		8	1	150		150			100.0		1,394,354		1,394,354			100.0	
Utah.....	1919		8		454		454			100.0		1,708,957		1,708,957			100.0	
Virginia.....	1919	1	11		1,847		1,847			100.0		12,765,281		12,765,281			100.0	
Washington.....	1919		8		90		90			100.0		1,363,434		1,363,434			100.0	
Wisconsin.....	1919	7	17	6	187	7	181	49	3.7	70.1	26.2	2,074,299	43,249	1,670,350	360,200	2.1	86.6	1.7
All other states.....	1919	4	29	2	3,061		3,037	24		99.2	0.8	17,477,656		17,023,500	2 454,156		97.4	2.6

¹ Includes the group "All other."

² Includes the group "individuals."

³ Less than one-tenth of 1 per cent.

CHEMICALS.

TABLE 10.—NUMBER AND HORSEPOWER OF TYPES OF PRIME MOVERS: 1919, 1914, AND 1909.

POWER.	NUMBER OF ENGINES OR MOTORS.			HORSEPOWER.					
	1919	1914	1909	Amount.			Per cent distribution.		
				1919	1914	1909	1919	1914	1909
Primary power, total.....	12,000	3,379	2,210	376,940	282,385	208,657	100.0	100.0	100.0
Owned.....	1,508	1,129	1,309	250,445	133,425	115,744	66.4	47.2	55.5
Steam Engines.....	1,355	1,061	1,231	241,749	124,329	103,488	64.1	44.0	49.6
Turbines.....	1,136	1,061	1,231	127,164	124,320	103,488	33.7	44.0	49.6
Internal-combustion engines.....	219	47	39	114,585	5,962	1,190	30.4	1.3	0.6
Water wheels, turbines and motors.....	122	21	39	5,004	3,135	11,066	1.3	2.1	0.6
Rented.....	31			3,602			1.0	1.1	5.3
Electric.....	10,492	2,250	901	126,495	148,959	92,913	33.6	52.8	44.5
Other.....	10,492	2,250	901	126,419	134,481	92,067	33.5	47.6	44.1
Generated by establishments reporting.....	6,960	2,621	1,281	76	14,478	846	(²)	5.1	0.4
Electric.....	17,452	4,871	2,182	235,973	172,510	156,709	100.0	100.0	100.0
Rented.....	10,492	2,250	901	126,419	134,481	92,067	53.6	78.0	58.8
Generated by establishments reporting.....	6,960	2,621	1,281	109,554	38,029	64,642	46.4	22.0	41.2

¹ Figures for horsepower include for 1909 the amount reported under the head of "Other" owned power. ² Less than one-tenth of 1 per cent.

TABLE 11.—FUEL CONSUMED, BY STATES: 1919 AND 1914.

STATE.	Cen- sus year.	COAL.					Gas (1,000 cubic feet).	STATE.	Cen- sus year.	COAL.					Gas (1,000 cubic feet).
		Anthra- cite ¹ (tons, 2,240 pounds).	Bitumi- nous (tons, 2,000 pounds).	Coke (tons, 2,000 pounds).	Fuel oils (bar- rels).	Gas- oline and other vola- tile oils (bar- rels).				Anthra- cite (tons, 2,240 pounds).	Bitumi- nous (tons, 2,000 pounds).	Coke (tons, 2,000 pounds).	Fuel oils (bar- rels).	Gas- oline and other vola- tile oils (bar- rels).	
United States.....	1919	389,356	3,844,667	457,259	789,347	18,427	1,836,998	Nebraska ³	1919	48,988			73,702	1,325	
	1914	491,603	2,667,248	275,440	500,668	(²)	2,744,939	New Jersey.....	1919	283,265	221,877	8,189	61,805	5,699	16,987
California ³	1919	17	56	1,716	496,136	60	24,352		1914	287,166	125,990	9,799	10,892	(²)	8,900
Colorado ³	1919		4,877		12		60	New York.....	1919	64,883	483,708	95,439	5,210	358	23,966
Georgia ³	1919	10	2,569	1,640					1914	125,066	363,440	75,062	7,344	(²)	31,440
Illinois.....	1919	132	407,312	20,353	11,110	610	15,359	Ohio.....	1919	596	714,592	93,108	226	8,424	75,086
	1914		254,457	7,072	322	(²)	70		1914		381,767	56,168	502	(²)	1,525,141
Indiana ³	1919	266	138,218	3,311	5,003			Pennsylvania.....	1919	17,872	441,199	7,893	48,507	734	99,059
Iowa ³	1919		1,287	2,500	105	25			1914	51,836	338,040	5,247	12,731	(²)	335,137
Kentucky ³	1919		613	607				Rhode Island.....	1919		6,016	77	2,652		
Louisiana.....	1919		1	1,500			4,014	Texas ³	1919	5	22	2,507	14,854	35	643
Maryland ³	1919		66,705	42	15,003		7,200	Utah ³	1919		30,101		12,086	822	
Massachusetts.....	1919	16,157	44,699	133	6,775		751	Virginia ³	1919	60	146,051	21,510	130		
	1914	3,292	46,570	9,782	50	(²)	880	Washington ³	1919		715		4,579	10	
Michigan.....	1919	190	967,341	161,828	14,228	205		West Virginia.....	1919		13,157	3,670	30		1,426,466
	1914	16,321	854,567	80,534	36	(²)	464,646	Wisconsin ³	1919		5,941	10		11	
Minnesota.....	1919	5,801	5,141	1,040	6,198	106	740	All other states.....	1919	52	55,917	23,740	7,232	3	137,904
Missouri.....	1919	50	37,564	3,446	3,764		4,480		1914	7,892	260,453	29,897	467,236	(²)	375,796
	1914	30	47,964	1,879	1,555	(²)	2,949								

¹ Includes some semianthracite.

² Included with figures for fuel oils.

³ Included in "All other states" in 1914.

MANUFACTURES.

SPECIAL STATISTICS.

MATERIALS.

Table 12 presents comparative statistics for materials used in the chemical industry, inclusive of "Coal-tar products" and "Sulphuric, nitric, and mixed acids," for 1919, 1914, 1909, and 1904. Establishments assigned to other industries but manufacturing chemicals as subsidiary products, did not, as a rule, report

the consumption of the materials called for by the chemical schedule, and hence the figures do not represent total consumption of the specified materials.

Principal materials, by industries.—The consumption of certain of the leading materials asked for specifically in the various special schedules are given in Table 13 by industries.

TABLE 12.—MATERIALS: 1919, 1914, 1909, AND 1904.

[Tons, 2,000 pounds.]

	1919				1914	1909	1904	PER CENT OF INCREASE. ¹		
	Total.	Chemicals.	Coal-tar products.	Sulphuric, nitric, and mixed acids.				1914-1919	1909-1914	1904-1909
Total cost.....	\$296,155,374	\$216,301,279	\$63,996,734	\$15,857,361	\$96,185,122	\$69,531,257	\$47,070,595	207.9	38.3	47.7
Sulphur:										
Tons.....	263,256	153,018	10,308	99,930	56,296	77,450	51,526	308.0	-27.5	50.7
Cost.....	\$6,062,915	\$3,599,988	\$218,162	\$2,244,785	\$1,162,632	\$1,433,743	\$1,071,229	422.0	-18.9	33.8
Pyrite:										
Tons.....	695,974	192,851	.....	503,123	889,695	597,691	334,207	-21.8	48.9	78.8
Cost.....	\$4,381,185	\$1,321,242	.....	\$3,059,943	\$3,769,467	\$3,170,188	\$1,745,416	16.2	18.0	81.6
Nitrate of soda:										
Tons.....	78,810	35,633	7,632	35,545	58,101	52,976	45,021	35.6	9.7	17.7
Cost.....	\$5,331,440	\$2,188,039	\$656,233	\$2,487,168	\$2,606,172	\$2,373,220	\$1,895,248	97.7	13.6	25.2
Sulphuric acid:										
Tons.....	452,445	219,676	57,512	175,257	104,774	58,552	104,489	174.0	352.0	-44.0
Cost.....	\$4,933,900	\$2,573,730	\$1,520,055	\$840,115	\$1,515,982	\$564,390	\$945,486	225.5	109.0	-40.3
Nitric acid:										
Tons.....	27,340	22,301	1,039	4,000	7,819	1,525	3,068	249.7	413.0	-50.3
Cost.....	\$689,713	\$295,311	\$194,402	\$200,000	\$641,405	\$139,591	\$320,818	7.5	359.0	-56.5
Mixed acid:										
Tons.....	28,971	4,078	24,893	.....	6,015	4,546	1,734	382.0	32.3	162.2
Cost.....	\$2,921,882	\$446,332	\$2,475,550	.....	\$698,664	\$335,672	\$156,605	318.0	108.0	114.3
Ammonium sulphate:										
Tons.....	4,366	4,102	240	24	9,586	1,675	5,676	-54.5	472.0	-70.5
Cost.....	\$368,222	\$339,431	\$26,582	\$2,209	\$567,249	\$88,013	\$356,109	-35.1	544.5	-75.3
Alcohol:										
Grain (ethyl)—										
Gallons.....	1,817,784	1,392,157	425,619	8	296,886	479,428	187,389	512.0	-38.1	156.0
Cost.....	\$950,438	\$714,635	\$235,779	\$24	\$145,066	\$287,416	\$449,604	555.0	-49.5	-36.1
Wood (methyl)—										
Gallons.....	2,888,789	2,302,617	585,068	1,101	1,464,273	949,212	601,077	97.3	54.3	57.9
Cost.....	\$3,631,183	\$2,793,080	\$835,630	\$2,483	\$577,122	\$370,017	\$367,223	529.0	56.0	0.8
Fuel and rent of power, cost.....	\$39,005,662	\$32,742,310	\$4,141,033	\$2,122,319	\$11,854,901	\$8,566,924	\$4,913,267	229.0	38.4	74.4
All other material, cost.....	\$225,878,834	\$169,287,201	\$53,693,318	\$4,898,315	\$72,556,462	\$52,202,083	\$31,849,790	214.1	39.0	49.8

¹ A minus sign (—) denotes decrease.

TABLE 13.—SPECIFIED MATERIALS, BY INDUSTRIES: 1919 AND 1914.

INDUSTRY.	1919		1914		INDUSTRY.	1919		1914	
	Quantity.	Cost.	Quantity.	Cost.		Quantity.	Cost.	Quantity.	Cost.
SULPHUR.					NITRATE OF SODA.				
Total, tons.....	570,769	\$13,671,065	82,248	\$1,730,647	Total, tons.....	418,371	\$31,233,537	412,748	\$19,264,181
Chemicals.....	153,018	3,599,988	52,679	1,085,877	Chemicals.....	35,633	2,188,039	25,715	1,176,733
Coal-tar chemicals.....	10,308	218,162	.....	.....	Coal-tar products.....	7,632	656,233	32,386	1,519,439
Sulphuric, nitric, and mixed acids.....	99,930	2,244,785	3,617	76,755	Sulphuric, nitric, and mixed acids.....	35,545	2,487,168	190,960	8,979,877
Explosives.....	25,797	659,219	15,832	372,763	Explosives.....	174,742	13,154,333	.....	.....
Fertilizers.....	221,558	5,669,331	2,041	42,716	Fertilizers:				
Petroleum, refining.....	5,241	136,828	2,035	42,423	For acid manufacture.....	21,732	1,602,614	15,134	704,581
Other industries.....	54,917	1,142,772	6,044	110,113	For mixed fertilizers.....	130,683	10,091,790	147,050	6,807,228
					Other industries.....	12,404	863,360	1,503	76,323
PYRITE.					SULPHURIC ACID.				
Total, tons.....	1,146,958	8,757,502	1,581,607	7,822,030	Total, tons.....	1,850,828	25,277,462	1,359,519	10,278,643
Chemicals.....	192,851	1,321,242	357,385	1,522,165	Chemicals.....	219,676	2,573,730	146,415	1,287,129
Sulphuric, nitric, and mixed acids.....	503,123	3,059,943	532,310	2,247,302	Coal-tar chemicals.....	57,512	1,520,055	118,359	228,833
Explosives.....	6,812	46,147	25,885	139,496	Sulphuric, nitric, and mixed acids.....	175,257	840,115	52,398	723,795
Fertilizers.....	398,602	3,919,050	613,842	3,590,235	Explosives.....	62,069	976,295	728,889	4,387,317
Petroleum, refining.....	26,275	224,700	23,669	163,630	Petroleum, refining.....	503,923	10,327,210	290,455	3,519,552
Other industries.....	19,295	186,820	28,516	159,202	Other industries.....	75,573	816,464	23,003	131,997

TABLE 13.—SPECIFIED MATERIALS, BY INDUSTRIES, 1919 AND 1914—Continued.

INDUSTRY.	1919		1914		INDUSTRY.	1919		1914			
	Quantity.	Cost.	Quantity.	Cost.		Quantity.	Cost.	Quantity.	Cost.		
NITRIC ACID.					ALCOHOL, GRAIN (ETHYL).						
Total, tons.....	32,940	\$1,490,546	12,612	\$1,148,850	Total, gallons.....	8,483,351	\$17,553,806	1,440,443	\$647,321		
Chemicals.....	21,957	295,311	5,363	448,898	Chemicals.....	1,392,157	714,635	379,119	210,812		
Coal-tar chemicals.....	1,039	194,402			Sulphuric, nitric, and mixed acids.....	425,619	235,779				
Sulphuric, nitric, and mixed acids.....	4,000	200,000			Explosives.....	8	24				
Explosives.....	1,537	200,267			Paint and varnish.....	39,884	167,447				
Other industries.....	4,407	600,566	446	31,041	Druggists' preparations, etc.....	2,985,735	1,724,112	1,061,324	436,599		
MIXED ACID.					Other industries.....	2,962,842	14,379,871				
Total, tons.....	47,387	4,706,895	25,273	1,746,141	Other industries.....	677,106	331,938				
Chemicals.....	4,078	446,332	6,018	698,764	ALCOHOL, WOOD (METHYL).						
Coal-tar chemicals.....	24,893	2,475,550			Total, gallons.....	10,653,665	10,095,283	2,454,224	1,000,119		
Explosives.....	16,637	1,567,691			19,255	1,047,377	Chemicals.....	2,302,617	2,793,080	1,466,773	577,997
Other industries.....	1,779	217,322			Chemicals.....	585,068	835,620				
AMMONIUM SULPHATE.					Sulphuric, nitric, and mixed acids.....	1,101	2,483				
Total, tons.....	140,368	13,121,408	159,534	9,584,062	Paint and varnish.....	244,561	303,998				
Chemicals.....	4,102	339,431	9,610	508,899	Druggists' preparations.....	73,208	106,147	987,451	422,122		
Coal-tar chemicals.....	240	26,582			Wood distillation.....	7,360,390	5,898,175				
Other industries.....	136,026	12,755,395			149,924	9,015,163	Other industries.....			86,720	155,780

PRODUCTS.

No important changes have been made in the classification of chemicals since the census of 1914, but additional delimitation of the groups has been found advisable, and some rearrangement of items. So far as practicable 1914 figures have been grouped to correspond with the statistics for 1919 so that comparisons may be fairly made.

The products are classified under 10 groups, and Table 14 presents the figures for group totals for 1919, 1914, and 1909.

TABLE 14.—PRODUCTS, GROUP TOTALS: 1919, 1914, AND 1909.

	1919	1914	1909
Total value.....	\$685,268,285	\$200,195,835	\$150,580,149
The chemical industry.....	438,658,869	158,053,602	117,741,103
Coal-tar products.....	135,482,161		
Sulphuric, nitric, and mixed acids.....	31,470,480	15,215,474	9,884,057
Chemicals, subsidiary products of other industries.....	79,659,775	26,926,759	22,954,989
GROUP.			
I.—Acids.....	86,194,195	32,837,254	26,068,617
II.—Ammonium and cyanogen compounds.....	23,067,553	8,064,913	(1)
III.—Sodas, sodium and compounds.....	99,689,828	32,626,395	25,048,019
IV.—Potash, potassium and compounds.....	18,407,253	7,905,744	(1)
V.—Alum, aluminum and compounds ²	43,433,482	(1)	(1)
VI.—Bleaching compounds.....	12,392,806	5,302,369	3,215,726
VII.—Coal-tar chemicals.....	133,499,742	13,492,453	7,969,672
VIII.—Plastics.....	77,477,041	13,895,784	7,472,732
IX.—Compressed and liquefied gases.....	43,203,918	10,415,325	(1)
X.—Chemicals, not elsewhere specified.....	156,672,155	52,898,172	48,851,270
Group total, gross.....	694,097,973	(1)	(1)
Intergroup duplications.....	50,105,073	(1)	(1)
Total chemicals, net.....	643,992,900	191,895,464	142,486,483
By-products and residues of chemical operations.....	25,923,661	4,409,620	5,884,608
By-products, not chemical.....	14,870,376	3,702,017	2,209,078
Amount received for contract work.....	480,848	188,734	

¹ Comparable figures not available.

² Alums—1919, \$17,055,891; 1914, \$3,487,969; 1909, \$3,022,355.

Group I is devoted exclusively to acids. Three groups, II, III, and IV, are built upon the most important alkalies—ammonium, sodium, and potassium—and include elements, oxides, hydroxides, and salts; while Group X gathers in all of the less important metals and basic elements, derivatives of both, and organic compounds. Salts in Groups II, III, IV, and X in a measure duplicate the acids of Group I.

Five groups depend upon other than chemical separations. Group V, alums, aluminum, and compounds, concerns chiefly a class of mordanting compounds, and Group VI, bleaching agents. Group VII is differentiated by the basic material. Group VIII, plastics, expresses by the title the character of the chemical products. Group IX is dependent upon physical state and method of marketing. The members of these five groups belong within one or more of the other subdivisions. It is designed to make each group, so far as possible, comprehensive of the products within its scope.

This duplication exists only to a small degree in the statistics for the prior censuses, and the amount of duplication in the statistics for 1919 is noted.

Owing to the fact that the term "Fine chemicals" is applied not only to compounds that are rare and of high unit value, but also to specially refined grades of other chemicals, a separation on this basis has not been attempted. It would imply another basis of separation, namely, that of purity or value, and with fine chemicals any conclusions drawn from the figures would be open to question on account of the large percentage of these products concealed in lump sums of unenumerated items.

The aggregate figures necessarily include the by-products and residues of chemical operations and the income from other sources of the establishments reporting. The total value of products, \$685,268,285, includes chemicals to the amount of \$643,992,900. The groups as presented involve a gross total of \$694,097,973, of which amount \$50,105,073 is inter-group duplications. For example, carbonic acid (carbon dioxide) value \$6,574,250, is included in Group I, Acids, and also in Group IX, Compressed and liquefied gases.

The following tabular statement shows the percentages of increase of the several items given in Table 14 for the census periods 1914-1919 and 1909-1914.

	PER CENT OF INCREASE (TABLE 14).	
	1914-1919	1909-1914
Total.....	242	33
The chemical industry.....	263	34
Coal-tar products.....	107	54
Sulphuric, nitric, and mixed acids.....	196	17
Chemicals, subsidiary products of other industries.....		
I.—Acids, aluminum, and compounds.....	162	26
II.—Ammonium and cyanogen compounds.....	186	
III.—Sodas, sodium and compounds.....	206	30
IV.—Potash, potassium and compounds.....	133	
V.—Alums, aluminum, and compounds.....	134	65
VI.—Bleaching compounds.....	889	69
VII.—Coal-tar chemicals.....	458	85
VIII.—Plastics.....	315	
IX.—Compressed and liquefied gases.....	196	8
X.—Chemicals, not elsewhere specified.....		
Total chemicals, net.....	236	35

GROUP I.—ACIDS.

Chemical substances can be subdivided into four main classes: (1) Acids, including acid oxides or anhydrides; (2) Bases, including basic elements, oxides and hydroxides; (3) Salts or combinations of acids with bases; and (4) Other compounds of neutral character. For purposes of census classification, free acids and their anhydrides are included in Group I, while bases are subdivided into a number of groups each of which includes a basic metal or element and its oxides, hydroxides, and salts, with acids. Thus acids appear as component parts of other groups, and the acids appearing in Group I are largely duplicated in the salts of other groups.

Table 15 presents the detailed statistics for acids for 1919, 1914, and 1909. The table shows the number of establishments reporting specific products, and, where available, the quantity made and consumed in the same establishment has been given in addition to that produced for sale. Average unit values have been carried into the table as an index of the advance in values where the production data for prior years were comparable. With respect to the

major acids, the distribution of the establishments by geographic divisions is given in Table 16.

TABLE 15.—GROUP I.—ACIDS.

	1919	1914	1909
Value of products.....	\$80,194,195	\$32,837,254	\$20,068,617
INORGANIC ACIDS, value.....	\$59,875,958	\$25,082,873	.....
Arsenic and arsenious acids:			
Number of establishments.....	6		
Total production, pounds.....	2,622,389		
For sale—			
Pounds.....	1,076,000	(1)	(1)
Value.....	\$108,233		
Made and consumed, pounds.....	1,546,389		
Boric (boracic) acid:			
Number of establishments.....	6	5	5
Pounds.....	13,454,100	8,584,311	5,554,914
Value.....	\$1,751,632	\$588,081	\$285,776
Unit value, pound.....	\$0.12	\$0.07	\$0.05
Carbonic acid (carbon dioxide CO ₂):			
Number of establishments.....	42	38	35
Pounds.....	50,771,411	50,445,779	47,953,291
Value.....	\$6,574,250	\$2,320,685	\$2,345,743
Unit value, pound.....	\$0.11	\$0.04	\$0.05
Hydrochloric (muriatic) acid:			
Number of establishments.....	40	31	38
Total production, tons.....	221,749	168,584	122,967
For sale—			
Tons.....	150,000	85,438	101,607
Value.....	\$4,312,253	\$1,348,805	\$1,758,355
Unit value, ton.....	\$29	\$16	\$17
Made and consumed, tons.....	71,650	83,146	20,700
Hydrofluoric acid:			
Number of establishments.....	6	9	10
Total production, pounds.....	5,732,198	7,200,248	8,027,200
For sale—			
Pounds.....	4,320,017	5,373,657	6,842,914
Value.....	\$440,184	\$325,540	\$294,379
Unit value, pound.....	\$0.10	\$0.06	\$0.04
Made and consumed, pounds.....	1,412,181	1,826,591	1,184,376
Mixed acid (sulphuric-nitric):			
Number of establishments.....	42	37	14
Total production, tons.....	114,886	112,124	.....
For sale—			
Tons.....	40,428	42,725	28,891
Value.....	\$4,426,637	\$2,201,480	\$1,860,787
Unit value, ton.....	\$95	\$51	\$65
Made and consumed, tons.....	68,458	69,399	.....
Nitric acid:			
Number of establishments.....	59	52	25
Total production, tons.....	86,992	78,589	68,717
For sale—			
Tons.....	19,436	14,085	13,663
Value.....	\$2,076,085	\$1,857,088	\$1,357,088
Unit value, ton.....	\$153	\$108	\$99
Made and consumed, tons.....	67,556	63,904	55,054
Phosphoric acid:			
Number of establishments.....	9	7	9
Total production, pounds.....	22,109,302	.....	.....
For sale—			
Pounds.....	13,379,501	12,420,191	.....
Value.....	\$1,711,148	\$680,239	\$607,905
Unit value, pound.....	\$0.13	\$0.05	.....
Made and consumed, pounds.....	8,729,801	.....	.....
Sulphuric acid:			
Number of establishments.....	216	194	183
Total production reduced to 50° Baumé, tons.....	5,552,581	4,071,566	2,764,455
For sale—			
Tons.....	3,331,362	2,338,284	1,479,200
Value.....	\$35,032,605	\$15,395,133	\$10,103,425
Unit value, ton.....	\$10.32	\$6.58	\$6.89
Made and consumed, tons.....	2,221,219	1,733,282	1,285,255
Production according to strength—			
For sale—			
50° Baumé—			
Tons.....	839,780	451,121	528,263
Value.....	\$9,543,118	\$2,709,350	\$3,176,430
60° Baumé—			
Tons.....	2,949,371	545,052	177,414
Value.....	\$9,498,800	\$3,754,806	\$1,038,358
66° Baumé—			
Tons.....	707,303	732,186	453,370
Value.....	\$13,521,310	\$8,042,422	\$5,454,002
Oleum or fuming—			
Tons.....	133,655	62,354	28,594
Value.....	\$3,369,371	\$888,495	\$494,635
Unit value, ton.....	\$31	\$14	\$15
Made and consumed, tons—			
50° Baumé.....	1,910,332	1,250,112	1,115,018
60° Baumé.....	70,681	249,927	11,970
66° Baumé.....	126,892	96,280	69,249
Oleum or fuming.....	18,149	15,404	3,743
Sulphuric acid, reclaimed:			
Number of establishments.....	65	14	.....
Total production, tons.....	473,555	.....	.....
For sale—			
Tons.....	95,119	136,360	7,069
Value.....	\$803,144	\$518,800	\$82,935
Made and consumed, tons.....	378,436	.....	.....

(See footnotes at end of table.)

TABLE 15.—GROUP I.—ACIDS—Continued.

	1919	1914	1909
ORGANIC ACIDS, value.....	\$26,318,237	\$7,754,381	.....
Acetic acid, value.....	\$4,264,044	\$1,272,294	.....
Acetic, dilute and pyroigneous—			
Number of establishments.....	13		
Total production, pounds.....	42,248,803		
For sale—			
Pounds.....	33,057,776		
Value.....	\$1,359,521		
Unit value, pound.....	\$0.04		
Made and consumed, pounds.....	9,191,027		
Acetic, glacial—			
Number of establishments.....	6	13	13
Total production, pounds.....	20,131,487	75,303,375	58,000,602
For sale—			
Pounds.....	19,244,980	70,617,637	56,928,773
Value.....	\$2,325,927	\$1,272,294	\$1,336,874
Unit value, pound.....	\$0.12		
Made and consumed, pounds.....	886,507	4,685,738	1,071,829
Acetic anhydride—			
Number of establishments.....	7		
Total production, pounds.....	1,794,985		
For sale—			
Pounds.....	1,213,861		
Value.....	\$578,596		
Unit value, pound.....	\$0.47		
Made and consumed, pounds.....	581,124		
Citric acid:			
Number of establishments.....	6	3	5
Total production, pounds.....	3,250,482	2,729,943	.....
For sale—			
Pounds.....	3,163,676	2,657,840	2,102,256
Value.....	\$3,047,371	\$1,516,336	\$777,235
Unit value, pound.....	\$0.96	\$0.57	\$0.37
Made and consumed, pounds.....	96,806	72,103	.....
Lactic acid:			
Number of establishments.....	4		
Value.....	\$781,828	(¹)	(¹)
Oleic acid:			
Number of establishments.....	15	7	8
Total production, pounds.....	44,895,453	23,187,579	.....
For sale—			
Pounds.....	44,350,574	21,932,736	16,377,063
Value.....	\$6,548,564	\$1,301,353	\$345,106
Unit value, pound.....	\$0.15	\$0.06	\$0.05
Made and consumed, pounds.....	544,879	1,254,843	.....
Stearic acid:			
Number of establishments.....	9	10	11
Total production, pounds.....	17,048,421	14,960,109	.....
For sale—			
Pounds.....	16,060,878	14,351,404	.....
Value.....	\$3,798,439	\$1,242,492	\$1,143,213
Unit value, pound.....	\$0.22	\$0.09	.....
Made and consumed, pounds.....	78,543	608,705	.....
Tannic acid:			
Number of establishments.....	4	5	
Pounds.....	845,065	853,830	(¹)
Value.....	\$746,825	\$287,142	.....
Unit value, pound.....	\$0.88	\$0.34	.....
Tartaric acid:			
Number of establishments.....	4		
Pounds.....	5,312,965	(¹)	(¹)
Value.....	\$4,262,376	.....	.....
Other acids:			
Inorganic ⁴	\$836,777	\$108,495	.....
Organic ⁵	\$2,870,790	\$2,134,764	\$3,220,206

¹ Not reported separately.
² Includes a large production under a long-term, low-priced contract.
³ Includes sulphur-trioxide, "Battery acid" and "Electrolyte sulphuric," 74,533 tons.
⁴ Includes, 1919, chlorosulphonic, chromic, hydrobromic, hydrofluosilicic, hypophosphorous, molybdic, silicic, sulphurous tungstic, vanadic, etc., and for 1914 sulphurous, hypophosphorous, arsenic, and hydrofluosilicic.
⁵ Includes, 1919, butyric, caproic, carbonic, cresylic, formic, gallic, glycerophosphoric, hydrocyanic, monochloroacetic, oxalic, phthalic anhydride, propionic, pyrogallic, thymic, valerianic, etc.

TABLE 16.—THE MAJOR ACIDS—DISTRIBUTION OF NUMBER OF ESTABLISHMENTS, BY GEOGRAPHIC DIVISIONS: 1919.

	United States.	New England.	Middle Atlantic.	North Central.	South Atlantic.	South Central.	Mountain.	Pacific.
Sulphuric.....	216	6	42	40	77	33	7	11
Sulphuric (reclaimed).....	65		21	19	2	14	4	5
Nitric.....	59	3	27	15	1	1	5	7
Mixed.....	42	1	17	14	1	1	5	3
Carbonic.....	42	4	10	15	3	6	.....	4
Hydrochloric.....	40	4	18	9	2	1	2	4
Acetic.....	21	2	9	7	2	.....	.....	1

Sulphuric acid.—Sulphuric acid may be considered the fundamental of the acid group, since nearly all other acids are made through its instrumentality, with the difference that sulphuric acid does not figure

in the final product, but remains with the residual salt or by-product of the process.

To show how extensively sulphuric acid is employed in the production of other acids, a synopsis of methods of manufacture is given—

A.—Direct action of sulphuric acid (usually upon a natural salt or by-product of another process), liberating free acid.

ACID SET FREE.	NATURAL SALT OR BY-PRODUCT: SOURCE—
Acetic.....	Acetates, wood distillation industry.
Boric.....	Borax from lake brines.
Carbonic.....	Coal-tar fraction, after caustic extraction.
Carbonic.....	Limestone or marble.
Chlorosulphonic.....	Chlorine and sulphuric acid.
Citric.....	Citrates, citrus fruit industry.
Gallic.....	Tannic acid, extracts industry. ¹
Hydrobromic.....	Brines from mines and lakes.
Hydrochloric.....	.....
Hydrocyanic.....	Gas, coke, and beet sugar industries.
Hydroferrocyanic.....	.....
Hydrofluoric.....	Fluorspar or cryolite.
Hydrofluosilicic.....	Fluorspar and sand, or by-product phosphate manufacture, fertilizer industry.
Lactic.....	Lactates, dairy industry.
Mixed.....	Mixture, nitric and sulphuric.
Nitric.....	Chili salt-peter.
Oxalic.....	Sawdust, lumber industry. ¹
Phosphoric.....	Bone ash or phosphate rock.
Phthalic.....	Naphthalene, coal-tar industry, with catalyst. ²
Tartaric.....	Tartrates, wine industry.
Valerianic.....	Fusel oil, distillation industry, with bichromate. ³
Vanadic.....	Carnotite ores, by-product radium industry.

¹ Action of boiling dilute sulphuric acid—hydroxylation.
² Action of concentrated sulphuric acid—oxidation.

B.—Action of sulphuric acid, after a preliminary operation.

Chromic.....	Alkaline fusion chrome iron ore, then sulphuric acid.
Silicic.....	Alkaline fusion quartz, then sulphuric acid.
Tungstic.....	Alkaline fusion tungsten ore, then sulphuric acid.
Formic.....	Alkali heated under pressure with CO, CO ₂ , or CO.
Hypophosphorous.....	Barium hydroxide heated with phosphorus.
Lactic.....	Specific bacterial fermentation, starch paste or sugar from corn, potato, molasses, etc., neutralized lime, then sulphuric acid.
Butyric.....	Same general method as lactic, specific bacteria.
Caproic.....	Similar to lactic.
Capronic.....	.....
Oleic.....	Alkaline saponification, fats and oils of slaughtering and meat packing, olive and cotton-seed oil industries, then sulphuric.
Stearic.....	Similar to oleic.
Oxalic.....	Formic acid process continued with more heat, neutralized lime and sulphuric acid added.

C.—Acids not employing sulphuric acid.

Arsenious.....	Roasting arsenical pyrites.
Molybdic.....	Roasting molybdenum sulphide ore.
Chloroacetic.....	Chlorine passed into acetic acid. ¹
Glycerophosphoric.....	Glycerine and phosphoric acid heated together. ¹
Pyrogallic.....	Gallic acid heated in autoclave with water.
Tannic.....	Extract of gall nuts.

¹ Acetic and phosphoric acids and sometimes chlorine produced by use of sulphuric acid.

D.—Additional methods developed for important acids, largely synthetic.

Acetic.....	Bacterial oxidation of alcohol. Synthesis from acetylene, catalytic.
Carbonic.....	Combustion, organic material. Fermentation, organic material.
Citric.....	Fermentation of sugar.
Hydrobromic.....	Synthesis from hydrogen and bromine, catalytic.
Hydrochloric.....	Synthesis from hydrogen and chlorine. By-product, Le Blanc soda process. (Class a.) By-product, chlorination processes.
Nitric.....	Synthesis of nitrogen and oxygen, electrolytic. Synthesis from ammonia and oxygen, catalytic.
Phosphoric.....	Synthesis from white phosphorus and oxygen.
Stearic.....	Synthesis from oleic, catalytic hydrogenation.

Sulphuric acid production.—Table 17 presents the statistics for sulphuric acid production, 1919 and 1914, distributed by industries, by process used in manufacture, and by states; also whether produced for sale or for consumption in the producing establishment. It gives also the weight of platinum in use in the industry.

MANUFACTURES.

TABLE 17.—SULPHURIC ACID (BASIS 50° BAUMÉ): 1919 AND 1914.

	TONS (2,000 POUNDS).		VALUE.	
	1919	1914	1919	1914
Total production.....	5,552,581	4,071,566		
For sale.....	3,331,362	2,338,284	\$35,932,605	\$15,395,123
Made and consumed.....	2,221,219	1,733,282		
<i>By industries.</i>				
Establishments engaged primarily in the manufacture of—				
Sulphuric, nitric, and mixed acids—				
For sale.....	1,685,341	1,359,183	18,112,942	9,014,538
Made and consumed.....	213,437	(1)		
Chemicals in general—				
For sale.....	524,135	500,488	6,460,983	3,773,318
Made and consumed.....	251,394	(1)		
Fertilizers—				
For sale.....	282,450	120,053	3,329,628	768,873
Made and consumed.....	1,529,624	(1)		
Explosives—				
For sale.....	42,041	133	537,077	1,713
Made and consumed.....	43,187	(1)		
Products of other industries—				
For sale.....	797,385	349,427	7,491,975	1,806,691
Made and consumed.....	183,607	(1)		
<i>By process.</i>				
Establishments using the:²				
Chamber process.....	3,757,887	2,961,815		
Contact process.....	1,141,418	698,413		
Both chamber and contact processes.....	653,276	411,338		
<i>Production, by states.</i>				
Alabama:				
For sale.....	61,218	38,317	795,058	293,525
Made and consumed.....	96,611			
California:				
For sale.....	367,773	114,058	4,732,759	945,276
Made and consumed.....	46,074			

¹ Figures not available.

² Chamber process only was reported by 24 establishments in 1919 and 13 in 1914; contact process only was reported by 185 establishments in 1919 and 172 in 1914; while both chamber and contact processes were reported by only 7 establishments in 1919 and 9 in 1914.

TABLE 17.—SULPHURIC ACID (BASIS 50° BAUMÉ); 1919 AND 1914—Continued.

	TONS (2,000 POUNDS).		VALUE.	
	1919	1914	1919	1914
Georgia:				
For sale.....	19,906	20,151	\$325,958	\$115,220
Made and consumed.....	252,899			
Illinois:				
For sale.....	470,092	340,252	4,483,311	1,848,031
Made and consumed.....	72,691			
Louisiana:				
For sale.....	16,232	(1)	162,572	(1)
Made and consumed.....	65,896			
Maryland:				
For sale.....	159,957	187,937	1,747,830	1,194,801
Made and consumed.....	330,928			
New Jersey:				
For sale.....	393,067	399,667	5,013,063	3,085,226
Made and consumed.....	249,072			
New York:				
For sale.....	69,699	63,970	1,098,800	532,938
Made and consumed.....	52,262			
Ohio:				
For sale.....	255,271	142,800	2,713,108	983,583
Made and consumed.....	117,085			
Pennsylvania:				
For sale.....	468,696	362,270	5,550,984	2,498,117
Made and consumed.....	93,874			
All other:				
For sale.....	1,049,451	659,862	9,300,162	3,898,466
Made and consumed.....	843,827			
<i>Weight of platinum used.</i>				
	TROY OUNCES.			
Total weight.....	41,851	29,835		
In stills or concentration pans.....	3,366	8,829		
In contact mass.....	38,485	21,006		

¹ Figures not available.

Sulphuric acid production, according to strength.—
Table 18 presents the statistics of production, 1919, according to strength, and whether produced for sale or for consumption in the producing establishment.

TABLE 18.—SULPHURIC ACID, 1919.

(Ton, 2,000 pounds.)

	Number of establishments.	PRODUCTION ACCORDING TO STRENGTH.										TOTAL ON BASIS OF 50° BAUMÉ.	
		50° Baumé.		60° Baumé.		66° Baumé.		Oleum.¹		Trioxide.		Tons.	Value.
		Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.		
Total production.....	216	2,750,112		1,020,052		834,195		76,678		75,126		5,552,581	
Produced for sale.....		839,780	\$9,543,118	949,371	\$9,498,800	707,303	\$13,521,316	63,316	\$1,993,018	69,839	\$1,373,353	3,331,362	\$35,932,605
Made and consumed (in establishment producing).....		1,910,332		70,681		126,892		12,862		5,287		2,221,219	
Alabama.....	13	85,811		20,394		31,017						157,829	
For sale.....				20,394	337,769	23,817	457,289					61,218	795,058
Made and consumed.....		85,811				7,200						96,611	
California.....	10	274,478		3,462		62,637		24,021				413,847	
For sale.....		228,414	2,542,872	3,462	31,943	62,637	1,036,564	24,021	1,121,380			367,773	4,732,759
Made and consumed.....		46,064										46,074	
Georgia.....	27	266,993		1,168		2,901						272,805	
For sale.....		14,044	220,619	1,168	11,463	2,901	93,876					19,906	325,958
Made and consumed.....		252,899										252,899	
Illinois.....	11	134,056		217,590		21,905		9,779		45,161		542,783	
For sale.....		92,698	948,297	202,132	2,032,654	20,534	464,901	3,958	108,859	45,161	928,000	470,092	4,483,311
Made and consumed.....		41,358		15,458		1,371		5,821				72,691	
Louisiana.....	5	57,713		18,105		1,189						82,128	
For sale.....		11,292	103,341	2,525	36,719	1,189	22,512					16,232	162,572
Made and consumed.....		46,421		15,580								65,896	
Maryland.....	7	424,287		34,000		16,065						490,885	
For sale.....		93,359	1,075,421	34,000	396,238	16,065	276,171					159,957	1,747,830
Made and consumed.....		330,928										330,928	
New Jersey.....	18	304,985		25,883		195,195		7,023				642,139	
For sale.....		113,129	1,420,578	24,354	403,980	158,325	3,024,409	7,023	161,096			393,067	5,013,063
Made and consumed.....		191,856		1,529		36,870						249,072	

¹ Includes battery acid and electrolyte sulphuric, 4,894 tons.

TABLE 18.—SULPHURIC ACID, 1919—Continued.

	Number of establishments.	PRODUCTION ACCORDING TO STRENGTH.										TOTAL ON BASIS OF 50° BAUMÉ.	
		50° Baumé.		60° Baumé.		66° Baumé.		Oleum.		Trioxide.		Tons.	Value.
		Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.		
New York.....	5	41,826		17,346		23,303		13,742				121,961	
For sale.....		10,758	\$149,644	9,201	\$177,893	20,978	\$573,555	9,341	\$107,708			69,699	\$1,093,800
Made and consumed.....		31,068		8,145		2,325		4,401				52,262	
Ohio.....	14	128,049		29,989		125,759				9,421		372,356	
For sale.....		39,310	380,226	25,790	307,887	110,361	1,853,834			9,421	\$171,161	255,271	2,713,108
Made and consumed.....		88,739		4,199		15,398						117,085	
Pennsylvania.....	19	160,084		109,855		111,875		504		11,136		562,570	
For sale.....		95,820	1,127,533	158,957	2,273,361	108,026	2,035,308	498	11,095	5,849	112,687	498,696	5,559,984
Made and consumed.....		64,264		10,898		3,849		6		5,287		93,874	
All other states ¹	87	871,820		482,280		242,349		21,609		9,408		1,893,278	
For sale.....		140,906	1,674,587	158,957	3,485,893	182,470	3,682,897	18,975	395,880	9,408	160,905	1,049,451	9,300,162
Made and consumed.....		730,914		14,872		59,879		2,634				843,827	
Florida.....		47,231										47,231	
Massachusetts.....		95,041				10,451						110,718	
Mississippi.....		33,352		8,000								43,352	
North Carolina.....		110,590										110,590	
South Carolina.....		164,835										164,835	
Tennessee.....		82,416										82,416	
Virginia.....		95,236										95,236	
Other.....		102,213		6,872		49,428		2,634				189,449	

¹ Includes Arizona, 1; Arkansas, 1; Colorado, 3; Connecticut, 2; Delaware, 1; Florida, 5; Indiana, 3; Kansas, 1; Kentucky, 1; Massachusetts, 4; Michigan, 3; Mississippi, 5; Missouri, 1; Montana, 1; North Carolina, 12; Oklahoma, 1; South Carolina, 14; Tennessee, 7; Texas, 5; Utah, 2; Virginia, 9; Washington, 1; West Virginia, 2; and Wisconsin, 2.

Table 19 summarizes the production figures for sulphuric acid for 1919, 1914, and 1909, according to strength, as reported, with the conversion figures for same to basis of 50° acid. It shows also the per cent distribution according to strength, and the per cent distribution of that made and consumed, according to strength.

TABLE 19.—DISTRIBUTION OF SULPHURIC ACID PRODUCTION: 1919, 1914, AND 1909.

DISTRIBUTION ACCORDING TO STRENGTH.			
	1919	1914	1909
Total as reported.....	Tons. 4,756,163	Tons. 3,402,946	Tons. 2,417,621
50°.....	2,750,112	1,701,233	1,643,281
60°.....	1,020,052	795,489	189,384
66°.....	834,195	828,468	552,619
Oleum and SO ₃	1,151,804	77,758	32,337
Same expressed as 50°.....	5,552,581	4,071,566	2,764,455
50°.....	2,750,112	1,701,233	1,643,281
60° as 50°.....	1,275,064	994,361	236,730
66° as 50°.....	1,251,233	1,242,699	828,929
Oleum and SO ₃ as 50°.....	276,112	133,273	55,515
Per cent distribution:			
Total.....	100.0	100.0	100.0
50°.....	57.8	41.8	59.4
60°.....	21.4	24.4	8.6
66°.....	17.5	30.5	30.0
Oleum and SO ₃	3.2	3.3	2.0
Per cent of each strength made and consumed (total for each strength being 100):			
Total as 50°.....	39.8	37.0	46.0
50°.....	69.3	74.0	68.0
60°.....	6.9	31.0	6.0
66°.....	15.2	12.0	18.0
Oleum and SO ₃	11.7	20.0	12.0

¹ Includes battery acid and electrolyte sulphuric, 4,694 tons.

The total for sulphuric acid made and consumed probably includes acid used in making mixed acid. Roughly calculated from the average unit values of the two acids concerned, the sulphuric acid so used,

expressed as 50°, amounted to about 30,000 tons in 1919 and 27,000 tons in 1914.

Of the 216 establishments making sulphuric acid, 24 used the contact process, 7 both contact and chamber processes, and 185 the chamber process only. That is, 31 concerns, or about one-seventh of the number, employed contact conversion either entirely or partly. Estimating the amount of acid made by contact mass in establishments using both processes from the amounts of platinum reported as used, about 87,200 tons of 50° was so made; so that 1,228,619 tons, or 22.2 per cent, of all sulphuric acid were made by contact methods and 4,305,735 tons, or 77.8 per cent, by the chamber method.

Platinum used in contact mass amounted to 38,485 troy ounces. This, together with 3,366 ounces reported in use in stills and pans, gives a total of 41,851 ounces.

The production of sulphuric acid, basis of 50°, as shown in Table 16, is given in the following tabular statement, ranked by states, with percentages of distribution.

	Tons.	Per cent.
Total production.....	5,552,581	100.0
New Jersey.....	642,139	11.6
Pennsylvania.....	562,570	10.1
Illinois.....	542,783	9.8
Maryland.....	490,885	8.8
California.....	413,847	7.5
Ohio.....	372,356	6.7
Georgia.....	272,895	4.9
Alabama.....	157,529	2.8
New York.....	121,961	2.2
Louisiana.....	82,128	1.5
Other states.....	1,893,278	34.1

Sulphuric acid is produced by the burning of sulphur or pyrite or pyrrhotite, and as a by-product in the roasting or smelting of zinc and copper ores. The amount of such ores employed as material for sulphuric acid manufacture was not reported. During the war, owing to restrictions in foreign trade in pyrite, there resulted a large increase in the employment of sulphur as a raw material; and in 1919 acid makers, especially in the interior, continued the use of brimstone. Spanish pyrite was used only at the coast. As the demand for spelter and copper was subnormal, especially in the early months of 1919, tonnage from this source was less.

As material, 570,169 tons of sulphur and 1,146,958 tons of pyrite were employed in the various industries. Plants using sulphur were as a rule smaller in size, roughly averaging 2,000 tons, while concerns using pyrite averaged 10,000 tons. The weight of sulphur was 32.2 per cent of the total tonnage, but using the factors $4\frac{1}{2}$ and $2\frac{1}{2}$ to estimate the quantity of 50° acid produced from sulphur and pyrite, respectively, we have from sulphur 2,382,746 tons of 50° acid; that is, 48.7 per cent, or about one-half of the total acid production, was from the burning of sulphur.

Production of sulphuric acid from zinc and copper ores.—Table 20 presents the statistics of production from zinc and copper ores (roasters and smelters), in 1919.

TABLE 20.—SULPHURIC ACID PRODUCTION FROM ZINC AND COPPER ORES: 1919.

[Ton, 2,000 pounds.]

	Number of establishments	Total production, tons.	Made and consumed, tons.	PRODUCED FOR SALE.	
				Tons.	Value.
Total.....	1 20	832,913	16,008	866,905	\$3,253,423
Copper smelters, terms of 60° Bé. ¹	6	364,991	410	364,581	2,084,087
Zinc smelters and roasters, terms of 60° Bé.	14	517,922	15,598	502,324	6,165,336
As reported (zinc smelters)—					
50°-60°		396,901	7,732	389,466	4,693,035
66° and sulphur trioxide		79,148	5,287	73,861	1,467,301

¹ Distribution by states: From copper ores 6—Tennessee, 2; and 1 each in Arizona, California, New Jersey, and Utah. From zinc ores 14—Illinois, 7; Pennsylvania, 3; and 1 each in Kansas, Ohio, West Virginia, and Wisconsin.

² Includes some production under a pre-war long-term contract.

Products closely related to sulphuric acid are sulphur trioxide, sulphur dioxide, and sulphurous acid; also reclaimed acid. Sulphur trioxide was produced as a by-product of the zinc smelting industry, all by the contact process. It is included with oleum and fuming sulphuric acid. Sulphur dioxide, which is marketed as a compressed and liquefied gas, used in the bleaching industry, was made in three plants, all burning sulphur. Sulphurous acid, marketed in carboys, was also manufactured by three companies burning sulphur as the raw material, and like sulphur dioxide, is used for bleaching purposes.

Reclaimed sulphuric acid was reported in large quantities, a total of 473,555 tons, consisting of 426,315

tons, or 90 per cent, from the petroleum industry; 44,657 tons, or 9.4 per cent, from the explosives industry; and the residue from the acid industry. The amount sold as such was 95,119 tons, at an average value of \$8.50 per ton. In 1914 the average value was \$3.80 a ton.

In 1919 sulphuric acid was reclaimed in 65 establishments, 90.3 per cent, or 427,421 tons, being reported from 45 plants in nine states (New Jersey, Indiana, New York, California, Texas, Pennsylvania, Illinois, Missouri, and Louisiana). Eight plants in the state of New Jersey reclaimed 161,566 tons, or 34.1 per cent of the total.

Nitric acid.—Nitric acid ranks next to sulphuric in commercial importance.

Table 21 presents the statistics of production for 1919 and 1914.

TABLE 21.—NITRIC ACID: 1919 AND 1914.

	1919	1914
Number of establishments.....	1 59	52
Production, tons (2,000 pounds).....	86,992	78,589
For sale—		
Tons.....	19,436	14,685
Value.....	\$2,976,095	\$1,591,825
Made and consumed, tons.....	67,556	63,904
Production, by establishments engaged primarily in the manufacture of:		
Sulphuric, nitric, and mixed acids.....	18,831	.....
For sale—		
Tons.....	3,861	9,794
Value.....	\$642,018	\$1,141,183
Made and consumed, tons.....	14,970	.....
Chemicals in general.....	18,962	.....
For sale—		
Tons.....	11,951	4,256
Value.....	\$1,749,215	\$385,259
Made and consumed, tons.....	7,011	.....
Explosives.....	48,588	.....
For sale—		
Tons.....	3,013	463
Value.....	\$537,800	\$63,760
Made and consumed, tons.....	45,575	.....
Other commodities—		
Tons.....	611	172
Value.....	\$47,062	\$11,423
Production, by states (all industries):		
Illinois.....	5,051	.....
For sale—		
Tons.....	798	552
Value.....	\$149,800	\$68,545
Made and consumed, tons.....	4,253	.....
New Jersey.....	28,918	.....
For sale—		
Tons.....	3,903	8,823
Value.....	\$520,500	\$1,048,597
Made and consumed, tons.....	25,015	.....
New York.....	4,212	.....
For sale—		
Tons.....	1,043	1,259
Value.....	\$192,012	\$107,201
Made and consumed, tons.....	3,169	.....
Pennsylvania.....	5,083	.....
For sale—		
Tons.....	980	500
Value.....	\$211,945	\$44,000
Made and consumed, tons.....	4,103	.....
All other states ²	43,728	.....
For sale—		
Tons.....	12,712	3,551
Value.....	\$1,901,838	\$328,222
Made and consumed, tons.....	31,016	.....

¹ Distribution by states: Pennsylvania, 11; New Jersey, 11; California, 6; Illinois, 5; New York, 3; Missouri, 3; Colorado, 3; Michigan, 3; Connecticut, 2; Ohio, 2; and 1 each in Alabama, Delaware, Indiana, Massachusetts, Montana, Utah, Washington, and Wisconsin.

² In order of production, 1919: Massachusetts, Missouri, Wisconsin, California, Delaware, Ohio, Indiana, Colorado, Washington, Connecticut, Michigan, Utah, Montana, and Alabama.

Nitric acid was reported in many degrees of strength and purity from dilute to 38°, 40°, 42°, and 100 per cent, fuming, and chemically pure. Conversions to uniform grade have not been made. As an indication of the grades, prices ranged from \$87 to \$485 a ton.

The increase in tonnage from 1914 to 1919 was 10.7 per cent, a large proportion being used in the same establishment, 77.7 per cent in 1919 and 81.3 per cent in 1914. Calculating from the unit values of nitric acid and 66° sulphuric acid, the total weight of mixed acid contained 57 per cent or 65,484 tons of nitric acid in 1919 and 41.9 per cent or 46,980 tons in 1914, which amounts are included in the item made and consumed. At a uniform average value, the total tonnage of nitric acid amounted in value to \$13,310,000 in 1919 and \$8,488,000 in 1914.

During the years intervening between 1914 and 1919, the period of the World War, nitric acid must have been made in very large amounts. The 1919 census, however, does not indicate the increases due to the war.

All of the nitric acid reported was made by treatment of nitrate with sulphuric acid, no synthetic nitrogen being included.

The tonnage of the explosives industry was 55.9 per cent of all nitric acid reported. The acid industry shows 79.5 per cent of the acid as made and used in the same works, the chemical industry 37 per cent and the explosives industry 93.8 per cent.

Mixed acid.—Table 22 presents the statistics of production for mixed acid for 1919 and 1914.

Mixed acid increased in quantity 2.4 per cent from 1914 to 1919 but more than doubled in value, for amount sold as such. As with nitric acid, more mixed acid was consumed in the same plant than was sold as such, 59.6 per cent and 61.9 per cent, respectively, for 1919 and 1914. Prices were less variable than for nitric acid and ranged from \$65 to \$137 per ton. Strengths or proportions of the mixture were in no case indicated.

The sulphuric and nitric acids represented in mixed acid are included in the made and consumed items under the respective acids. Estimating the value of all mixed acid from the unit values for that sold as such, we have for 1919, \$10,914,000 and for 1914, \$5,718,000.

As with nitric acid, the table shows that much the larger part of mixed acid is produced in the explosives industry, 62.8 per cent in 1919.

TABLE 22.—MIXED ACID: 1919 AND 1914.

	1919	1914
Number of establishments.....	142	37
Production, tons (2,000 pounds).....	114,886	112,124
For sale—		
Tons.....	40,428	42,725
Value.....	\$1,426,637	\$2,204,450
Made and consumed, tons.....	68,458	69,399
Production, by establishments engaged primarily in the manufacture of:		
Sulphuric, nitric, and mixed acids.....	32,636	.....
For sale—		
Tons.....	29,663	23,616
Value.....	\$2,539,989	\$1,294,381
Made and consumed.....	2,973	.....
Chemicals in general.....	10,076	.....
For sale—		
Tons.....	5,930	11,264
Value.....	\$788,669	\$723,356
Made and consumed, tons.....	4,140	.....
Explosives.....	72,174	.....
For sale—		
Tons.....	10,829	7,845
Value.....	\$777,979	\$186,713
Made and consumed, tons.....	61,345	.....
Production, by states (all industries):		
Illinois.....	11,925	.....
For sale—		
Tons.....	7,735	1,297
Value.....	\$320,799	\$97,710
Made and consumed, tons.....	4,190	.....
New Jersey.....	40,545	.....
For sale—		
Tons.....	15,633	18,541
Value.....	\$1,403,103	\$879,373
Made and consumed, tons.....	24,912	.....
Pennsylvania.....	8,117	.....
For sale—		
Tons.....	487	2,034
Value.....	\$95,575	\$111,952
Made and consumed, tons.....	7,630	.....
All other states ²	54,299	.....
For sale—		
Tons.....	22,573	20,853
Value.....	\$2,307,160	\$1,115,445
Made and consumed, tons.....	31,726	.....

¹ Distribution, by states: Pennsylvania, 9; New Jersey, 6; Illinois, 5; Missouri, 3; 2 each in California, Colorado, Michigan, New York, Ohio, and Utah; 1 each in Alabama, Connecticut, Delaware, Indiana, Montana, Washington, and Wisconsin.

² In order of production, 1919: California, Missouri, New York, Delaware, Wisconsin, Connecticut, Washington, Utah, Colorado, Ohio, Michigan, Montana, Alabama, and Indiana.

Hydrochloric or muriatic acid.—Table 23 presents statistics for hydrochloric acid for 1919 and 1914.

The total tonnage, 221,749 tons, places it second in rank among the acids, the gain from 1914 to 1919 being 31.5 per cent. While a larger part of the total was made and consumed in 1914 than in 1919, both years showed considerable amounts so used—32.3 per cent in 1919 and 49.3 per cent in 1914.

Nearly all of the 40 establishments making hydrochloric acid reported it in 18° and 20° strengths; some was returned as 22° and as 100 per cent, while the purity ranged from commercial to chemically pure. Three establishments made it synthetically from electrolytic chlorine, three reported it as a by-

product from chlorination processes, while the bulk was made by the usual process from salt and sulphuric acid. The employment of niter cake, with 33 per cent available sulphuric acid, in lieu of sulphuric acid, apparently was not indicated. Prices ranged from \$16 to \$80 a ton.

The acid and chemical industries produced all of the hydrochloric acid reported in 1919, the total amount being about equally divided between these two branches of chemical manufacture.

TABLE 23.—HYDROCHLORIC ACID: 1919 AND 1914.

	1919	1914
Number of establishments.....	140	31
Production, tons (2,000 pounds).....	221,749	168,584
For sale—		
Tons.....	150,000	85,433
Value.....	\$4,312,253	\$1,348,805
Made and consumed, tons.....	71,659	83,146
Production, by establishments engaged primarily in the manufacture of:		
Sulphuric, nitric, and mixed acids.....	109,087	.....
For sale—		
Tons.....	91,864	33,654
Value.....	\$2,344,703	\$495,930
Made and consumed, tons.....	17,223	.....
Chemicals in general.....	112,662	.....
For sale—		
Tons.....	58,226	51,784
Value.....	\$1,937,460	\$852,875
Made and consumed, tons.....	54,436	.....
Production, by states (all industries):		
New Jersey.....	22,855	.....
For sale—		
Tons.....	19,232	25,721
Value.....	\$668,345	\$406,986
Made and consumed, tons.....	3,623	.....
New York.....	19,507	.....
For sale—		
Tons.....	19,437	5,353
Value.....	\$522,858	\$78,334
Made and consumed, tons.....	70	.....
Pennsylvania.....	24,060	.....
For sale—		
Tons.....	22,068	13,679
Value.....	\$733,558	\$217,440
Made and consumed, tons.....	1,992	.....
All other states ¹	155,327	.....
For sale—		
Tons.....	89,353	40,685
Value.....	\$2,387,492	\$646,045
Made and consumed, tons.....	65,974	.....

¹ Distribution, by states: Pennsylvania, 8; New Jersey, 5; New York, 5; California, 4; Illinois, 3; Ohio, 3; 2 each in Colorado, Connecticut, and Massachusetts; and 1 each in Delaware, Indiana, Michigan, Louisiana, Kansas, and West Virginia. Of these, electrochemical production by 3 establishments—New York, 2, and West Virginia, 1.

² Includes 418 tons produced by manufacturers of other commodities.

³ In order of production, 1919: Illinois, Indiana, Ohio, Delaware, Massachusetts, California, Kansas, Louisiana, Colorado, Connecticut, West Virginia, and Michigan.

By-products from the manufacture of nitric and hydrochloric acids are niter cake and salt cake, included in Group III, Sodium compounds. The production of niter cake, calculated from the nitric acid, with an assumed average of 61 per cent strength, must have been approximately 270,000 tons, valued at \$931,500, and of dry salt cake from the manufacture of 30 per cent hydrochloric acid approximately 250,000 tons of a value of \$3,800,000.

Carbonic acid or carbon dioxide.—Carbon dioxide or CO₂ is the acid anhydride of a hypothetical acid of the composition CO(OH)₂, which supposedly exists in water solution but can not be separated as such. Salts of this acid indicate such a formula. The commercial value of free carbonic acid or CO₂ consists in the fact that at ordinary temperatures it is a gas that

can be compressed and liquefied so as to be readily transported; that the raw materials for its production are plentiful and cheap; that it has a pleasant and slightly acid taste and is not toxic. Its principal use is in effervescing drinks.

Liquefied carbon dioxide is second in rank among acids for the value of product actually sold. None was reported as made and consumed by the same establishment. Second in value and third in amount produced for sale, carbonic acid ranks among the major acids. The statistics of production for the censuses, 1899 to 1919, inclusive, are given in Table 24. Growth in this industry since 1909 has been steady but not phenomenal in number of establishments or in quantity, which increased 5 per cent from 1909 to 1914, and about 20 per cent from 1914 to 1919.

TABLE 24.—CARBONIC ACID GAS, OR CARBON DIOXIDE (CO₂).

		Number of establishments.	Pounds.	Value.
United States.....	1919.....	42	59,771,411	\$6,574,250
	1914.....	38	50,445,779	2,320,685
	1909.....	35	47,053,201	2,345,743
	1904.....	.....	35,991,627	1,348,999
	1899.....	.....	12,084,281	719,394
By states: ¹	Illinois.....	4	9,142,964	1,051,976
	Ohio.....	5	5,551,063	597,626
	Pennsylvania.....	3	2,534,220	303,137
	All other.....	30	42,547,164	4,621,502

¹ States and number of establishments in order of quantity production: New York, 5; Illinois, 4; New Jersey, 2; Ohio, 5; Georgia, 2; Massachusetts, 4; California, 4; Missouri, 3; Virginia, 1; Pennsylvania, 3; Texas, 2; Tennessee, 2; Louisiana, 1; Minnesota, 1; Kentucky, 1; and Wisconsin, 1.

Minor acids, inorganic.—*Arsenic acid* production 2,622,389 pounds, was by oxidation with litharge or nitric acid from 1960 tons of arsenious acid or white arsenic, reported by six establishments in New Jersey, Illinois, Maryland, California, and Michigan. Arsenious acid is a product of the smelting and refining industries. Much of the arsenic used for making arsenical insecticides is derived from the latter sources.

Boric or boracic acid was reported by six plants in five states—New Jersey, Pennsylvania, California, New York, and Missouri. Three concerns produced 12,757,296 pounds from colemanite or other borate ores and three produced the crude material and refined 696,804 pounds. All of the boric acid reported was of refined grades, prices varying from 11 cents to 20 cents per pound, and averaging 12 cents.

Hydrofluoric acid, made from fluorspar and sulphuric acid, totaling 5,732,198 pounds, was reported by six plants in five states—New York, Pennsylvania, Ohio, New Jersey, and Connecticut. About 25 per cent was made and consumed in further manufacture by the same establishment. Prices ranged from 10 to 44 cents a pound for chemically pure grade. Hydrofluoric acid has been reported in the last three censuses with a decrease in quantity and number of establishments.

Phosphoric acid production, 22,109,302 pounds, was reported by nine establishments in six states—New Jersey, Rhode Island, Illinois, New York, Missouri, and Delaware. A large proportion, 8,729,801 pounds, or 39.5 per cent, was made and reused. All of that reported was made from bone or phosphate rock and sulphuric acid. A number of grades were shown, 40 per cent, 50 per cent, 85 per cent, U. S. P., and the pentoxide or acid anhydride, and prices varied from 8 to 32 cents a pound, averaging 13 cents.

Other inorganic acids, comprising chlorosulphonic, sulphur dioxide (sulphurous acid anhydride), hydrofluosilicic, tungstic, vanadic, molybdic, chromic, hydrobromic, hypophosphorus, silicic, and sulphurous acids, in order of value as named, amounted to \$797,514, and miscellaneous unenumerated acids to \$39,263.

Organic acids.—The total value of organic acids for 1919 was \$26,318,237, and so far as they could be separated the corresponding value for 1914 was \$7,754,381. Organic acids as a group, therefore constituted 31.1 per cent of the value of all acids. In order of decreasing weight they ranked acetic, oleic, stearic, tartaric, and citric, while in value acetic dropped from first to last place. That is, acetic acid was produced in the largest quantity at much the lowest unit value.

Acetic acid.—Acetic acid was reported in 1919 in the three grades of dilute, including pyroligneous, glacial or 100 per cent, and anhydride. The totals of all grades for three census years are given in the following tabular statement:

	1919	1914	1909
Number of establishments.....	18	13	13
Total production..... pounds..	64,175,275	75,303,375	58,000,602
For sale..... pounds.....	53,510,597	70,617,037	55,923,776
Value.....	\$4,264,044	\$1,272,294	\$1,336,874
Unit value.....	\$0.107	\$0.018	\$0.024
Made and consumed.....	10,658,673	4,685,738	1,076,829
Per cent made and consumed.....	17.0	6.0	2.0

The larger number of plants manufactured dilute acetic acid from calcium acetate and sulphuric acid. Production by fermentation of alcohol and by purification of pyroligneous acid was also reported. Strength and quality ranged from crude and commercial to 28 per cent, 36 per cent, 56 per cent, redistilled, and U. S. P., prices for crude to 28 per cent being 2½ to 5 cents a pound, and for 56 per cent from 7 to 8½ cents a pound.

All of the glacial acetic acid was made from acetate of lime as the raw material. Acetic anhydride was partly made from acetate, from dilute or glacial acetic acid purchased as such, and from acid derived by fermentation of alcohol or of kelp. Both phosphorus and sulphur chlorides were employed for the dehydration. No synthetic acetic anhydride or acid was reported. Four establishments making glacial acetic also reported the dilute acid, but those pro-

ducing the anhydride made no other form of acetic acid.

Stearic acid retained about the same relative position among acids, in rank, while *oleic acid* rose relatively. These acids are produced simultaneously from the same raw materials, the production of one being limited by the production of the other; but as liquid fats contain a greater proportion of oleic acid, it is possible to select raw material with the view of increasing one or the other of these two ingredients. Shortage of importation of olive-oil foots within recent years may account in part at least for underproduction and high price of the more liquid fatty acid.

The nine establishments reporting stearic acid also produced oleic, a large proportion of both being derived from animal fats, greases, and tallow, some from soy-bean oil, cottonseed-oil foots, and other vegetable sources. The totals included among products in the table are exclusive of oleic and stearic acids made and consumed in the soap industry, which is the largest producer of these fatty acids. In order of production the states rank for stearic acid, Ohio, New York, Pennsylvania, New Jersey, and Montana, while for oleic acid the order is Ohio, Pennsylvania, New Jersey, New York, Indiana, Montana, and Rhode Island. The proportion of stearic to the total in the nine establishments making both acids varied from 21 to 50 per cent, the average being 33 per cent, or about one-third of the total.

Tartaric, citric, and lactic acids are used for many of the same purposes—as components of soft drinks and effervescing salts or in the textile industries. The four establishments making tartaric acid were located in New York, Ohio, and California and employed argols as raw material.

Six plants in four states—New York, Pennsylvania, New Jersey, and California—produced citric acid from citrate of lime in the East and from cull lemons in the West.

Four establishments in three states—Massachusetts, Pennsylvania, and Missouri—produced lactic acid from various organic materials by specific bacterial fermentation.

Tannic acid was produced by four establishments in three states—New York, Missouri, and Pennsylvania—two of these being refiners and manufacturers of medicinal or U. S. P. grades, and two engaged primarily in the manufacture of dyestuffs and extracts from original sources.

Other organic acids consisted of hydrocyanic, gallic, oxalic, pyrogallic, creosote, carbolic, monochloroacetic, thymol or thymic, formic, butyric, phthalic anhydride, cresol or cresylic, valerianic or valeric, propionic, and glycerophosphoric, in order of value as named.

Hydrocyanic or prussic acid is used for fumigating citrus fruits and was practically all reported from

California, except small amounts refined in the East. Although as an acid it is included in Group I, it is also a cyanogen derivative, and its principal value depends upon the properties of the cyanogen present, so that it is included primarily in Group II, Cyanogen compounds. Sodium cyanide and fruit pits were used as raw materials.

Gallie and pyrogallie acids were produced in refined and medicinal qualities only, from tannic and gallic acids, respectively. *Formic and oxalic acids* resulted in part from synthetic processes, from caustic and sawdust, and two establishments refined only. The *carbolic acid* reported includes only that made in establishments engaged in the chemical industries and does not cover that made and used in the coal-tar industries. It resulted from synthetic processes by the usual method of sulphonation and fusion in caustic. One establishment refined only, to 100 per cent grade. *Monochloroacetic acid* was made by use of acetate of lime and electrolytic chlorine.

Creosote was of refined quality for medicinal purposes and was derived from wood tar; *thymol or thymic acid* was derived by the usual method from thyme oil; *butyric and propionic acids* by specific bacterial fermentation of starch, corn sugar, molasses, or other carbohydrate material; *phthalic acid anhydride* resulted from catalytic processes, using naphthalene and toluene as raw material; *cresol or cresylic acid* was a refined product; *valerianic acid* was the result of oxidation of fusel oil with bichromate and sulphuric acid, and *glycerophosphoric acid* by the combination of glycerine with phosphoric acid.

GROUP II.—AMMONIUM AND CYANOGEN COMPOUNDS.

Ammonium and cyanogen compounds, presented in Table 25, constitute an important chemical group, particularly when all forms of commercial nitrogen and its combinations are considered. The following is a summary of some of the values reported in 1919, that might be enumerated as "Nitrogen and fixed nitrogen compounds."

	Group No.	Value.
Total nitrogen compounds.....		\$98,079,732
Ammonium and cyanogen compounds.....	II	23,087,553
Nitrogen compounds, other groups:		
Nitrogen gas.....	IX	45,416
Nitrous oxide gas.....	IX	515,164
Nitric acid.....	I	2,976,095
Mixed acid, 57 per cent nitric.....	I	3,648,658
Nitrates, nitrites.....	I to X	5,971,823
Ammonic alum, amines, cyanides.....	V and X	751,441
Pyroxylin, nitrocellulose.....	VIII	33,979,217
Ammonia and ammonium sulphate—Gas and coke industries.....		27,124,365

If to the above there is added the values of the nitro, nitroso, amido and amino compounds, proteins and alkaloids, of the coal-tar, explosives, fertilizer, textile, pharmaceutical and other primary industries, the total would inadequately express the value of nitrogen in the cycle of industrial operations.

With the exception of some ammonia, ammonium chloride and sulphate, and cyanide, made from cyanamid and metallic sodium produced electrolytically, no nitrogen reported for the year 1919, was fixed by synthetic processes.

TABLE 25.—GROUP II.—AMMONIUM AND CYANOGEN COMPOUNDS.

	1919	1914	1909
Value of products.....	\$23,087,553	\$8,064,913	(1)
Ammonia, anhydrous: ²			
Number of establishments.....	39	14	15
Total production, pounds.....	27,957,000		
For sale—			
Pounds.....	27,530,000	16,659,780	11,069,846
Value.....	\$7,224,473	\$3,140,848	\$2,544,238
Unit value, pound.....	\$0.29	\$0.19	\$0.21
Made and consumed, pounds.....	427,000		
Ammonia, aqua:			
Number of establishments.....	27		
Total production, pounds.....	45,467,000		
For sale—			
Pounds.....	30,918,000	35,544,246	20,983,476
Value.....	\$2,241,321	\$1,412,236	\$899,520
Unit value, pound.....	\$0.07	\$0.04	\$0.04
Made and consumed, pounds.....	14,549,000		
Ammonium chloride (sal ammoniac):			
Number of establishments.....	8	3	
Pounds.....	13,212,619	11,511,934	
Value.....	\$1,595,340	\$641,040	(1)
Unit value, pound.....	\$0.12	\$0.06	
Ammonium sulphate: ³			
Number of establishments.....	16		
Total production, pounds.....	33,401,000		
For sale—			
Pounds.....	32,873,000	8,846,616	
Value.....	\$1,595,447	\$211,314	(1)
Unit value, pound.....	\$0.05	\$0.02	
Made and consumed, pounds.....	528,000		
Ammonium bromide and iodide:			
Number of establishments.....	4	(1)	(1)
Value.....	\$160,523		
Ammonium fluoride:			
Number of establishments.....	3	(1)	(1)
Pounds.....	340,156		
Value.....	\$94,276		
Cyanogen compounds:			
Ferro and ferricyanides of sodium, potassium, iron (Prussian blue), and calcium—			
Number of establishments.....	14		
Pounds.....	4,684,611		
Value.....	\$1,467,665		
Other—Hydrocyanic (prussic) acid, cyanides of copper, gold, mercury, nickel, potassium, silver, sodium, and zinc; cyanogen chloride, dicyandiamine, thiocyanates of ammonium, barium, and sodium, value.....	\$5,647,777	\$2,398,674	\$1,941,883
Other ammonium compounds:			
Inorganic—Ammonium alum, ammonium chrome alum, carbonate, hypophosphite, nitrate, persulphate, phosphate, sulphide, vanadate, and miscellaneous, value.....	\$2,759,616		
Organic—Acetate, benzoate, diphenylamine, hexamethylenetetramine, oxalate, valerate, value.....	\$311,115	\$200,801	(1)

¹ Figures not available.

² Product of the chemical and manufactured gas industries. The production of anhydrous ammonia by the by-product coke ovens, as reported by the Geological Survey (mainly ammoniacal liquor and sulphate sold on pound basis of NH_3) was as follows: 1919, 34 establishments, 51,646,764 pounds; value, \$5,692,950 (unit value 11 cents a pound); 1914, 25,370,509 pounds, value, \$2,309,137 (unit value, 9 cents a pound).

³ Product of the chemical, fertilizer, and manufacture gas industries. The production of ammonium sulphate by the by-product coke ovens, as reported by the Geological Survey, was as follows: 1919, 36 establishments, 544,231,935 pounds, sales, 557,619,631 pounds, value, \$21,075,718 (unit value, 37 cents a pound); 1914, ammonia sulphate or reduced to equivalent in sulphate, 170,763,906 pounds, value, \$4,693,590 (unit value, 27 cents a pound).

Ammonium compounds, as shown in Group II, were valued at \$15,952,111, and cyanogen compounds \$7,115,442. Aqua and anhydrous ammonia constituted 59.3 per cent of all ammonium compounds, and the sulphate 10 per cent. If ammonia and ammonium sulphate of the coke and gas industries be included, however, the total for ammonium compounds is \$43,076,476, of which aqua and anhydrous ammonia form 37.9 per cent and the sulphate 51.6 per cent. Some duplication is shown in the figures for aqua ammonia.

Since 1914 aqua ammonia has increased 28 per cent in amount produced but decreased in amount sold, while the production of anhydrous ammonia has increased 68 per cent.

The materials reported as employed for aqua and anhydrous ammonia were ammoniacal liquor, ammonium sulphate with lime to liberate the fixed ammonia, and cyanamid. The strengths of solutions were not reported with sufficient clearness to make an estimate of total NH₃ possible. Among products some reports gave the strength of aqua ammonia as 16°, 20°, and 26°, the prices being 2-3 cents, 4-5 cents, 6 cents and above, respectively. Using the price as a basis of estimating the strength when not stated, the total of 45,466,904 pounds of aqua ammonia reported by the chemical industry consisted of 16,163,315 pounds of 20° (including a very small amount of 16°), or about 36 per cent of the total, and 29,303,589 pounds of 26°, or 64 per cent. Taking the 20° liquor as 17 per cent NH₃ and 26° as 24 per cent NH₃, the ammonia content of aqua ammonia reported by chemical establishments was 10,952,770 pounds. This amount, together with 27,529,599 pounds of anhydrous ammonia of the chemical industry and 51,646,764 pounds from the coking industry makes the equivalent of 90,129,133 pounds of anhydrous ammonia produced in 1919.

Aqua ammonia was reported by 27 establishments in 14 states. Eight states—Pennsylvania, Washington, New Jersey, Rhode Island, Ohio, Michigan, Missouri, and Massachusetts—each produced over 2,000,000 pounds, and aggregated 90.7 per cent of the total. Four establishments in Pennsylvania alone produced 49.7 per cent of the total.

Anhydrous ammonia, 27,529,599 pounds, was produced by 39 establishments in 21 states. Eighteen plants in 6 states—Missouri, Illinois, Pennsylvania, New York, Ohio, and Washington—totaled 91.9 per cent of the whole, while the first 3 states, in 8 establishments, produced 75.7 per cent.

Ammonium sulphate produced by the chemical, gas, and fertilizer industries, exclusive of coke, aggregated 33,400,598 pounds made by 16 establishments in 10 states. Seven establishments in New Jersey, Massachusetts, and Pennsylvania reported 93.3 per cent of the total. The coke industry produced 557,619,631 pounds, so that a total of 591,020,229 pounds, or 295,510 tons, of ammonium sulphate was manufactured in 1919.

Other salts of ammonium were derived by neutralization of an acid by ammonium hydroxide. The latter was obtained from ammoniacal liquors, aqua ammonia, ammonium sulphate and caustic alkali or cyanamid. The acids were made by the usual methods—hydrobromic and hydrochloric acids largely from electrolytic bromine and chlorine, valerianic acid

by the oxidation of fusel oil with bichromate and sulphuric acid, and vanadic acid from carnotite ore. Ammonium salts, excepting the sulphate, were 30.6 per cent of ammonium compounds, the chloride and phosphate constituting a large part.

Cyanogen compounds included within the chemical industry amounted in value to \$7,115,442, or an increase of 196 per cent over 1914. Part was derived from electrolytic sodium or cyanamid. The greater proportion of the ferrocyanide group consisted of Prussian blue and the larger part of the cyanides of the sodium derivative, and hydrocyanic acid. Cyanogen chloride and dicyandiamine were derived from electrolytic chlorine and cyanamid, respectively. A large part of the cyanogen compounds were produced from cyanogen press-cake.

GROUP III.—SODAS, SODIUM, AND COMPOUNDS.

Table 26 presents the statistics for the sodium group for 1919, 1914, and 1909.

TABLE 26.—GROUP III.—SODAS, SODIUM, AND COMPOUNDS.

	1919	1914	1909
Value of products.....	\$93,682,828	\$32,626,325	\$25,048,019
INORGANIC.			
Sodium:			
Borate (borax)—			
Number of establishments.....	8	7	.....
Tons.....	29,635	26,501	20,154
Value.....	\$4,622,286	\$2,071,774	\$1,756,922
Unit value, ton.....	\$156	\$78	\$87
Bichromate—			
Number of establishments.....	5	4	.....
Total production, tons.....	124,081	.....	.....
For sale—	.....	.....	.....
Tons.....	22,902	11,824	(*)
Value.....	\$5,337,389	\$1,125,398	.....
Unit value, ton.....	\$239	\$95	.....
Made and consumed, tons.....	1,089	.....	.....
Bromide—			
Number of establishments.....	5	.....	.....
Pounds.....	1,242,443	(*)	(*)
Value.....	\$511,812	.....	.....
Carbonates—			
Soda ash—			
Number of establishments.....	18	10	11
Total production, tons.....	1,507,424	.....	.....
For sale—	.....	.....	.....
Tons.....	1,023,480	935,305	646,057
Value.....	\$31,195,149	\$10,937,945	\$10,362,656
Unit value, ton.....	\$30	\$12	\$16
Made and consumed, tons.....	473,944	.....	.....
Sal soda (including monohydrate crystals)—			
Number of establishments.....	41	50	50
Tons.....	82,992	106,591	83,644
Value.....	\$2,272,770	\$1,510,449	\$1,158,882
Unit value, ton.....	\$27	\$14	\$13
Bicarbonate—			
Number of establishments.....	10	5	7
Total production, tons.....	100,894	.....	.....
For sale—	.....	.....	.....
Tons.....	141,556	90,169	82,800
Value.....	\$3,695,417	\$1,439,014	\$1,515,045
Unit value, ton.....	\$26	\$16	\$18
Made and consumed, tons.....	49,338	.....	.....
Sesquicarbonate—			
Number of establishments.....	5	(*)	(*)
Tons.....	37,854	.....	.....
Value.....	\$655,500	.....	.....
Fluoride—			
Number of establishments.....	4	(*)	(*)
Pounds.....	1,364,441	.....	.....
Value.....	\$177,420	.....	.....
Hydroxide (caustic soda)—			
Number of establishments.....	29	25	17
Total production, tons.....	333,361	.....	.....
For sale—	.....	.....	.....
Tons.....	322,746	291,539	131,612
Value.....	\$29,792,695	\$9,104,920	\$5,264,887
Unit value, ton.....	\$94	\$33	\$40
Made and consumed, tons.....	10,615	.....	.....
Iodide—			
Number of establishments.....	7	(*)	(*)
Pounds.....	29,284	.....	.....
Value.....	\$103,868	.....	.....

(See foot notes at end of table.)

TABLE 26.—GROUP III.—SODAS, SODIUM, AND COMPOUNDS—CON.

	1919	1914	1909
INORGANIC—continued.			
Sodium—Continued.			
Nitrate, refined—			
Number of establishments.....	7	(*)	(*)
Tons.....	10,153		
Value.....	\$934,643		
Phosphate—			
Number of establishments.....	10	6	
Total production, tons.....	23,867		
Monobasic (4 establishments).....	4,321		
Dibasic (9 establishments).....	9,063		
Tribasic (5 establishments).....	9,883		
For sale—			
Tons.....	22,351	15,397	12,290
Value.....	\$2,438,917	\$853,578	\$540,282
Unit value, ton.....	\$109	\$55	\$44
Made and consumed, tons.....	1,516		
Silicate—			
Number of establishments.....	17	13	
Tons.....	286,791	169,049	34,170
Value.....	\$3,052,318	\$1,648,854	\$'66,621
Unit value, ton.....	\$21	\$10	\$11
Sulphates—			
Niter cake—			
Number of establishments.....	38	31	24
Total production, tons.....	97,826	46,143	
For sale—			
Tons.....	81,170	24,129	27,546
Value.....	\$281,476	\$31,580	\$53,693
Unit value, ton.....	\$3.47	\$1.30	\$1.95
Made and consumed, tons.....	16,666	22,014	
Salt cake—			
Number of establishments.....	34	29	
Total production, tons.....	179,003	110,273	
For sale—			
Tons.....	122,908	90,442	(*)
Value.....	\$1,630,139	\$841,887	
Unit value, ton.....	\$16	\$9	
Made and consumed, tons.....	56,095	19,821	
Glauber's salt—			
Number of establishments.....	27	20	
Total production, tons.....	42,206		
For sale—			
Tons.....	38,330	31,537	46,471
Value.....	\$894,264	\$427,808	\$512,474
Unit value, ton.....	\$22	\$12	\$11
Made and consumed, tons.....	3,876		
Refined anhydrous—			
Number of establishments.....	6		
Total production, tons.....	2,776		
For sale—			
Tons.....	2,708	(*)	(*)
Value.....	\$221,232		
Unit value, ton.....	\$82		
Made and consumed, tons.....	68		
Thiosulphate (Hypo)—			
Number of establishments.....	9		
Total production, tons.....	29,818		
For sale—			
Tons.....	29,678	(*)	(*)
Value.....	\$1,541,087		
Made and consumed, tons.....	140		
Sulphide—			
Number of establishments.....	17	5	
Total production, tons.....	39,735		
For sale—			
Tons.....	35,178	20,273	7,673
Value.....	\$2,316,253	\$516,044	\$206,450
Unit value, ton.....	\$66	\$25	\$27
Made and consumed, tons.....	4,557		
Sulphite—			
Number of establishments.....	8	5	
Total production, tons.....	8,666		
For sale—			
Tons.....	7,299		(*)
Value.....	\$539,030	\$66,649	
Unit value, ton.....	\$75		
Made and consumed, tons.....	1,467		
Washing compounds (not containing soap)—			
Number of establishments.....	3	7	
Tons.....	861	12,441	(*)
Value.....	\$71,021	\$204,230	
Other inorganic sodium compounds, ⁶ value.....	\$7,021,278	\$1,703,535	(*)
ORGANIC.			
Sodium:			
Acetate—			
Number of establishments.....	12		
Total production, pounds.....	2,260,459		
For sale—			
Pounds.....	2,196,113	(*)	(*)
Value.....	\$105,505		
Made and consumed, pounds.....	64,346		
Benzoate—			
Number of establishments.....	4		
Pounds.....	120,447		(*)
Value.....	\$68,004	\$61,490	
Citrate—			
Number of establishments.....	6		
Pounds.....	118,417		
Value.....	\$143,386		
Other organic sodium compounds, ⁶ value.....	\$5,706,363	\$80,630	(*)

(See footnotes at end of table.)

TABLE 26.—GROUP III.—SODAS, SODIUM, AND COMPOUNDS—CON.

DISTRIBUTION OF NUMBER OF ESTABLISHMENTS, BY GEOGRAPHIC DIVISIONS: 1919.

	Total number.	New England.	Middle Atlantic.	East North Central.	West North Central.	South Atlantic.	South Central.	Mountain.	Pacific.
INORGANIC									
Sodium:									
Borate.....	8		4	1					3
Bichromate.....	5		3	1		1			
Bromide.....	5		1	2	1	1			
Carbonate—									
Soda ash.....	18		4	4	2	4			4
Sal soda.....	41	2	11	6	3	2		3	14
Bicarbonato.....	10		4	2	1	2			1
Sesquicarbonate.....	5		2	1					2
Fluoride.....	4		3	1					
Hydroxide (caustic).....	29	4	12	7	2	3			1
Iodide.....	7		6		1				
Nitrate.....	7		3	1	2				1
Phosphate.....	10		7		1	2			
Silicate.....	17		6	7	1				3
Sulphate—									
Niter cake.....	38	3	15	9	2	3	1	4	1
Salt cake.....	34	3	15	8	1	2	2	2	1
Glauber's salt.....	27	3	12	3	4	2			3
Ref. anhydrous.....	6		5	1	1				1
Thiosulphate.....	9		5	1	1				1
Sulphide.....	17	1	7	4	2	2	1		
Sulphite.....	8		5		1	1			1
Washing compounds.....	3		1			1			1
ORGANIC.									
Sodium:									
Acetate.....	12		9	2	1				
Benzoate.....	4		3		1				
Citrate.....	6		5		1				

¹ The totals for items reported 1914, \$32,621,335, and 1909, \$25,048,019, are not comparable with total for 1919. The total for 1909 (\$25,048,019) includes \$33,707 of unclassified sodium products not shown in detail.

² Includes neutral chromate.

³ Figures not available.

⁴ Includes caustic liquor and soda lye.

⁵ Includes, 1919, sodium metal, sodium chlorate, hypophosphite, manganate, nitrate, silicofluoride, burnt, chrome and sodium alums, aluminate, aluminum fluoride (refined cryolite), arsenate, arsenite, bisulphite, gold chloride, hypochlorite, perborate, peroxide, titanium sulphate, uranate, uranium nitrate, etc.

⁶ Includes, 1919, sodium butyrate, formate, oxalate, propionate, sulphocarbonate, cyanide and ferrocyanide, formaldehyde-hydrosulphite, potassium tartrate, thiocyanate, uranium acetate, etc.

The manufacture of sodium compounds for the year 1919, exclusive of common salt, rock salt, and brines and of sodium salts produced in other special industries such as coal-tar chemicals and dyestuffs, amounted to more than three times the value of the previous census, and reached the grand total of nearly 3,000,000 tons and \$100,000,000, of which products to the value of \$9,042,986 have also been included within other classifications in this report. Sodium cyanides, alums, bleaching compounds, and electrolytic products appear here and elsewhere in these tables.

The increase in the use of sodium compounds is probably in part due to the substitution of sodium for potassium in bichromates, cyanides, nitrates, prussiates, hydroxide, and other salts, which, previous to the shortage caused by the war, were considered inferior for certain industrial applications, notably in the making of nitrate explosives, the oxidation of aniline black and the production of Prussian blue. After being subjected to more careful methods of purification in order to remove deliquescent salts and other impurities, sodium compounds have been found in many instances to be fully equal or better than potassium, the forced recognition of which fact will be of lasting benefit to industry.

Demand for the principal soda products—soda ash, bicarbonate, caustic, and bleaching powder—slumped in the early part of 1919, factories running at from 25 to 30 per cent capacity until June, but from then on until October and November, though manufacturing costs continued high, demand and activities increased until they reached pre-war conditions. Extensive exports of finished goods dependent upon alkalis for their preparation, glass, soap, petroleum products, textiles, and various sodium chemicals, at least in part caused this increased output.

Sodium compounds are very largely used in the textile, leather, and paper industries, as the following statement will show:

SODIUM SALT.	Employed in—
Acetate.....	Mordant manufacture.
Alum.....	Mordanting of paper and textiles, loading, sizing.
Aluminate.....	Mordanting.
Arsenate.....	Dyeing.
Bichromate and chromate.....	Chrome tanning, textile mordant, printing, bleaching.
Bisulphate.....	Dyeing (substitute for sulphuric acid).
Bisulphite.....	Dyeing, paper bleaching, source of SO ₂ .
Borate.....	Tanning, sizing, mordanting, fireproofing.
Carbonates.....	Dyeing, printing, cleansing, bleaching, dogumming.
Chlorate.....	Dyeing, printing, oxidizing agent.
Formaldehyde—hydrosulphite.....	Reducing agent in vat dyeing, bleaching, discharging, printing.
Hydroxide (caustic).....	Tanning, mercerizing, manufacturing of dyes, wood pulp, and paper.
Hypochlorite.....	Bleaching, other oxidizing processes.
Nitrite.....	Diazotizing in the manufacture of azo dyes, nitroso compounds, and in dyeing textiles.
Oxalate.....	Textile processes.
Perborate.....	Bleaching, oxidizing.
Peroxide.....	Bleaching, oxidizing.
Phosphate.....	Textiles, especially silk weighting and dyeing.
Prussiate.....	Manufacturing of Prussian blue for calico dyeing, printing.
Silicate.....	Fireproofing, dyeing, bleaching adhesive in fiber and paper board, sizing, weighting.
Sulphates.....	Dyeing (fixing and equalizing agent), manufacture of ultramarine and sodium sulphide.
Sulphide.....	Dyeing sulphur colors, tanning, artificial silk manufacture, sulphide colors, depilatory agent.
Thiosulphate.....	Chrome tanning, antichlor in bleaching, paper manufacture, mordanting, manufacture of coal-tar green.
Titanium sulphate.....	Mordanting.
Washing compounds.....	Cleansing.

In the paper industry, for instance, for the production of sulphite, soda and sulphate pulps, large amounts of soda ash, salt cake, and niter cake are employed; alum serves as a sizing or fixing agent for dyes, the silicate acts as an adhesive in laminated papers like wall boards. For boiling rags, caustic or carbonate is employed, and, for bleaching of rags or pulp, the hypochlorite is used.

Of those compounds which have been included in "Other sodium compounds," the outstanding items arranged in the order of their value are cyanide, metal, prussiate, chlorate, aluminum fluoride, formaldehyde-hydrosulphite, peroxide, alums, potassium tartrate, and hypophosphite.

The two important sodium compounds, soda ash and caustic, are preeminently in the lead both in quantity and value of production and together constitute 61 per cent of the quantity and 52 per cent of the value of the entire group.

It can readily be seen that the total of 49,338 tons of bicarbonate of soda reported as made and con-

sumed in further manufacture is but a fraction of that required for the manufacture of the soda ash, crystalline carbonate and sesquicarbonate reported. Making the necessary calculations from the formulas of these salts (soda ash, Na₂CO₃; sesquicarbonate, Na₄H₂(CO₃)₃ · 3 aq., and Na₂CO₃ · 10aq., with factors of 1.60, 1.03, and 0.59, respectively) and adding the weight of bicarbonate reported sold as such, the total amount of bicarbonate made amounted to 2,691 thousand-ton units.

Salt cake and niter cake, at one time considered as by-products and more or less a drug upon the market, advanced in both price and value, niter cake showing phenomenal gains, to more than double the quantity and nearly three times the price. This would indicate that many new uses have been found for niter cake as a substitute for sulphuric acid and other acids and acid salts in the explosives, soap, fertilizer, paper, dyeing, tanning, and other industries.

The manufacture of bichromate and sulphide, both used largely in the textile and leather industries, has increased very considerably so that these salts rank among the more important sodium compounds judging by the amounts and value of their output.

More than 50 separate compounds of sodium were reported in the 1919 census, some of which were derived by simple processes and others by involved methods, especially from the engineering standpoint. Briefly, they were derived in the following ways:

SODIUM SALT.	Process or method of manufacture.
<i>From original sources.</i>	
Biborate.....	Natural borate, or calcium ore, roasted then boiled with sodium carbonate.
Carbonate.....	From "Trona" by fractional crystallization.
Chloride.....	Natural brines and salt mines.
Fluoride.....	Cryolite, roasted, then boiled with carbonate.
Nitrate.....	Mined in Chili, refined.
Sulphate.....	From natural brines by fractional crystallization.
<i>Single and simple operation.</i>	
Alums.....	Sodium and aluminum sulfates crystallized from solution to form double salt.
Sodium gold chloride.....	Two salts crystallized together from solution, as with alums.
Carbonate, soda ash.....	Calcined bicarbonate (loss of water).
Carbonate, crystals.....	Crystallized from water solution.
Carbonate, sesqui.....	Bicarbonate heated in solution (loss of CO ₂ , addition of water).
Thiocyanate.....	Sodium cyanide solution boiled with sulphur.
<i>Neutralization in solution.</i>	
Acetate.....	Carbonate and acetic acid.
Aluminate.....	Carbonate and aluminum hydroxide.
Arsenite.....	Carbonate and arsenious oxide.
Benzoate.....	Carbonate and benzoic acid.
Bicarbonate.....	Carbonate and carbon dioxide.
Bisulphite.....	Carbonate and sulphur dioxide (caustic also used).
Butyrate.....	Hydroxide and butyric acid.
Chromate.....	Carbonate and bichromate.
Fluoride.....	Carbonate and hydrofluoric acid.
Glycerophosphate.....	Carbonate and glycerophosphoric acid.
Hypophosphite.....	Carbonate and hypophosphorous acid.
Oxalate.....	Carbonate and oxalic acid.
Propionate.....	Carbonate and propionic acid.
Silicofluoride.....	Carbonate and silicofluoric acid (fluosilicic).
Sulphite.....	Carbonate and sulphur dioxide.
Sulphocarbolate.....	Carbonate and sulphocarbolic acid.
Tartrate.....	Carbonate and acid tartrate.
<i>Substitution of sulphuric acid for another acid.</i>	
Bisulphate.....	Sulphuric acid acting on a nitrate (niter cake).
Sulphate.....	Sulphuric acid acting on a chloride (salt cake).

SODIUM SALT.	Process or method of manufacture.
	<i>Interchange in solution, solid precipitate formed and removed.</i>
Acetate.....	Calcium acetate and sodium sulphate.
Bromide.....	Iron bromide and sodium carbonate.
Citrate.....	Calcium citrate and sodium sulphate.
Ferrocyanide.....	Calcium ferrocyanide and sodium carbonate.
Hydroxide.....	Calcium or barium hydroxide and sodium sulphate.
Iodide.....	Iron iodide and sodium carbonate.
Phosphate.....	Dicalcium phosphate and sodium carbonate.
Thiosulphate.....	Calcium thiosulphate and sodium sulphate.
	<i>Oxidation.</i>
Arsenate.....	Sodium arsenite oxidized with NaNO_3 by calcination or fusion.
Ferrocyanide.....	Ferrocyanide oxidized with chlorine in solution.
Manganate.....	MnO_2 fused with NaOH or Na_2CO_3 and NaNO_3 .
Perborate.....	Borax heated slightly in solution with Na_2O_2 or H_2O_2 .
Peroxide.....	Metallic sodium heated to 300° in aluminum trays in current of dry air, free of CO_2 .
Thiosulphate.....	Sulphide liquor from Leblanc soda process oxidized by air, Na_2SO_4 added to calcium salt.
	<i>Combination and interchange usually by aid of heat.</i>
Bicarbonate.....	Salt, ammonia and carbon dioxide (Solvay process) combined under pressure and heat.
Bichromate.....	Fusion of chrome ore with lime and soda, and solution of product separated by sulphuric acid.
Cyanide.....	Sodamid (NaNH_2) heated with carbon and sodium cyanamid.
Ferrocyanide.....	Purified spent oxide from gas works heated with lime, calcium ferrocyanide salted out, and calcium separated by sodium carbonate.
Formate.....	Caustic and carbon dioxide heated under pressure.
Hydrosulphite.....	Sodium bisulphite with zinc metal, lime added, and product salted out from solution.
Nitrite.....	Sodium nitrate fused in iron pans and lead added at $450-500^\circ$.
Silicate.....	Silica, sodium carbonate and coal heated in crucible, extracted by water in autoclaves.
Sulphide.....	Sodium bisulphate, salt and coal heated above 950° .
	<i>Electrolytic.</i>
Sodium metal.....	Salt, in molten condition, electrolyzed.
Chlorate.....	Hot, concentrated, alkaline solution of salt electrolyzed.
Cyanide.....	From cyanamid derived from sodamid produced from metallic sodium and ammonia; made electrolytically.
Hydroxide.....	Solution of salt electrolyzed.
Hypochlorite.....	Cold dilute solution of salt electrolyzed.
Peroxide.....	Oxidation of metallic sodium made electrolytically.
Nitrate.....	Synthesis of components, electrolytically.

Many of these processes are dependent on the production of the necessary acid and of sodium carbonate, hydroxide, nitrate and sulphate or calcium salts such as the acetate, citrate, ferrocyanide, hydroxide and phosphate that are derived as by-products in other industries (wood distillation, citrus products, gas industry, lime or fertilizer industries). Other salts resulting from the use of by-products are the tartrate, from the wine industry, bisulphate and sulphate from the acid industry, arsenite and arsenate from the smelting and refining industry, and thiosulphate from the Leblanc soda process. Some are directly dependent upon natural sources other than soda salts, such being the borate, chromates, manganate, and silicate from calcium, borate, chrome ore, manganese, and sand.

Of the natural sources of sodium compounds the chloride, nitrate and borate are the most important.

Carbonates of sodium.—The four forms of carbonate of soda reached an aggregate total of \$37,848,836. Bicarbonate of sodium, being the basis for all the other carbonates, was produced in much greater

amounts than is indicated by the tabulation, the production being estimated at 2,691 thousand tons, and at the average price of \$26 a ton would have approximated a value of \$70,000,000. The amount reported was 190,894 tons and the value of portion sold was \$3,695,417 produced by 10 establishments in 8 states of which 4 states—Michigan, New York, Virginia, and California—produced 99.2 per cent of the total amount. Of this a very small part resulted from refining or recovery processes and less than 5 per cent from natural brines in California. Over 95 per cent was made by the Solvay ammonia-brine process.

Similarly, about 98.5 per cent of the total amount of soda ash reported (1,507,424 tons), was produced by the Solvay process. Eighteen establishments in 12 states were concerned in the manufacture of soda ash, of which 5 states—Michigan, Ohio, New York, Virginia and Kansas—produced 90 per cent. The cost per ton varied from \$24 to \$40 with an average of \$30.20. Grades of strength and purity were not reported.

Carbonates from natural brines in California are made by burning coke and limestone in kilns to produce CO_2 gas which is charged into the brine waters. Crystals of bicarbonate that form are separated by filters and calcined in oil burning furnaces which produce dense soda ash. By-products reported included lime which is usually employed further for the production of caustic liquor.

The production of crystalline carbonates of soda, known as sal soda, washing compounds and sesquicarbonate, increased but slightly. The alkali strengths of sal soda and soda ash bear the ratio of 21.7 to 48 (or 58) per cent Na_2O , so that instead of \$27 to \$30, per ton the actual cost of the crystals to the consumer was \$60 to \$74 a ton. The ash averaged \$30. Since soda ash is sufficiently pure to be used for almost every purpose it is not surprising that the production of crystal compounds has failed to keep step with that of the calcined ash. This comparison does not include washing compounds which are of more or less unknown composition and command much higher prices.

Crystal compounds were derived from the same sources and were made by many of the same establishments as other carbonates. Thirteen establishments reported soda ash as the source of crystal soda.

Sodium hydroxide.—Twenty-nine concerns in 13 states reported the production of 333,361 tons of caustic soda. Of these, 15 establishments in Michigan, New York, and Ohio, unitedly produced nearly 89 per cent. Seven companies merely repacked and sold about 6 per cent of the total. Production by the electrolytic method from common salt was reported by 15 establishments with 28 per cent of the total.

Sodium silicate.—Seventeen establishments in nine states produced 286,791 tons of silicate of soda, none being used for further processes in the same works. Indiana, Ohio, New Jersey, Illinois, and Pennsylvania in the order named produced nearly 84 per cent of the total, two states in the far west (California, Washington), produced less than 6 per cent, four in the middle west 61 per cent and three on the east coast 33 per cent.

Sodium sulphate.—Sulphate of sodium in its several forms reached a value of \$4,838,198. Previous to 1914 niter cake was used to a limited extent only for its acid value, and the sulphate content was wasted. It now has important applications in the sulphate pulp industry and in gas recovery. Two-thirds was produced in seven Eastern states, and nearly one-third in seven Middle states, a very small fraction in the West. More than half of the niter cake was made in the production of nitric acid for the explosives industry.

Theoretically the 86,992 tons of nitric acid reported under Group I, and the additional nitric acid used for making mixed acid (about 57 per cent of 114,886 tons), required the production of 240,000 tons of niter cake, of which 67,556 tons were made and consumed, leaving about 172,000 tons as the probable production of niter cake, much of which was waste product.

Salt cake was produced in 15 states and 34 establishments, the total weight being 179,000 tons, of which 8 states—New Jersey, Illinois, Indiana, Ohio, Delaware, Pennsylvania, Massachusetts, and New York—made 89.5 per cent. An unusually large proportion of the total salt cake manufactured, 31.3 per cent, was used by manufacturers themselves in further processes of manufacture, of sodium sulphide, Glauber's salt and anhydrous sulphate.

Glauber's salt, or crystallized sodium sulphate, totaled 42,206 tons, made in 15 states by 27 establishments, 13 plants in 5 states—New Jersey, Massachusetts, Pennsylvania, Indiana, and Delaware—producing 74 per cent. Six companies produced 2,776 tons of anhydrous sodium sulphate, refined. A total of 29,818 tons of thiosulphate or "hyposulphite" was reported by 9 establishments in 7 states, 4 of which—New Jersey, Delaware, Indiana, and Pennsylvania—produced 29,799 tons, or nearly the entire amount.

Sulphides and sulphites.—Sodium sulphide was produced by 17 establishments in 11 states, and totaled 39,735 tons of all grades, or 57,000 tons when calculated to a basis of 30 per cent, or sodium sulphide crystals. About 99.4 per cent of the total was made in 8 states and nearly 80 per cent in New Jersey, Indiana, Delaware, and Massachusetts. With the exception of a small amount merely subjected to refining methods, the great bulk, or about 88.3 per cent, was made from salt cake by reduction, and 11.7 per cent by conversion from barium sulphide.

Sodium sulphite is made by saturating a solution of soda ash with sulphur dioxide to form the bisulphite, then adding more soda to form the normal salt. It also results as a by-product in the manufacture of phenol, cresol, etc. A total of 8,666 tons was made by eight firms in six states, and of this amount, 8,278 tons, or nearly 96 per cent, were made in two states—New Jersey and Maryland.

Several grades of sodium sulphite are included in the total, crystals, ground, anhydrous, dry powdered, and pure. Crystal sulphite equaled 83 per cent of the total weight.

Borax, otherwise called biborate or tetraborate of soda, amounting to 29,635 tons, was produced in eight establishments in six states, of which 27,744 tons, or 93 per cent, originated in California. Of the total amount produced 25,807 tons, or 87 per cent, was obtained from the mineral colemanite, a crude borate of calcium. The colemanite is calcined, which causes the borate portion to lose water of crystallization and form a powder easily separated from contaminating minerals by mechanical means. When boiled with sodium carbonate solution, this powder forms borax and calcium carbonate, which is removed by filtration, and the solution is concentrated to crystallization.

Borax is used in large amounts for enameling, glazing, for making borosilicate glass which has many applications, in laundry and kitchen, in tanning, dyeing and paper industries, as a flux, larvicide, antiseptic, etc.

Sodium bichromate and chromate were produced in five establishments in four states, a total of 24,081 tons, by the usual method using chrome ore, lime, soda ash, and an acid for the final neutralization of excess alkali.

Ten companies reported a total of 23,867 tons of phosphate of sodium, of which 4,321 tons were monosodium phosphate, reported by four establishments; 9,663 tons disodium salt reported by nine, and 9,883 tons trisodium salt reported by five. Several grades of purity were reported—commercial, technical dry, U. S. P. granular, and U. S. P. anhydrous. The monosodium salt shows the highest unit value. Five firms in New Jersey produced 19,006 tons, or about 80 per cent of the total.

Other sodium compounds are considered in connection with other groups—cyanides in Group II; alums in Group V; perborate, hypochlorite, bisulphite, and hydrosulphite in Group VI; and arsenate and arsenite in Group X.

Sodium compounds produced by aid of electricity.—Sodium hydroxide, cyanide, metal, chlorate, peroxide, hypochlorite, and nitrite, valued at \$13,919,315 were produced by electrolytic processes. All originate from common salt, which when electrolyzed in molten condition yields metallic sodium from which is derived the cyanide and peroxide; when electrolyzed in warm aqueous solution produces the hydroxide, in cold dilute solution the hypochlorite, and in concen-

trated alkaline solution the chlorate. The nitrite is formed by synthetic processes. The amounts used by the coal-tar industry do not appear here.

Other figures are for the production of bromide, fluoride, and iodide of sodium. With "Other compounds" are included sodium hypophosphite, manganate, and silicofluoride. Of these, sodium bromide was derived from original sources, three establishments in Michigan and West Virginia mining and purifying the crude salt, and two others refining and producing the chemically pure product.

Organic sodium compounds.—The present census, in addition to sodium benzoate, has segregated the acetate and citrate and with "Other organic compounds" has included the butyrate, formate, oxalate, propionate, and sulphocarbolate, the total value of which reached \$6,083,258. A comparison with the total for inorganic sodium salts would seem to show great disproportion, but in fact the chemical industry, as such, includes a very small proportion of sodium compounds of organic nature, produced in bulk, these appearing under drugs and medicinals, coal-tar chemicals, and other industries.

Five states and 11 concerns produced an aggregate of 2,260,459 pounds of acetate of soda (New Jersey, Missouri, New York, Pennsylvania, and Michigan), of which New Jersey turned out about 90 per cent.

Benzoate of soda, 120,447 pounds, was made by five establishments in three states—New York, Missouri, and Pennsylvania. This was but a small part of the total benzoate as the bulk is included under the coal-tar industry.

Three states and six establishments were concerned in the production of 118,417 pounds of sodium citrate.

Many alkali salts of organic character are formed by simple neutralization of an acid by an alkali, or by interchange of acid components between a calcium salt of the organic acid and an alkali sulphate (acetate, benzoate, butyrate, citrate, oxalate, propionate, sulphocarbolate, tartrate) so that the manufacture becomes a question closely dependent upon the derivation of the corresponding acid. Calcium acetate, a by-product of wood distillation, calcium citrate from the citrus fruit, and acid tartrate from fermentation industries, supply the original material for three organic salts. Other organic acids are made only by synthetic methods (benzoic, formic, oxalic, sulphocarbolic) or by carefully controlled bacterial action (acetic, butyric, propionic).

GROUP IV.—POTASH, POTASSIUM, AND COMPOUNDS.

Potash is a term indiscriminately used in the trade, so the special schedule designed to collect data on the production of "Potash from original sources" included the carbonate, chloride, sulphate, hydroxide, and even alum and borate, from lake brines, potash-bearing rocks, cement and blast-furnace dust and ashes of beet pulp, kelp, distillery wash and wood.

All of these products were marketed as "Potash" and were used primarily as components of fertilizers, frequently irrespective of the kind of salt.

In tabulating the information the salts have been recorded as crude carbonate, chloride, and sulphate. Table 27 presents the statistics of production for potash and potassium compounds.

TABLE 27.—GROUP IV.—POTASH, POTASSIUM, AND COMPOUNDS.

	1919	1914	1909
Value of products.....	\$18,407,253	\$7,905,744	(1)
Potash from original sources: 2			
Number of establishments.....	75		
Tons.....	109,737	(1)	(1)
Value.....	\$7,215,164	(1)	(1)
Carbonate, crude—			
Number of establishments.....	44		
Pounds.....	48,664,478		
Value.....	\$2,300,027	\$49,651	\$88,990
Chloride, crude—			
Number of establishments.....	24		
Pounds.....	144,435,589	(1)	(1)
Value.....	\$4,169,333		
Sulphate, crude—			
Number of establishments.....	7		
Pounds.....	26,374,661	(1)	(1)
Value.....	\$745,804		
Acetate:—			
Number of establishments.....	6		
Pounds.....	69,095	(1)	(1)
Value.....	\$47,473		
Bitartrate, (cream of tartar):—			
Number of establishments.....	6	8	5
Pounds.....	4,854,550	12,646,120	15,592,937
Value.....	\$2,620,351	\$3,124,958	\$2,925,883
Bromate, bromide, chlorate, chloride (refined), and iodate:—			
Number of establishments.....	9		
Pounds.....	4,324,268	(1)	(1)
Value.....	\$1,258,507		
Carbonate and bicarbonate, refined:—			
Number of establishments.....	7		
Pounds.....	401,140	(1)	(1)
Value.....	\$154,844		
Citrate:—			
Number of establishments.....	6		
Pounds.....	64,088	(1)	(1)
Value.....	\$100,754		
Hydroxide (caustic):—			
Number of establishments.....	13		
Pounds.....	8,358,834	(1)	(1)
Value.....	\$2,206,008		
Iodide:—			
Number of establishments.....	7		
Pounds.....	388,678	(1)	(1)
Value.....	\$1,298,980		
Sulphate, refined; persulphate; sulphide; bisulphite and metabisulphite:—			
Number of establishments.....	12		
Pounds.....	877,178	(1)	(1)
Value.....	\$100,751		
Unit value, pound.....	\$0.54	\$0.25	\$0.19
Other potassium compounds, 1919:—			
Inorganic—Bichromate and chromate, refined nitrate, permanganate, phosphate, etc.....	\$2,548,114	\$4,731,135	(1)
Organic—Binoxalate and oxalate, and Rochelle salts.....	\$856,307		

1 Figures not available.

2 Potash from original sources as reported to the Geological Survey, 1919:

SOURCE.	Number of producers.	Crude potash, quantity, net tons.	Available content of potash (K ₂ O).		
			Per cent of K ₂ O.	Quantity, net tons.	Per cent distribution.
Total.....	102	116,634	27.8	32,474	100.0
Mineral:					
Natural brines.....	17	473,571	29.3	21,590	66.5
Alumite.....	7	6,599	34.8	2,294	7.1
Dust from cement mills.....	14	11,065	10.8	1,258	3.8
Dust from blast furnaces, and silicate rocks.....	8	2,408	9.2	221	0.7
Organic:					
Beet-sugar refinery waste.....	11	12,423	29.0	3,601	11.1
Molasses distillery waste.....	6	8,791	32.9	2,892	8.9
Wood ashes.....	35	807	60.0	484	1.5
Kelp and miscellaneous industrial waste.....	4	370	36.2	134	0.4

a A considerable portion lost through accident at plant.

The reports gave the K_2O content of the brines as varying from 0.2 per cent to 2.4 per cent; wood ashes from 1.7 per cent to 5 per cent; kelp as having a K_2O content of 1.75 per cent; sugar-beet pulp, 0.32 per cent; blast-furnace flue dust, 7.5 to 9 per cent; cement dust 2.7 to 4.4 per cent; alunite, 4.5 per cent.

A summary of methods of manufacture is given:

1. The acetate, bicarbonate, binoxalate, bisulphate, bisulphite, metabisulphite, bromide, chromate, citrate, iodide, oxalate, and phosphate are made by neutralization or combination of the desired acid, its acid salt or oxide, with potassium *carbonate* or *hydroxide*,

2. The bichromate, bromate, ferrocyanide, a portion of the hydroxide, and the nitrate are formed by interchange of a compound of another base than potassium having the desired negative groups, with crude potassium *chloride*, *carbonate*, or *sulphate* usually a precipitate being formed and removed.

3. The carbonate, chloride, and sulphate not included in crude salts result by refining of the crudes.

4. The chlorate, a portion of the hydroxide, and possibly of the permanganate and persulphate, are made from the *chloride*, *sulphate*, or *hydroxide*, by electrolytic methods.

5. The ferricyanide and permanganate are made by neutralization of the corresponding acid with crude *carbonate* and subsequent oxidation with chlorine or ozone.

6. The cyanide and sulphide result from reduction of the *carbonate* (and ammonia) or of the sulphate by means of carbon at a high heat.

7. Finally, the double tartrates with sodium (Rochelle salt) and antimony (tartar emetic) result from potassium *bitartrate* by treatment with an excess of the respective cobase.

It may be noted that in the formation of all these potassium compounds there is the constant recurrence of the use of one or another of the crude potashes, either as *bitartrate*, carbonate, chloride, or sulphate.

Aside from crude potash salts for fertilizer purposes and for further manufacture, the most important products manufactured were the halogens as a group, especially the iodide, and the hydroxide. The refinement of crude carbonate as such did not reach a high figure, although seven establishments made reports. Neither did the eight establishments reporting various forms of sulphur derivatives such as alum, the refined sulphate, persulphate, sulphide, and bisulphide produce these in large amounts, the sulphites and alum covering nearly the whole. Potassium nitrate is being separated from Chile saltpeter—a natural source of nitrates, consisting mainly of sodium nitrate with a small percentage of the potassium salt—by more than one concern. Usually this salt and the bichromate are made by interchange of bases between potassium chloride and

the corresponding sodium salts in water solution in which the resulting sodium chloride is more soluble, so that the potassium compound may be recovered by fractional crystallization.

Potassium hydroxide or caustic potash was produced by 13 establishments, the greater part by electrolytic decomposition of the chloride.

The *bromide*, *iodide* and *refined chloride* of potassium in order of value as named, were produced in 11 establishments, a total of 1,736,422 pounds valued at \$1,909,224. The oxidized forms as *chlorate*, *bromate* and *iodate* were reported by 5 plants producing 2,976,524 pounds valued at \$648,263. Electrolytic methods were employed for the latter salts, while the former group of bromide, iodide and chloride, even though refined, should rightly be considered as salts derived from original sources, bromide and chloride both originating in the salt mines of Michigan and West Virginia and the iodide produced from caustic potash and iodine which is obtained from the ash of seaweed or mother liquors of Chile saltpeter refining.

Organic salts of potassium included the *bitartrate*, *Rochelle salts*, *tartar emetic*, *citrate*, *oxalate*, etc., in the order named, the total production being valued at \$3,624,885. The bitartrate was made by six companies in three states—New York, California, and Ohio—from pomace or argols. The double tartrate was derived from the same sources. Six establishments in Missouri, New York and Pennsylvania produced refined qualities of potassium acetate, at prices ranging from 45 cents to \$1.05 and averaging 68 cents. There was no indication of quality, except prices.

Potassium citrate was produced only in refined grades, U. S. P., and chemically pure, six establishments reporting 64,088 pounds, value \$100,754.

Potassium compounds as a whole have been restricted in growth on account of the difficulty in obtaining basic salts.

GROUP V.—ALUMS, ALUMINUM, AND COMPOUNDS.

Table 28 presents the statistics for the aluminum group. The usual separation of aluminum compounds into alums as distinct from aluminum and its other salts has been made as heretofore, except that aluminum sulphate is classed as a simple aluminum salt and not as alum. For convenience of comparison, and owing to the similarity of their applications, burnt and chrome alum are included in the subgroup "Alums," although they contain no aluminum.

Practically all aluminum salts find applications as mordants, paper sizes, and dye-lake bases. Chrome alum, however, is especially adapted to chrome tanning, and aluminum sulphate to white tanning of leather; aluminium acetate to water proofing and as an embalming fluid; aluminum chloride for use in petroleum refining and as a catalytic agent in organic syntheses; and ammonium alum for medicinal pur-

poses. For water purification, aluminum sulphate and soda alum are mainly used.

TABLE 28.—GROUP V.—ALUMS, ALUMINUM, AND COMPOUNDS.

	1919	1914	1909
Value of products.....	\$13,433,482	(¹)	(¹)
Alums.....	\$17,055,891	\$3,467,969	\$3,022,355
Ammonium alum—			
Number of establishments.....	8		
Total production, tons.....	3,949		
For sale—			
Tons.....	3,797	(¹)	(¹)
Value.....	\$304,018		
Made and consumed, tons.....	152		
Potash alum—			
Number of establishments.....	4	5	
Tons.....	393	6,382	5,127
Value.....	\$65,745	\$219,968	\$155,319
Unit value, ton.....	\$167	\$34	\$30
Sulphate (concentrated alum)—			
Number of establishments.....	19	11	
Total production, tons.....	312,872		
For sale—			
Tons.....	312,759	92,500	77,737
Value.....	\$15,665,526	\$1,728,566	\$1,312,751
Unit value, ton.....	\$50	\$19	\$17
Made and consumed, tons.....	113		
Other alums—			
Number of establishments.....	12		
Total production, tons.....	15,337		
For sale—			
Tons.....	15,322	57,973	55,283
Value.....	\$1,020,602	\$1,419,435	\$1,554,285
Unit value, ton.....	\$67	\$26	\$28
Made and consumed, tons.....	15		
Aluminous abrasives:			
Number of establishments.....	3		
Tons.....	11,306	(¹)	(¹)
Value.....	\$2,032,588		
Aluminum chloride:			
Number of establishments.....	7		
Total production, tons.....	4,411	(¹)	(¹)
For sale—			
Tons.....	4,265		
Value.....	\$362,445		
Made and consumed, tons.....	146		
Aluminum hydroxide and oxide, refined:			
Number of establishments.....	5		
Total production, tons.....	6,375		
For sale—			
Tons.....	3,847	(¹)	(¹)
Value.....	\$514,649		
Made and consumed, tons.....	2,528		
All other—Aluminum and alloys, aluminum nitrate, calcined bauxite, refined cryolite, etc., value.....	\$23,467,909	(¹)	(¹)

¹ Figures not available.
² 1919—Burnt, chrome and soda alums; 1914—Burnt and soda alums, porous, excelsior and pearl, ammonium, alum cake, etc.

Simple salts of aluminum, such as the sulphate, chloride, hydrate, and sodium aluminate, being stronger in the essential ingredient per unit of weight and also cheaper, have almost replaced alums.

In no other group are so many products derived primarily from one raw material. With few exceptions, all originate in the mineral bauxite, a natural hydrate or hydrous oxide containing from 30 to 60 per cent Al_2O_3 . Arkansas leads in its production. From it directly or indirectly, are derived the metal, the acetate, chloride, fluoride, hydroxide, oxide and sulphate, calcium and sodium aluminates, and ammonium, burnt and soda alums, or 93 per cent of all aluminum products.

Among other sources of aluminum compounds we find alunite, a hydrous sulphate of aluminum and potassium, mined principally in Utah, which has been developed since 1914 mainly as a source of potassium sulphate, aluminum compounds appearing as a by-product. Potash alum is derived only in part from alunite.

Clay, a hydrous silicate of aluminum, is the source of aluminous abrasives and alum cake (for which no figures were reported in 1919). Especially pure clay, or kaolin, is sometimes used instead of bauxite.

The following scheme, giving in brief detail the methods of manufacture, illustrates the relative dependency of aluminum compounds upon bauxite, alunite, or clay as a material:

MATERIAL.	Product.
Bauxite:	
Calcined, leached, and solution treated with CO_2 or air.....	Hydrate.
Hydrate, calcined.....	Oxide.
Oxide electrolyzed.....	Metal.
Oxide or clay electrolyzed.....	Abrasives.
Hydrate with acetic, hydrochloric, hydrofluoric, nitric, or sulphuric acids.....	Salts—Acetate, chloride, fluoride, nitrate, sulphate.
Sulphate and alkali sulphate.....	Burnt alum.
Alum calcined.....	Sodium or calcium aluminates.
Hydrate or ore calcined with soda ash or lime.....	
Alunite:	
Roasted, leached, crystallized.....	Potash alum.
Clay:	
Electrolyzed.....	Abrasives.
Cryolite:	
Roasted, etc.....	Refined cryolite.
Ferrous and ammonium sulphate solutions mixed and double salt crystallized.....	Iron alum.
Alkali bichromate in dilute sulphuric acid reduced with sulphurous acid.....	Chrome alum.

Aluminum hydroxide, or refined bauxite, and the oxide derived by calcination, were made in large quantities and consumed in the further manufacture of the metal and its salts, but the figures are not available. Amounts reported as sold form but a small part of the total production.

Aluminum sulphate consists of from 50 per cent to nearly 100 per cent aluminum sulphate, according to its state of hydration. Alums contain from 34 to 38 per cent or less of aluminum sulphate. All establishments with one exception gave bauxite and sulphuric acid as raw materials. Calculated as crystallized salt containing 50 per cent aluminum sulphate, the 312,872 tons reported in 1919 required about 160,000 tons of 30 per cent bauxite ore. For the 6,375 tons of alumina and hydroxide reported, an additional 21,250 tons were required. The total bauxite required for the three items of aluminum metal, its oxide or hydroxide, and sulphate, irrespective of other compounds, would be 560,000 tons of 30 per cent ore.

The manufacture of *aluminum chloride* differs from the usual union of an hydroxide or oxide with an acid in solution in water, in that chlorine or hydrochloric acid is allowed to react upon the metal itself, the carbide, or a mixture of the oxide and carbon, all heated to high temperature. Of the other compounds of aluminum, refined cryolite and bauxite are of most importance, only small amounts of acetate, nitrate, and sodium aluminate being produced.

The figures for alums in 1914 included several salts of aluminum which in the present census are to be found in the subgroup "Aluminum and its compounds, other than alum." To this extent comparisons of the two groups are not correct.

GROUP VI.—BLEACHING COMPOUNDS.

Bleaching compounds are of three principal kinds, and may be classified as chlorine, peroxide, and sulphur bleaches. Chlorine and peroxide bleaches are similar in that they are oxidizing agents and decompose the impurities by the addition of oxygen or removal of hydrogen to form water, while sulphur bleaches abstract oxygen or act as reducing agents. The latter effect is not so stable, the tendency being for the bleached material to take up oxygen from the air and, in part at least, regain its former state.

All bleaches act in presence of water. Chlorine and hypochlorites (by virtue of the chlorine set free by acids) attack the water, freeing oxygen, the active agent, in the nascent or extremely reactive state. Peroxides in themselves are very unstable, readily giving up oxygen, also in the nascent condition. Sulphur dioxide, either as such or liberated from bisulphites and sulphites by acids, is the active agent in all sulphur bleaches. It removes oxygen from the more unstable impurities forming sulphuric acid with the water present.

TABLE 29.—GROUP VI.—BLEACHING COMPOUNDS.

	1919	1914	1909
Value of products.....	\$12,392,806	\$5,302,359	\$3,215,728
Chlorine bleaches:			
Chlorine—			
Number of establishments ¹	14	7	
Total production, pounds.....	91,141,000		
For sale—			
Pounds.....	34,392,000	12,217,000	(?)
Value.....	\$1,425,917	\$472,836	
Unit value, 100 pounds.....	\$4.15	\$3.87	
Made and consumed, pounds.....	56,749,000		
Hypochlorites (calcium and sodium)—			
Number of establishments ¹	16	14	9
Pounds.....	252,850,000	310,380,000	116,802,000
Value.....	\$4,781,350	\$2,916,225	\$1,786,846
Unit value, 100 pounds.....	\$1.89	\$0.94	\$1.53
Peroxide bleaches:			
Barium peroxide—			
Number of establishments ¹	3		
Pounds.....	3,134,000	(?)	(?)
Value.....	\$569,483		
Hydrogen peroxide—			
Number of establishments ¹	11	20	17
Pounds.....	31,515,000	32,595,000	9,926,000
Value.....	\$2,257,282	\$1,308,596	\$870,541
Other peroxide bleaches.....	\$612,045	(?)	(?)
Sulphur bleaches:			
Bisulphite of calcium, soda, potassium, etc.—			
Number of establishments ¹	14	14	15
Pounds.....	39,225,000	26,346,000	31,718,000
Value.....	\$961,284	\$243,559	\$226,154
Unit value, 100 pounds.....	\$2.49	\$0.92	\$0.71
Sulphur dioxide—			
Number of establishments ¹	3		
Pounds.....	856,000		
Value.....	\$99,896		
Other sulphur bleaches, value.....	\$1,073,464	\$366,143	\$332,187
Other bleaching compounds, not specified, value.....	\$612,085		

¹ States and number of establishments in order of production, 1919: Chlorine (14): New Hampshire, 1; New York, 5; Michigan, 3; Maine, 1; Pennsylvania, 1; West Virginia, 2; and Missouri, 1. Hypochlorites (16): New York, 5; Michigan, 2; California, 2; Virginia, 1; Rhode Island, 2; Pennsylvania, 2; Maryland, 1; and West Virginia, 1. Barium peroxide (3): Ohio, 1; New York, 1; and West Virginia, 1. Hydrogen peroxide (11): New York, 4; New Jersey, 2; Missouri, 2; Illinois, 1; Ohio, 1; and California, 1. Bisulphites (14): Massachusetts, 3; Delaware, 1; New Jersey, 2; New York, 2; Maryland, 1; Pennsylvania, 1; Missouri, 3; and California, 1. Sulphur dioxide (3): New Jersey, 1; Wisconsin, 1; and Virginia, 1. ² Figures not available.

While in amounts produced the order is chlorine, peroxide, and sulphur bleaches, in ratio of increase the order is reversed. Hypochlorites and hydrogen peroxide have decreased in tonnage, liquid chlorine

apparently having displaced both. The electrolytic production of sodium and potassium hydroxides, developed as a result of the necessities of war, required an outlet for excess chlorine, with consequent reduction in price below other bleaches. Liquid chlorine was practically the same price in 1919 as in 1914.

Chlorine bleaches were produced by electrolytic decomposition of common salt, the resultant gas being compressed and cooled to a liquid and marketed in steel cylinders, or conducted into caustic lime or soda to form "Chloride of lime" or soda; that is, hypochlorites of calcium and sodium.

Liquid chlorine within five years increased from 6,000 tons to more than 17,000 tons, marketed, and in addition in 1919, 28,000 tons were used in the producing plants for further manufacture of chlorine products such as chloracetic acid, sulphur chloridés, carbon tetrachloride, chloroform, hydrochloric acid, tin salts, and other metallic chlorides, exclusive of that used for the production of bleaching powder.

Fourteen establishments in seven states—New Hampshire, New York, Michigan, Maine, Pennsylvania, West Virginia, and Missouri—manufactured liquid chlorine. Since it is a by-product of that portion of the caustic soda and caustic potash industries employing electrolysis, and must have been produced in equi-molecular amounts, the actual production must have been 85,212 tons. That is, more than 85,000 tons of chlorine were made, and since 45,000 tons were reported and either used directly as a bleaching agent or for the manufacture of the various chlorine compounds enumerated above, there remains about 40,000 tons which must have been consumed in the manufacture of bleaching powders or lost.

Hypochlorites included but 2,400 tons of sodium salt. The total production of calcium and sodium hypochlorites amounted to 126,425 tons, made by 16 concerns in 8 states, New York and Michigan producing 82 per cent of the whole. At an average of 30 to 35 per cent chlorine, this weight of bleaching powder required from 38,000 to 45,000 tons of chlorine for its manufacture, which agrees fairly well with the above estimate based on the caustic produced.

Peroxide bleaches, second in importance, gained in favor for special applications and in spite of competition with the cheaper chlorine and its derivatives. Eleven plants in six states—New York, New Jersey, Missouri, Illinois, Ohio, and California—made hydrogen peroxide, 77.6 per cent of the total amount being attributable to six establishments in the first two states.

Barium peroxide, while not the most important of the peroxide bleaches when the amount sold is considered, is in fact the primary compound from which hydrogen peroxide is derived. Approximately 80,000 tons of barium peroxide were required to produce the hydrogen peroxide reported.

A considerable amount of sodium perborate was made and the value is included among other peroxide bleaches as the action is due to the liberation of hydrogen peroxide or nascent oxygen.

Among *sulphur bleaches* bisulphite of sodium (including a small amount of the calcium salt), was the most important product, for although sulphur dioxide is the active ingredient the sodium compound, being a dry powder, is a more convenient method of transporting it.

Five states—Delaware, Massachusetts, New Jersey, New York, and Maryland—produced 98.8 per cent of the total. As in the case of sulphites, bisulphite of soda was reported in a number of grades, as solution, liquid 38°, anhydrous, metabisulphite, dry, and dry powdered. Low-grade material totaled 11,377 tons and ranged in price from \$20 to \$40 per ton, while the higher grades ranged from \$67 per ton upward, according to purity and strength, and averaged \$72 per ton.

A notable amount of formaldehyde hydrosulphite bleaching compound was made and is included in the value of other sulphur bleaches. Prior to 1914 this was imported.

GROUP VII.—COAL-TAR CHEMICALS.

This branch of the industry includes establishments distilling tars for the production of crudes, those synthesizing intermediates from crudes and those building up from these intermediates a variety of finished products. Coal-tar intermediates may be fashioned into dyes or dye-lakes, photographic chemicals, medicinals, perfumes, flavors, synthetic tanning materials, synthetic phenolic resins, and other synthetics. The general statistics for this branch of the chemical industry are presented as a separate section of this report on chemicals and allied products entitled "Coal-tar products." Table 30 presents the statistics for products, by groups.¹

Coal or oil when dry distilled yields volatile combustible compounds and a solid residue. Part of the volatile portion is utilized in the gas industry, and the residual coke by the metallurgical industries, distillation being so regulated that in the one case the largest possible proportion of volatile matter results, while the other aims to produce the greatest amount of solid residue.

An average distribution of the three main distillation products from coal is shown to be 16 per cent gas, 19 per cent vapors including 2 per cent water, and 65 per cent coke. Gas and coke are used without material change. The vapors are condensed by cooling or recovered in solvents and are usually retreated for a partial separation of individual components. Aside from about 2 per cent ammoniacal water the liquefied

compounds are primarily tar and light oils. Either or both may be redistilled or sold as such. A large part of the oils and some tar are in fact fractionated in the establishment where produced, so that the by-products of the gas and coke industries are not the original crude tar and light oils but are the several fractions resulting from further distillations and separations, such as crude benzol, toluol, xylol, phenols, cresols, carbazol, pyridine, naphthalene, solvent naphtha, dead or creosote oil, anthracene oil, pitch, refined or prepared tar and sometimes tar-coke.

TABLE 30.—GROUP VII.—COAL-TAR CHEMICALS.

	1919	1914	1909
Total value.....	\$133,499,742	\$13,492,453	\$7,969,672
Crudes:			
Number of establishments.....	56	40	42
Value.....	\$21,148,814		
Intermediates:			
Number of establishments.....	100	88,065,156	\$4,057,591
Pounds.....	117,470,401		
Value.....	\$28,210,517		
Dyes and color lakes:			
Number of establishments.....	100	12,169,635	12,658,770
Pounds.....	65,909,250	\$4,652,947	\$3,683,553
Value.....	\$69,318,785		
Photographic chemicals:			
Number of establishments.....	11		
Pounds.....	384,181		
Value.....	\$1,189,995		
Medicinals:			
Number of establishments.....	25		
Pounds.....	5,724,245		
Value.....	\$8,679,377		
Flavors and perfumes:			
Number of establishments.....	13	774,350	228,528
Pounds.....	861,143		
Value.....	\$2,643,698		
Synthetic phenolic resins:			
Number of establishments.....	6		
Pounds.....	3,696,757		
Value.....	\$2,268,676		

DISTRIBUTION OF NUMBER OF ESTABLISHMENTS, BY STATES.

	Crudes.	Intermediates.	Dyes and color lakes.	Photographic chemicals.	Medicinals.	Flavors and perfumes.	Synthetic phenolic resins.
United States.....	56	99	106	11	25	14	6
NEW ENGLAND:							
Massachusetts.....	3	5	7				
Rhode Island.....	1	1	1				
Connecticut.....	1	2					
MIDDLE ATLANTIC:							
New York.....	4	21	33	5	9	3	
New Jersey.....	3	40	29	3	7	7	4
Pennsylvania.....	10	9	8	1	2		1
EAST NORTH CENTRAL:							
Ohio.....	9	6	5		1		
Indiana.....	1	1					
Illinois.....	6	5	7	1	2	2	1
Michigan.....	1	2	2		1		
Wisconsin.....	2	1	4		1		
WEST NORTH CENTRAL:							
Minnesota.....	3						
Missouri.....	3	1	2		1	1	
SOUTH ATLANTIC:							
Maryland.....			1		1		
District of Columbia.....	1						
Virginia.....		1	2			1	
West Virginia.....	1	2	2				
Georgia.....			1				
EAST SOUTH CENTRAL:							
Tennessee.....	1	1	1				
Alabama.....	2						
Louisiana.....	1						
MOUNTAIN AND PACIFIC:							
Utah.....	1						
Washington.....	3						
California.....		1	1	1			

¹ See report of United States Tariff Commission, Census of dyes and coal-tar chemicals, 1919, for detailed statistics of production.

² Reported as "Coal-tar distillery products."
³ Coal-tar dyes and intermediates made largely from stock of foreign origin.
⁴ Reported as "Chemicals or medicinal preparations from coal tar."

Much crude tar, especially of the gas industry, is purchased by distillers who make a specialty of the fractionation of light oils and tar. These distillers, who do not properly form part of either the gas or the coke industry, are included for census purposes with the coal-tar chemical industry, under the group "Crudes." Products of the distillation of tar by these special distillers are the same but differ in relative quantities of ingredients separated by treatment of tar and oils in the original establishments. Basic materials for coal-tar chemicals are derived therefore from two sources, (1) from the gas and coke industries where light oils and some tar are worked up as by-products, and (2) from tar distillers within the industry proper. Tar as such and much of the heavier fractions from various distillations are used for many purposes, as fuel, insecticides, wood preservatives, and roofing materials, only a small part of the total bulk of material being employed for the synthesis of coal-tar compounds.

Upon redistillation tar leaves a semisolid carbonaceous residue of "pitch," almost equal in percentage weight to the proportion of coke in the original coal. Water vapor amounts to about 4 per cent, heavy oils to 20 per cent, and loss as gas about 1 per cent, leaving approximately 13 per cent of the distillate which may be available for coal-tar syntheses. This distillate consists of benzol and its homologs, 2.5 per cent; phenol and homologs, 2 per cent; pyridine and quinoline, 0.25 per cent; naphthalene and acenaphthene, 6 per cent; and anthracene and phenanthrene, 2 per cent.

Coal therefore upon distillation yields 17 per cent light oils and tar, in about the proportion of 1 to 4, and when the tar is redistilled it yields nearly 13 per cent material that may in part be used for organic syntheses, to the extent of 1.5 per cent of the original coal.

In the same way the light oils are fractionated into a number of distillates, all of which separations are extremely variable, and repeated fractionations are required to isolate the individual chemicals required as "crudes" for synthesis of coal-tar intermediates.

The coal-tar chemical group includes crudes, intermediates and finished compounds.

Commercially it is customary to apply the term "crudes," to the basic hydrocarbons, with slight regard to their condition of purity. Benzols, toluols, xylols, naphthalenes in the unrefined states as well as benzene, toluene, and other refined products are spoken of as crudes. A crude remains a crude until chemical change has been brought about, only an alteration in composition denoting the change from crude to intermediate.

For census and tariff purposes, however, a distinction is made between grades of naphthalene and of anthracene, more refined grades being taken out of the class of crudes and included with intermediates. So also the phenols, cresols, and other tar acids of defined strengths produced by distillation of tar, which by general usage are classed with crudes, are

put for tariff reasons with synthetic phenol as intermediates, whether of technical or pure quality.

The statistics concerning products were collected on a joint schedule in cooperation with the United States Tariff Commission, the Bureau of the Census section being confined to group totals for production. The values as reported by the census and those by the Tariff Commission necessarily will not agree since the latter include intermediates reported to have been made and consumed in the same works, while the census figures are confined to the marketed products of the establishments, or products in form and condition to be marketed. Table 30 covers establishments making coal-tar derivatives only, while the totals in the text which follows also include contributing industries where coal-tar chemicals were of secondary importance.

Crudes.—The materials used for the production of coal-tar "crudes" were distributed as follows:

Coal tar.....	barrels (50 gals.)..	3, 478, 884
Oil tar.....	barrels (50 gals.)..	669, 561
Gas-house tar.....	barrels (50 gals.)..	104, 175
		4, 252, 620
Other organic materials:		
Liquids.....	barrels (50 gals.)..	148, 110
Solids.....	tons (2,000 lbs.)..	72, 000

The liquids under "Other organic materials" included solvent naphtha, benzol, toluol, cresols, creosote oil, drip and holder oil, gasoline and other distillates, while the solids consisted of phenol, naphthalene, pitch, and coal. Converting all of these to a weight basis makes a total of over 1,000,000 tons of material.

From this amount of material a total of 926,000 tons of distillates and residues was obtained with a value of \$22,000,000, and together with tarred felt, roofing, and other products the total value of products from 60 establishments distilling crude tar and related coal-tar distillates was \$33,000,000. If with this is combined the value of similar distillates in the gas and coke industries the total value reached over \$70,000,000.

The distribution of these products was not made in census reports. If the figures reported from the gas and coke schedules are combined with those in the report of the Tariff Commission for the various distillates we find:

	Gallons.	Value.
Liquid distillates:		
Tar.....	338, 507, 667	\$11, 579, 801
Light oil.....	93, 304, 713	10, 608, 880
Benzene.....	68, 152, 464	12, 697, 474
Toluene.....	2, 034, 542	687, 181
Solvent naphtha.....	4, 079, 025	675, 359
Other refined oils.....	54, 146, 434	6, 668, 862
Total.....	560, 224, 850	\$42, 917, 557
Solid distillates:		
	Pounds.	
Naphthalene.....	38, 372, 647	\$1, 731, 806
Anthracene.....	1, 381, 944	238, 977
Other distillates.....	1, 309, 927, 746	10, 907, 617
Total.....	1, 349, 682, 337	\$12, 878, 400
Grand total, value.....		\$55, 795, 957

Intermediates.—In the absence of detailed statistics for intermediates only totals can be given, namely, that 112 establishments in the coal-tar and related industries produced 137,763,929 pounds, with a value of \$43,788,510.

Finished products.—One hundred and seventy-six establishments in the coal-tar and related industries made finished products which were distributed as follows:

	Pounds.	Value.
Dyes.....	81,497,833	\$75,534,445
Medicinals.....	10,227,427	16,893,951
Flavors.....	1,682,875	5,120,299
Synthetic resins.....	3,696,757	2,268,656
Photo chemicals.....	463,527	1,278,764
Perfumes.....	63,720	313,318
Total value		\$101,409,433

GROUP VIII.—PLASTICS.

Table 31 presents the statistics for plastics, 1919 and 1914.

TABLE 31.—GROUP VIII.—PLASTICS:¹ 1919 AND 1914.

	1919	1914
Number of establishments.....	² 35	24
Value of products.....	³ \$77,477,041	\$13,895,784
In form for further manufacture (rods, sheets, blocks, etc.):		
Pyroxylin (including products sold under trade names)—		
Number of establishments.....	² 4	
Total production, pounds.....	20,752,950	
For sale—		
Pounds.....	16,743,064	
Value.....	\$20,855,988	\$3,778,374
Made and consumed, pounds.....	4,009,886	
Collodion and liquid solutions of pyroxylin—		
Number of establishments.....	² 10	
Total production, pounds.....	19,343,463	
For sale—		
Pounds.....	17,171,313	
Value.....	\$3,810,187	(⁴)
Made and consumed, pounds.....	2,172,150	
Rubber substitutes—		
Number of establishments.....	² 11	
Total production, pounds.....	7,755,476	
For sale—		
Pounds.....	7,291,776	
Value.....	\$1,309,644	
Made and consumed, pounds.....	463,700	\$5,526,740
Finished articles of pyroxylin and rubber substitutes (made in the producing establishment) and nitro-cellulose, value.....	\$9,870,895	
Other plastics, viscose, etc., including artificial silk, value.....	\$41,630,827	\$4,590,670

¹ Production in 1909. Number of establishments, 24; value of products, \$7,472,732.

² Distribution by states:

All establishments, 35; New Jersey, 10; Massachusetts, 9; New York, 5; 2 each in Illinois, Connecticut, Ohio, and Pennsylvania; and 1 each in Missouri, Maryland, and Virginia.
Pyroxylin, 4. New Jersey, 2; and Massachusetts, 2.
Collodion, 10. New Jersey, 5; and 1 each in Connecticut, Illinois, Missouri, New York, and Pennsylvania.
Rubber substitutes, 11. Massachusetts, 4; New Jersey, 2; New York, 2; and 1 each in Connecticut, Illinois, and Maryland.

³ Not including establishments engaged primarily in the manufacture of motion-picture films (not exposed), viz: 18 establishments in 1919, with products valued at \$72,152,797.

⁴ Figures not available.

This group embraces the pyroxylin plastics sold under such trade names as celluloid, fiberloid, xylonite, etc., and fabrications thereof; pyroxylin or soluble cotton, collodion, and liquid solutions of pyroxylin; phenolic condensation plastics, such as bakelite and condensite; rubber substitutes; viscose, artificial silk; and plastics formed by using a cementing material,

caoutchouc, casein, gums, etc., and a filler, which may be molded or shaped. The total value includes the value of finished goods manufactured in the producing establishments, as well as the value of stock sold for further manufacture.

Artificial silk ranked first in value, with viscose as the predominating basic material for its manufacture. Cellulose acetate silk is a growing product. Only three companies reported artificial silk manufacture in 1919.

Pyroxylin plastics constituted 45 per cent of the total value of the group. Collodion, or liquid solution of pyroxylin, was made in 10 establishments; dry nitro-cellulose in 4. Rubber substitutes have kept pace with other plastics in growth.

GROUP IX.—COMPRESSED AND LIQUEFIED GASES.

Table 32 presents the statistics for compressed and liquefied gases. Certain gases, anhydrous ammonia, carbon dioxide, and chlorine, are primarily classed in other groups, where the detailed statistics will be found.

TABLE 32.—GROUP IX.—COMPRESSED AND LIQUEFIED GASES.

[Cubic feet at atmospheric pressure.]

	1919	1914	1909
Value of products.....	\$43,263,918	\$10,415,325	(¹)
Acetylene: ²			
Number of establishments.....	49	40	
Total production, cubic feet.....	313,558,000		
For sale—			
Cubic feet.....	311,390,000	121,696,000	(¹)
Value.....	\$7,140,757	\$2,317,605	
Average value per 100 cubic feet.....	\$2.29	\$1.90	
Made and consumed, cubic feet.....	2,168,000		
Ammonia, Anhydrous (see Group II).....	\$7,224,473	\$3,140,848	\$2,544,238
Carbon dioxide (see Group I).....	\$6,574,250	\$2,320,685	\$2,345,743
Chlorine (see Group VI).....	\$1,425,917	\$472,836	
Hydrogen:			
Number of establishments.....	² 40	6	
Total production, cubic feet.....	138,177,000		
For sale—			
Cubic feet.....	137,082,000	1,669,000	(¹)
Value.....	\$851,307	\$16,671	
Average value per 100 cubic feet.....	\$0.62	\$1.00	
Made and consumed, cubic feet.....	1,095,000		
Nitrogen:			
Number of establishments.....	8		
Cubic feet.....	2,162,000	(¹)	(¹)
Value.....	\$45,416		
Nitrous oxide (laughing gas):			
Number of establishments.....	8	7	5
Gallons.....	25,740,000	17,838,000	9,175
Value.....	\$515,164	\$213,099	\$38,589
Average value per 100 gallons.....	\$2.00	\$1.19	\$4.90
Oxygen:			
Number of establishments.....	94	51	20
Electrolytic.....	30		
Other.....	55		
Cubic feet.....	1,173,414,000	104,714,000	3,814,000
Electrolytic.....	131,477,000		
Other.....	1,041,937,000		
Value.....	\$16,577,389	\$1,820,448	\$177,439
Average value per 100 cubic feet.....	\$1.41	\$1.75	\$4.63
Other gases—(1) sulphur trioxide; (2) blaugas, oil, and carbonylhydrogen; (3) argon; (4) sulphur dioxide; and (5) carbon monoxide; named in order of value.....	\$2,909,155	\$104,135	\$59,759

¹ Figures not available.

² Not including acetylene distributed through mains by public service companies: 1919, 37 establishments, 5,077,000 cubic feet, value \$30,647; and 1914, 125 establishments, 14,888,000 cubic feet, \$104,019.

³ Distribution by states, Ohio 4; Pennsylvania, 4; Michigan, 3; Missouri, 3; 2 each in California, Indiana, New Jersey, New York, Oklahoma, and Utah; and 1 each in Arkansas, Colorado, Connecticut, Illinois, Iowa, Kentucky, Louisiana, Massachusetts, Nebraska, Oregon, Texas, Utah, Virginia, and Wisconsin.

⁴ Equivalents in cubic feet; 1919, 3,432,000; 1914, 2,378,400.

⁵ Quantity reported in pounds.

Hydrogen employed for the hydrogenation of oils, generated *in situ* in the nascent condition and immediately absorbed, was not measured nor reported. Argon finds employment as a filler for electric incandescent lamps and the demand has increased greatly within the last five years in consonance with the growth of the primary industry. Its employment commercially is only recent and a direct result of the demand for oxygen, with consequent refinement of the methods for the fractionation of liquid air. Five establishments in four states reported production.

Liquid air must have been prepared in very large quantities to supply the requirements for argon, nitrogen, and oxygen. Twenty-three states and 49 establishments produced acetylene; 29 states and 94 plants, oxygen; and 25 states and 40 plants hydrogen, made electrolytically from water.

GROUP X.—CHEMICALS NOT ELSEWHERE SPECIFIED.

The group carries the two major subdivisions, organic and inorganic. Distinction should be made between the purely organic and inorganic compounds, and the composites, such as the salts of metals with organic acids. Much depends upon which is the valuable constituent. As a rule compounds containing both organic and inorganic constituents have been classed as organic.

Table 33 presents the statistics of production for 1919, 1914, and 1909

TABLE 33.—GROUP X.—CHEMICALS, NOT ELSEWHERE SPECIFIED.

	1919	1914	1909
Value of products.....	\$156,672,155	\$52,898,172	\$48,851,270
ORGANIC.....	\$72,141,542	\$16,377,955	\$14,039,748
Alcohols: ¹			
Amyl alcohol—			
Number of establishments.....	5		
Total production, gallons.....	241,254	(²)	(²)
For sale—			
Gallons.....	141,535		
Value.....	\$497,906		
Made and consumed, gallons.....	99,719		
Glycerin (glycerol)—			
Crude—			
Number of establishments.....	91		
For sale—			
Pounds.....	21,402,735	16,568,920	
Value.....	\$2,961,583	\$2,278,976	
Unit value, pound.....	\$0.14	\$0.14	
Made and consumed in soap industry, pounds.....	38,350,994		
Refined—			
Number of establishments.....	31		79,677,490
Total production, pounds.....	69,464,298	60,944,799	\$11,752,580
For sale—			
Pounds.....	67,342,822	59,810,405	
Value.....	\$20,724,033	\$10,779,204	
Unit value, pound.....	\$0.31	\$0.18	
Made and consumed, pounds.....	2,121,476	1,134,394	
Other—butyl, diacetone, limone, and propyl alcohols; dextrin citronellol, geraniol, guaiacol, iso-eugenol, linalool, nerol, resorcinol, rhodinol, terpineol, some ethyl alcohol (\$126,299), and methyl alcohol (\$5,763) produced in chemical establishments, value.....	\$553,234	(²)	(²)
Aldehydes:			
Formaldehyde—			
Number of establishments.....	6	3	3
Total production, pounds.....	25,006,815		
For sale—			
Pounds.....	19,663,753	8,426,247	3,794,486
Value.....	\$3,938,322	\$655,174	\$363,717
Unit value, pound.....	\$0.20	\$0.08	\$0.10
Made and consumed, pounds.....	5,343,062		

¹ Not including (except as noted under "Other alcohols") ethyl or grain alcohol, the product of distilleries; nor methyl or wood alcohol, for which see "Wood distillation."

² Figures not available; included with unclassified.

TABLE 33.—GROUP X.—CHEMICALS, NOT ELSEWHERE SPECIFIED—Continued.

	1919	1914	1909
Aldehydes—Continued.			
Vanillin—			
Number of establishments.....	4		(¹)
Pounds.....	134,687	129,619	
Value.....	\$1,365,941	\$525,219	
Unit value, pound.....	\$10.14	\$4.35	
Other, including acetic, anisic, citral, and decyl aldehydes; chloralhydrate; formaldehyde; hydrosulphite; heliotropin; and miscellaneous.....	\$1,794,268	(¹)	(¹)
Carbon and hydrocarbon compounds:			
Carbon bisulphide—			
Number of establishments.....	8		
Total production, pounds.....	15,469,567		
For sale—			
Pounds.....	11,606,193	(¹)	(¹)
Value.....	\$640,346		
Made and consumed, pounds.....	3,863,374		
Other—acetylene, blau gas, oil gas, calcium carbide, silicon carbide, thymene, etc.....	\$28,362,198		
Esters:			
Amyl acetate—			
Number of establishments.....	8		
Total production, gallons.....	125,725		
For sale—			
Gallons.....	96,143	180,237	238,774
Value.....	\$350,573	\$465,064	\$442,771
Unit value, gallon.....	\$3.65	\$2.58	\$1.85
Made and consumed, gallons.....	29,582		
Ethyl acetate—			
Number of establishments.....	7		
Total production, pounds.....	5,780,549		
For sale—			
Pounds.....	2,657,947	(¹)	(¹)
Value.....	\$340,011		
Made and consumed, pounds.....	3,122,602		
Other—amyl and ethyl butyrate, amyl valerate, butyl acetate, ethyl formate, etc.....	\$1,007,794	(¹)	(¹)
Ethers:			
Ethyl ether (sulphuric ether)—			
Number of establishments.....	10		
Total production, pounds.....	4,875,255		
For sale—			
Pounds.....	4,111,755	2,120,082	1,163,631
Value.....	\$1,103,076	\$278,816	\$190,164
Unit value, pound.....	\$0.27	\$0.13	\$0.16
Made and consumed, pounds.....	763,500		
Ethyl nitrite (nitrous ether)—			
Number of establishments.....	5		
Pounds.....	43,153	(¹)	(¹)
Value.....	\$30,856		
Other—methyl ether, etc.....	\$22,570	(¹)	(¹)
Halogen compounds:			
Carbon tetrachloride—			
Number of establishments.....	5		
Total production, pounds.....	11,908,704		
For sale—			
Pounds.....	9,811,779	(¹)	(¹)
Value.....	\$803,643		
Made and consumed, pounds.....	2,096,925		
Chloroform—			
Number of establishments.....	6		
Pounds.....	1,677,641	1,333,954	1,809,685
Value.....	\$516,625	\$295,817	\$477,538
Unit value, pound.....	\$0.31	\$0.22	\$0.26
Ethyl chloride—			
Number of establishments.....	6		
Pounds.....	248,103	(¹)	(¹)
Value.....	\$166,235		
Other—chlor acetyl and ethylene chloride, ethyl bromide, ethyl iodide, iodoform, monobrom benzene, monobrom camphor, tetrachlorethane, and thymol iodide.....	\$254,248	(¹)	(¹)
Ketones:			
Acetone—			
Number of establishments.....	4	8	
Pounds.....	6,045,914	10,425,817	7,761,696
Value.....	\$767,042	\$1,099,585	\$812,978
Unit value, pound.....	\$0.13	\$0.11	\$0.10
Acetone oil—			
Number of establishments.....	3		
Gallons.....	99,692	(¹)	(¹)
Value.....	\$127,831		
Methyl ethyl ketone (methyl acetone)—			
Number of establishments.....	6		
Pounds.....	1,158,032	(¹)	(¹)
Value.....	\$167,734		
Other—violet ketones and miscellaneous.....	\$97,351	(¹)	(¹)
Other specified organic chemicals—amines, various coal-tar products, alcohols, refined camphor, oleo resin, ossein, thymol, and sulphonal.....	\$1,409,158	(¹)	(¹)
Other unclassified organic chemicals.....	\$4,138,359	(¹)	(¹)
INORGANIC.....	\$84,530,613	\$36,520,217	\$34,811,522
Antimony:			
Chloride—			
Number of establishments.....	4		
Pounds.....	103,466	(¹)	(¹)
Value.....	\$15,554		

¹ Figures not available; included with unclassified.

TABLE 33.—GROUP X.—CHEMICALS, NOT ELSEWHERE SPECIFIED—Continued.

	1919	1914	1909
Antimony—Continued.			
Sulphide—			
Number of establishments.....	5	(1)	(1)
Pounds.....	2,983,378	(1)	(1)
Value.....	\$808,433	(1)	(1)
Other—oxide, oxychloride, potassium, antimonyl tartrate.....	\$366,040	(1)	(1)
Arsenic:			
Arsenate of calcium—			
Number of establishments.....	5	(1)	(1)
Pounds.....	1,191,868	(1)	(1)
Value.....	\$248,459	(1)	(1)
Arsenate of lead—			
Number of establishments.....	12	11	(1)
Total production, pounds.....	11,514,275	8,847,656	(1)
For sale—			
Pounds.....	11,465,788	8,641,856	(1)
Value.....	\$2,090,341	\$511,688	(1)
Unit value, pound.....	\$0.18	\$0.06	(1)
Made and consumed, pounds.....	48,487	205,800	(1)
Other—arsenous and arsenic acid, arsenical salts of copper, magnesium, sodium and zinc, etc., some metal, and sulphide.....	\$1,160,567	\$134,294	(1)
Barium:			
Carbonate—			
Number of establishments.....	4	(1)	(1)
Pounds.....	12,906,705	(1)	(1)
Value.....	\$369,465	(1)	(1)
Chloride—			
Number of establishments.....	9	(1)	(1)
Total production, pounds.....	8,743,098	(1)	(1)
For sale—			
Pounds.....	5,811,579	(1)	(1)
Value.....	\$229,544	(1)	(1)
Made and consumed, pounds.....	2,931,519	(1)	(1)
Nitrate—			
Number of establishments.....	4	(1)	(1)
Total production, pounds.....	2,025,185	(1)	(1)
For sale—			
Pounds.....	903,377	(1)	(1)
Value.....	\$85,319	(1)	(1)
Made and consumed, pounds.....	1,121,808	(1)	(1)
Sulphate (blanc fixe)—			
Number of establishments.....	10	11	8,152,000
Pounds.....	13,635,789	18,278,000	\$86,986
Value.....	\$250,100	\$257,415	\$1.07
Unit value, 100 pounds.....	\$1.88	\$1.41	(1)
Sulphide—			
Number of establishments.....	7	(1)	(1)
Total production, pounds.....	21,908,754	(1)	(1)
For sale—			
Pounds.....	5,084,931	(1)	(1)
Value.....	\$106,317	(1)	(1)
Made and consumed, pounds.....	16,823,823	(1)	(1)
Other—barium chlorate, dioxide, fluoride, phosphate, thiocyanate, etc.....	\$646,758	\$103,204	(1)
Bismuth:			
Subnitrate—			
Number of establishments.....	7	(1)	(1)
Total production, pounds.....	283,286	(1)	(1)
For sale—			
Pounds.....	279,786	(1)	(1)
Value.....	\$811,487	(1)	(1)
Made and consumed, pounds.....	3,500	(1)	(1)
Other, nitrate, oxide, subgallate, etc., and metal.....	\$424,015	(1)	(1)
Bromine:			
Liquid—			
Number of establishments.....	5	(1)	(1)
Pounds.....	211,555	(1)	(1)
Value.....	\$92,047	(1)	(1)
Other—ammonium, calcium, potassium and sodium bromides and bromates, organic bromides, etc., (see the respective groups).....	\$1,425,684	(1)	(1)
Calcium:			
Acetate—			
Number of establishments.....	86	78	70,739
Total production, tons.....	84,478	83,542	\$2,118,443
For sale—			\$26.95
Tons.....	76,955	81,761	(1)
Value.....	\$2,082,232	\$2,138,909	(1)
Unit value, ton.....	\$34.85	\$26.16	(1)
Made and consumed, tons.....	7,523	1,781	(1)
Chloride—			
Number of establishments.....	15	7	(1)
Tons.....	74,699	44,753	(1)
Value.....	\$1,043,301	\$342,271	(1)
Unit value, ton.....	\$14.00	\$7.65	(1)
Phosphate—			
Number of establishments.....	7	3	(1)
Pounds.....	44,270,166	24,192,974	(1)
Value.....	\$4,727,364	\$1,298,566	(1)
Average value, 100 pounds.....	\$10.72	\$5.37	(1)
Other—calcium bisulphite, bromide, carbonate, hypochlorite, sulphide and sulphate, etc., \$5,177,241; carbide, citrate, ferrocyanide, lactate, lactophosphate, sulphocarbonate, etc., \$10,436,916.....	\$15,609,157	(1)	(1)
Cerium compounds—carbonate, chloride, dioxide, fluoride, nitrate, oxalate, etc.....	\$132,283	(1)	(1)
Chromium sulphate, and chromium compounds, n. e. s. (see Group V).....	\$610,933	(1)	(1)
Cobalt, salts and compounds.....	\$217,089	(1)	(1)

¹ Figures not available; included with unclassified.

TABLE 33.—GROUP X.—CHEMICALS, NOT ELSEWHERE SPECIFIED—Continued.

	1919	1914	1909
Copper:			
Carbonate—			
Number of establishments.....	5	(1)	(1)
Pounds.....	327,949	(1)	(1)
Value.....	\$92,230	(1)	(1)
Sulphate (blue vitriol)—			
Number of establishments.....	14	14	36,540,553
Pounds.....	35,287,881	37,152,351	\$1,531,574
Value.....	\$3,164,611	\$1,598,844	\$1.19
Average value, 100 pounds.....	\$8.97	\$4.30	(1)
Other copper salts and compounds.....	\$575,537	\$14,383	(1)
Gold:			
Chloride—			
Number of establishments.....	4	(1)	(1)
Ounces.....	7,229	28,817	42,544
Value.....	\$76,152	\$291,658	\$430,944
Other gold salts and compounds.....	\$66,017	(1)	(1)
Iodine, resublimed and minor iodides:			
Number of establishments.....	7	(1)	(1)
Pounds.....	105,731	(1)	(1)
Value.....	\$438,002	(1)	(1)
Iron:			
Chloride, crystals (ferric)—			
Number of establishments.....	7	(1)	(1)
Pounds.....	917,849	(1)	(1)
Value.....	\$71,572	(1)	(1)
Chloride, liquor (ferric)—			
Number of establishments.....	9	(1)	(1)
Pounds.....	977,133	(1)	(1)
Value.....	\$64,859	(1)	(1)
Oxide—			
Number of establishments.....	6	6	(1)
Tons.....	30,417	\$105,682	(1)
Value.....	\$574,970	(1)	(1)
Sulphate (coppers)—			
Number of establishments.....	32	29	\$12,819
Tons.....	\$59,383	46,239	\$78,467
Value.....	\$993,939	\$352,772	\$6.12
Unit value, ton.....	\$16.74	\$7.63	(1)
Other iron compounds—			
Inorganic ferroalloys other than blast-furnace products, iron-by-hydrogen, chloride (ferrous), nitrate, sulphide, vanadate, etc.....	\$9,274,214	\$3,592,793	(1)
Organic, acetate, iron ferrocyanide, oxalate, valerate.....	\$661,975	(1)	(1)
Lead:			
Acetate—			
Number of establishments.....	9	(1)	(1)
Total production, pounds.....	5,131,133	(1)	(1)
For sale—			
Pounds.....	4,183,621	7,290,936	(1)
Value.....	\$552,435	(1)	(1)
Made and consumed, pounds.....	947,512	\$474,430	(1)
Arsenate (see Arsenate of lead).....	\$335,906	(1)	(1)
Other lead salts.....	\$502,542	(1)	(1)
Lithium salts, bromide, carbonate, chloride, etc.....			
Number of establishments.....	4	(1)	(1)
Pounds.....	544,022	(1)	(1)
Value.....	\$70,512	(1)	(1)
Chloride—			
Number of establishments.....	7	(1)	(1)
Pounds.....	26,282,436	(1)	(1)
Value.....	\$445,087	(1)	(1)
Oxide—			
Number of establishments.....	6	(1)	(1)
Pounds.....	9,031,650	(1)	(1)
Value.....	\$1,176,858	(1)	(1)
Sulphate (Epsom salts)—			
Number of establishments.....	20	12	10
Total production, pounds.....	59,067,335	29,265,115	21,621,297
For sale—			
Pounds.....	58,696,632	\$296,999	\$189,791
Value.....	\$1,497,077	\$1.00	\$0.88
Av. value, 100 lbs.....	\$2.55	(1)	(1)
Made and consumed, pounds.....	370,703	(1)	(1)
Other magnesium salts, metal, and alloys.....	\$376,843	(1)	(1)
Manganese:			
Borate—			
Number of establishments.....	3	(1)	(1)
Pounds.....	141,828	(1)	(1)
Value.....	\$27,996	(1)	(1)
Other manganese salts and compounds.....	\$71,399	(1)	(1)
Mercury:			
Chloride, mercuric (corrosive sublimate)—			
Number of establishments.....	4	(1)	(1)
Total production, pounds.....	447,080	(1)	(1)
For sale—			
Pounds.....	437,015	(1)	(1)
Value.....	\$648,774	(1)	(1)
Made and consumed, pounds.....	10,065	(1)	(1)
Chloride, mercurous (calomel)—			
Number of establishments.....	3	605,701	(1)
Pounds.....	256,388	\$513,023	(1)
Value.....	\$414,388	(1)	(1)
Other mercury compounds, cyanide, oxide, and miscellaneous preparations.....	\$711,856	(1)	(1)

² Iron sulphate produced by chemical plants 12,898 tons, by rolling mills 9,788 tons, and by wire mills 36,747 tons.

³ Includes (1909) 5,845 tons made and consumed.

⁴ Not including ferromanganese alloys.

TABLE 33.—GROUP X.—CHEMICALS, NOT ELSEWHERE SPECIFIED—Continued.

	1919	1914	1909
Nickel compounds—carbonate, cyanide, formate, hydrate, nitrate, sulphate, black salts, and miscellaneous.....	\$641,645	\$157,149	(1)
Phosphorus, metal, chloride, sesquisulphide, and miscellaneous.....	\$910,591		
Radium salts:			
Number of establishments.....	7		
Milligrams.....	27,627	(1)	(1)
Value.....	\$2,985,777		
Silver:			
Nitrate—			
Number of establishments.....	7		
Total production, ounces.....	3,055,903		
For sale—			
Ounces.....	3,017,889	2,563,235	2,030,399
Value.....	\$2,184,051	\$340,059	\$727,428
Unit value, ounce.....	\$0.72	\$0.33	\$0.36
Made and consumed, ounces.....	38,014		
Other silver salts and compounds, chloride, collargol, cyanide, nucleinate, oxide, proteinate, and miscellaneous.....	\$257,722		
Strontium salts—bromide, carbonate, chloride, iodide, lactate, nitrate, salicylate, sulphate, etc.....	\$319,373	(1)	(1)
Sulphur:			
Refined—			
Number of establishments.....	9		
Tons.....	52,099	31,166	25,269
Value.....	\$2,712,944	\$1,141,100	\$391,501
Unit value, ton.....	\$52.07	\$36.61	\$35.28
Chloride (red and yellow)—			
Number of establishments.....	8		
Total production, pounds.....	4,048,066		
For sale—			
Pounds.....	2,353,807	(1)	(1)
Value.....	\$124,088		
Made and consumed, pound.....	2,294,259		
Other sulphur compounds.....	\$15,926	(1)	(1)
Thorium compounds—nitrate, oxide.....	\$664,843		
Tin:			
Chloride, stannous (crystals)—			
Number of establishments.....	4		
Pounds.....	587,963		
Value.....	\$251,843		
Unit value, pound.....	\$0.42		
Chloride, stannic (tetra and bi)—			
Number of establishments.....	4		
Pounds.....	8,411,453	8,291,239	10,293,377
Value.....	\$2,735,392	\$2,028,511	\$1,535,350
Unit value, pound.....	\$0.32	\$0.24	\$0.15
Oxide—			
Number of establishments.....	4		
Pounds.....	1,352,345		
Value.....	\$899,525		
Unit value, pound.....	\$0.67		
Titanium compounds—sodium sulphate, potassium oxalate, etc. ²	\$98,188	(1)	(1)
Uranium compounds—acetate, sodium acetate, chloride, nitrate, nitrite, sodium uranate, etc.....	\$6,233	(1)	(1)
Vanadium and compounds ²	\$698,678	(1)	(1)
Zinc:			
Carbonate—			
Number of establishments.....	4		
Pounds.....	91,083		
Value.....	\$16,645		
Chloride—			
Number of establishments.....	19		
Pounds.....	74,089,063		
Value.....	\$4,349,096		
Oxide ² —			
Number of establishments.....	5		
Total production, pounds.....	6,185,602		
For sale—			
Pounds.....	4,299,002	40,786,880	25,054,213
Value.....	\$374,188	\$1,130,959	\$472,302
Made and consumed, pounds.....	1,886,000		
Sulphate—			
Number of establishments.....	12		
Total production, pounds.....	12,041,730		
For sale—			
Pounds.....	7,325,544		
Value.....	\$267,001		
Made and consumed, pounds.....	5,616,186		
Other zinc compounds—arsenite, borate, cyanide, nitrate, resinata, stearate, sulphocarbonate, valerate, etc.....	\$442,780		
Other rare earth compounds, n. e. s.—beryllium nitrate, neodymium chloride, zirconium oxide, etc.....	\$42,171		
Other rare metals, n. e. s.—molybdenum, silicon, tungsten.....	\$1,806,978	(1)	(1)
UNCLASSIFIED.			
Crude, commercial, and fine chemicals, not reported separately, value.....	\$4,699,105	\$10,154,408	\$26,748,736

Organic (Group X).—A separate presentation of amyl alcohol was possible though the total of 241,254 pounds is but a portion of the fusel oil produced, the bulk being made by the distilling industries and not here included.

Alcohols used for flavoring and perfumery, including a small amount of ethyl and methyl alcohols reported by chemical establishments, amounted to \$538,540.

Among aldehydes, formaldehyde still takes leading place, the production being 25,006,815 pounds or nearly three times the weight reported in 1914. Six companies, in five states—New Jersey, Michigan, Pennsylvania, New York, and Missouri—represent the combined production.

Under miscellaneous aldehydes, certain items reported as "Formaldehyde products" or as "Aldehyde products," that might have been more properly placed with synthetic resins or plastics, in the absence of further information are included. These, together with formaldehyde-hydrosulphite, of Group VI, amounted to \$1,663,784, so that formaldehyde and its compounds totaled \$5,602,100.

Four establishments produced vanillin, almost all originating in New Jersey.

The subgroup, "Carbon and hydrocarbon compounds," was difficult to delimit, as some items were of rather indefinite character. Calcium carbide was reported by six establishments in five states—Michigan, New York, Minnesota, Virginia, and Iowa. The production of 15,469,567 pounds of carbon bisulphide is a notable increase over 1914. Eight plants in five states—New York, Michigan, Pennsylvania, California, and West Virginia—made this chemical, a large proportion, nearly 25 per cent, being consumed in the works where made.

Apparently the production of amyl acetate is decreasing, a cheaper substitute having been found. In 1909 the production was 1,470,568 pounds; in 1914 it was 1,300,052 pounds, and in 1919, including that made and used in the same works, 906,764 pounds. On the other hand, the production of ethyl acetate or acetic ether in 1919 was 5,780,549 pounds, of which 54 per cent was used in the same works for further manufacture.

Acetone, acetone oil, and methyl acetone were made largely by the old process of dry distillation of acetate of lime. One firm reported acetone made from fermentation acetic acid. During the war molasses was fermented and the alcohol converted to acetic acid and acetone, but no production was reported for 1919. Butyl alcohol, a by-product of fermentation processes is now much in demand as a solvent.

Other alcohols, aldehydes, hydrocarbons, esters, ethers, halogen compounds, ketones, and miscellaneous organic chemicals were made in great variety and in some instances in large quantities. Sulphuric ether has doubled in quantity and price. Nitrous

¹ Figures not available; included with unclassified.
² Not including ferroalloys (of Ti, or V., as the case may be).
³ Not including zinc oxide reported in the paint industry 139,661 tons; value, \$24,982,299. Total production from all sources, 142,753 net tons.

ether, carbon tetrachloride, ethyl chloride, acetone oil, and methyl ethyl ketone are reported separately for the first time. Comparisons with 1914 are therefore not possible, but a large increase in production is at least indicated.

A summary of the chemicals under the heading "Other" in each subgroup follows, the most important being given in order of their value:

Alcohols.—Resorcinol, terpineol, guaiacol, geraniol, iso-eugenol.

Aldehydes.—Chloral hydrate, heliotropin, anisic aldehyde, decyl aldehyde, citral.

Carbon and hydrocarbons.—Carbon electrodes, condensed smoke, refined carbon, stearin pitch, paraffin wax.

Esters.—Ethyl butyrate, butyl acetate, amyl butyrate, amyl valerate, ethyl formate.

Ethers.—methyl ether and miscellaneous (can not separate).

Halogen compounds.—Iodoform, brom camphor, ethyl bromide, acetyl chloride, tetrachlorethane.

Ketones.—Violet ketone and miscellaneous (can not separate).

Miscellaneous.—Camphor, sulphone methanes, diphenylamine, osseine, oleo resin vanillin.

Inorganic (Group X).—The totals for the subgroups have been made to cover all chemicals containing the characteristic element, and therefore include some items appearing in other places in this group or in other groups which because of their composition belong in more than one class. For instance, arsenic compounds would not be complete without arsenous and arsenic acid anhydrides; barium compounds without the dioxide; nor calcium compounds without the carbide and hypochlorite. Each group within itself is a unit, so far as possible, but as a result there are duplications and the grand totals can not be used for comparisons without limitation.

The summary which follows involves many omissions and inequalities. Sulphur, for instance, does not include sulphuric and sulphurous acids, and the infinite number of other sulphur combinations. Chromium does not include its ferroalloys, nor have ferroalloys been considered except as reported to the chemical industries proper.

The inorganic products of this group may be further classified into (a) *nonmetals* or negative elements, such as chlorine, bromine, iodine, phosphorus, silicon, and sulphur; (b) *alkali earths*, barium, calcium, lithium, magnesium, and strontium; (c) *rare earths*, cerium, thorium, and other (beryllium, neodymium, zirconium); (d) *common metals* (forming basic salts)—cobalt, copper, iron, lead, mercury, nickel, and zinc, (forming basic and acid salts)—antimony, arsenic, bismuth, chromium, manganese, and tin; (e) *rare metals* (forming basic salts)—gold, platinum, radium, silver; (forming basic and acid salts)—molybdenum, titanium, tungsten, uranium, and vanadium.

Potassium and sodium, which would naturally form a separate group as alkalis, closely related to alkali earths, and aluminum, which would belong in (d), have been considered as separate groups.

Arranged in order of decreasing value the totals of the subgroups as shown in Table 33, combined with chemicals containing the characteristic element from other groups, stand as follows:

SUBGROUP.	1919	SUBGROUP.	1919
Calcium.....	\$24,062,654	Bromine.....	\$1,499,738
Silicon.....	18,407,429	Bismuth.....	1,235,502
Iron.....	11,641,530	Antimony.....	1,190,027
Phosphorus.....	10,877,547	Lead.....	888,341
Other rare metals.....	9,614,061	Thorium.....	664,843
Chromium.....	7,122,230	Nickel.....	641,645
Zinc.....	5,449,710	Lithium.....	502,542
Copper.....	4,671,656	Strontium.....	319,373
Tin.....	3,886,760	Cobalt.....	217,689
Magnesium.....	3,613,204	Gold.....	143,069
Arsenic.....	3,527,740	Corium.....	132,283
Radium.....	2,985,777	Vanadium.....	102,678
Sulphur.....	2,852,958	Manganese.....	99,395
Silver.....	2,441,773	Titanium.....	93,188
Iodine.....	1,904,130	Other rare earths.....	42,171
Mercury.....	1,775,018	Uranium.....	6,233
Barium.....	1,683,503	All other.....	4,699,195

Nonmetals or negative elements.—The nonmetals are found or produced in the elemental form and appear as such in Group X. They also occur as acids, shown in Group I, or salts of these acids, found in all groups.

Chlorine has been considered in Group VI as a bleaching agent, and its compounds as hypochlorites also. Chlorates are chiefly used in the explosives industry or medicinally. Chlorides are so plentiful in nature that their production is confined mainly to refining methods. The largest production of chlorides is in the form of sodium chloride or common salt, included elsewhere as a separate industry.

Bromine was produced from the mother liquors of salt deposits partly by direct electrolysis, partly by treatment of the liquors with electrolytic chlorine, and partly by chemical processes. Five establishments in Michigan and Ohio made liquid bromine, which is a valuable assistant in organic syntheses and is used medicinally and for photographic purposes. Its principal value, however, lies in its combinations as bromides and bromates, which, although they have been included in other groups, are gathered under the heading "Bromine" to complete this item.

Calculating each salt to its bromine content, assuming 95 per cent purity, the total amount of bromine represented on the chemical tabulation for 1919 was 2,165,000 pounds. These figures do not include bromine compounds produced by the coal-tar, pharmaceutical, perfume, and other synthetic organic chemical industries, which employ large quantities.

Iodine is found in the form of iodates in Chile salt peter and as the iodide in ashes of sea plants. Firms reporting iodine, resublimed, and various organic and inorganic iodides, were manufacturers of fine chemicals, some giving crude iodine as material. In all, 438,000 pounds of iodides, valued at \$1,499,976, were produced, and included potassium iodide, sodium iodide, iodoform, thymol iodide, potassium iodate, ethyl iodide, and cadmium iodide. These with resublimed iodine made the value of the whole group

\$1,904,130. Calculating the iodides to their iodine content, the total iodine represented on the table was 438,878 pounds, three-fourths of which was combined.

Phosphorus, as phosphates, finds its largest use in the fertilizer industry, which is elsewhere reported. As an element it is widely used in technical processes and in alloys, while in combination with oxygen it forms acids and salts. It has the additional power of combination with more negative elements as phosphorus sulphides and chlorides, and in conjunction with hydrogen may act as a base, as in phosphonium compounds. Five concerns made elemental phosphorus, the oxychloride, sesquisulphide, trichloride, and pentachloride, in order of value. A little more than 2 per cent of the element was in the form of red phosphorus. Nearly all of the derivatives were made from phosphorus, which was derived from phosphate rock largely or entirely by electrothermic processes.

Combinations of phosphorus occur elsewhere in the table as glycerophosphoric, hypophosphorous, and phosphoric acids, in Group I; as ammonium, potassium, and sodium hypophosphites and phosphates, in Groups II, III, and IV; and as barium and calcium phosphates in Group X, alkali earth compounds. The total for all of these was 126,226,000 pounds, of a value \$10,877,547, the most valuable being calcium phosphate, sodium phosphate, phosphoric acid, and ammonium phosphate.

Although *silicon* in the form of the oxide and of silicate rocks is the commonest mineral known, and its employment as an ingredient of resistant materials and apparatus is very extensive, in the chemical industry as such it has appeared to a limited extent only as soluble silicates used in the paper and textile industries. Since the production of elemental silicon and its alloys by electrolytic processes, however, this chemical and its compounds have become of much greater importance. The total amount as derived from the tables including silicon carbide and derivatives, sodium silicate, ferrosilicon, sodium silico fluoride, copper-silicon, silicon metal, and silicic acid, represents more than 312,000 tons, and \$18,407,429.

Nine establishments in six states—New Jersey, New York, California, Texas, Maryland, and Missouri—refined 52,099 tons of *sulphur*, none of these plants producing the chlorides. Eight concerns in five states—Michigan, West Virginia, New York, California, and New Jersey—produced 4,648,066 pounds of sulphur chlorides, largely of the yellow variety, almost 50 per cent of the total production being used in the same plant for further processes of manufacture. All of these chlorides were made from sulphur and electrolytic chlorine.

Alkali earths.—The alkali earths occur in Group X as elements, alloys, or salts, and in other groups as bleaching compounds and electrolytic products.

The figures for *barium* compounds are exclusive of the paint and pigment industry which is the largest producer of sulphide, sulphate, carbonate, and chloride. In order of decreasing weight, including made and consumed, the items reported separately in 1919 are the sulphide, sulphate, carbonate, chloride, dioxide (for detail, see Group VI), and nitrate; while in order of value for the part sold this becomes dioxide, carbonate, sulphate, chloride, sulphide, and nitrate. That is, the sulphide and dioxide exchange places, since the latter had a high value as the basis for peroxide bleaches and the former was about 77 per cent by weight made and reused in the same plant, with no value assigned. About 55 per cent of the nitrate was made and reused.

Barium compounds are derived from the sulphate and carbonate minerals, large quantities of the former being mined in the United States. These may be ground and used directly as pigments but are even more valuable when first converted to soluble salts and reprecipitated in very finely divided condition as the sulphate or carbonate. The peroxide is made by roasting the carbonate to the oxide and further roasting it with excess oxygen. The sulphide is produced from the sulphate by roasting with a reducing agent such as coal. It is used largely for the manufacture of sodium sulphide, a chemical much in demand in the application of sulphide colors in the dyeing industry. Barium chloride and nitrate, both water soluble, find many applications in ceramics, explosives, as source of green light, and in solution for the precipitation of finely divided barium pigments and color lakes.

Other barium compounds in the table consist of the phosphate, chlorate, fluoride, thiocyanate, and miscellaneous salts, the phosphate forming a very large proportion of these. The total production of barium compounds was 31,503 tons, the part reported for sale being valued at \$1,683,503.

A great variety of *calcium* compounds are represented, the arsenate, bisulphite, bromide, carbide, ferrocyanide, and hypochlorite being duplicated in other groups or subgroups of Group X. Including these, a total of 451,690 tons of calcium compounds valued at \$24,062,054 were produced, not including 26,123 tons of calcium-magnesium chloride of a value of \$321,596 reported by the salt industry, nor does it cover the use of calcium in the organic chemical industries. Calcium may be said to rival sodium and potassium in importance as a chemical base.

In order of value the compounds of calcium rank—carbide, phosphate, hypochlorite, acetate, chloride,

arsenate, precipitated sulphate, citrate, precipitated carbonate, lactate, ferrocyanide, sulphocarbonate, bromide, etc. The carbide and hypochlorite constitute 90 per cent of the whole. Carbide is included with the electrolytic chemicals, the bisulphite and hypochlorite in Group VI, the arsenate is valuable for its arsenic content and is shown in Group X with arsenic; the sulphate, carbonate, sulphide, and oxide in bulk are used as pigments, cements, in metallurgy and ceramics and do not appear here, but in purified condition are used as dentifrices, medicinally, and as reagents, and are included among chemicals. The ferrocyanide is a by-product of the gas and coke industries and in bulk is employed for the production of ferrocyanogen pigments, referred to under Group II. Bromide, citrate, lactate, lactophosphate, and sulphocarbonate of calcium are mainly useful medicinally and for photographic purposes.

Calcium compounds are derived from carbonate, phosphate, and sulphate mineral deposits. The former when burned to the oxide or quicklime and then dissolved in water or "slaked" to form the hydroxide, is the basis for many of the salts.

Calcium acetate is the basis for production of acetic acid in all three forms, and of acetone. The amount shown in the table was produced by the wood distillation industry, 86 establishments in 11 states reporting 84,478 tons, 1 establishment reporting brown acetate, the others the gray variety. Three plants made and consumed part of their product. Fourteen concerns in Michigan made 47.2 per cent of the total. Seventy-five plants in Michigan, Pennsylvania, and New York produced 89 per cent and 11 others in Wisconsin, Missouri, Tennessee, West Virginia, Connecticut, Kentucky, Alabama, and Mississippi the remaining 11 per cent.

Calcium chloride was made in 15 plants in 6 states—New York, Michigan, West Virginia, Ohio, California, and Missouri—a total of 74,699 tons, valued at \$1,043,301, the unit values running from \$5 to \$32 a ton, and averaging \$14. Seven establishments in New York and Michigan produced 92 per cent of the whole. The increase from 1914 to 1919 was 67 per cent in weight and about double in price and number of establishments.

One establishment obtained calcium chloride from natural brines by evaporation; three were refiners; others produced it from lime and hydrochloric acid; others from electrolytic chlorine, probably as a by-product; and a large part was the by-product of the Solvay soda process. Calcium chloride is valuable in the dry and wet condition, and was sold both ways. In dehydrated form it is used as a drying agent and preservative, for fireproof paint and sizing. In solution as brine, it finds application in freezing and cooling operations, as an antifreezing solution in automobile and airplane radiators, and as a dust preventive.

Seven establishments in Illinois, Missouri, New Jersey, and New York made 44,270,166 pounds of calcium phosphate, valued at \$4,727,364. Three in Illinois producing 72.3 per cent of the total amount. None was reported as made and consumed in the same plant. The total does not include crude acid calcium phosphates of the fertilizer industry. It was all, however, the acid phosphate or dicalcium phosphate. Like the chloride, the phosphate is marketed both dry and in solution.

Lithium salts were not reported separately in sufficient detail to indicate accurately the relative proportions of the different salts. As shown, the carbonate, bromide, and chloride were made in the order named. The total of \$502,542 was the value of 466,595 pounds sold, 277,185 pounds in addition being made and used in the same establishment, or a total of 743,780 pounds of miscellaneous lithium salts.

A total of \$3,613,203 for *magnesium* and its salts in 1919 represents several items not reported separately in previous years. The carbonate was largely of the light precipitated variety, and the rest of highly refined grade. Four establishments in Pennsylvania, California, and New York produced it. Seven plants in Michigan, California, Ohio, and Pennsylvania made 13,141 tons of the chloride largely from brines, about 91 per cent being produced in three plants in Michigan. Six concerns reported 9,031,650 pounds of the oxide of magnesium. The states represented were Pennsylvania, California, and New York.

Magnesium sulphate or Epsom salts was the most valuable of the magnesium compounds. A total of 59,067,335 pounds was reported by 20 establishments in 10 states—Ohio, Michigan, Maryland, Illinois, Georgia, Washington, Pennsylvania, California, New York, and Missouri—4 plants in Ohio making 40 per cent of the total. Prices varied greatly, the average being 2.5 cents per pound. Increases in the periods 1909 to 1914 and 1914 to 1919 were 35.3 per cent and 101.8 per cent, respectively.

All other magnesium compounds consisted in large part of the metal, the fluosilicate, arsenite, and alloys, with a considerable amount of unspecified salts. Magnesium compounds are derived mainly from the carbonate, which exists plentifully as a mineral, by calcination or solution. It has many applications technically which require production in large bulk and is not considered nor reported with chemicals.

Strontium salts were reported in considerable variety, as nitrate, carbonate, bromide, chloride, iodide, lactate, salicylate, and sulphate, the first three comprising 98.6 per cent of the quantity and 92.8 per cent of the total value of all strontium salts. Almost all were produced by manufacturers of fine chemicals, as strontium and its salts are employed usually for their medicinal qualities, or as the source of red signal lights, or flares and

other pyrotechnics, and for coloring iridescent glass. Qualities ranged from crude to chemically pure.

Rare earths.—Rare earths, so-called, have been distributed through the table in three items, cerium compounds, thorium compounds, and other rare earths, including beryllium, neodymium, and zirconium oxides and salts. The total value of these earths was \$839,297, of which thorium derivatives constituted nearly 80 per cent.

Thorium compounds, value \$664,843, consisted of several derivatives of which thorium nitrate and mesothorium together amounted to over 99 per cent in value. Four plants in New Jersey produced all of it, from monazite sand. *Cerium* compounds were valued at \$132,283, and were reported as the fluoride, chloride, oxalate, nitrate, carbonate, dioxide, and miscellaneous products. Other rare earths, \$42,171, included *zirconium* oxide, *beryllium* nitrate, *neodymium* chloride, and miscellaneous products.

Common metals.—Many of the common metals are useful as such and as salts in which they appear as the basic element, and in addition may be combined with oxygen to form negative groups or acid rests which, with more basic elements, find extensive employment technically. Those metals which, from a commercial standpoint, are usually basic or electrolytically positive, appearing only as metals, alloys, or in salts as the positive element, are cobalt, copper, iron, lead, mercury, nickel, and zinc, while those metals which are not only useful as above but also form salts in which they are part of the negative group are antimony, arsenic, bismuth, chromium, manganese, and tin. These metals, giving a greater variety of combinations, are to be found, like the acids, in other groups as antimonates, arsenates, bismuthates, chromates, manganates, and stannates, of sodium, potassium, calcium, etc.

Antimony metal and its alloys were not reported on the chemical schedule. Its compounds are used mainly as pigments, precipitated as the sulphide or as dye lakes, or as mordants in the leather and textile industries. A total of 4,045,619 pounds having a value of \$1,190,027, of antimony derivatives were reported by 11 establishments in 5 states—New York, New Jersey, Massachusetts, Connecticut, and Missouri. Potassium antimony tartrate is also classed with Group IV. The sulphide ore stibnite or antimony needles, either directly or after conversion to the metal or oxide, was the raw material used.

Arsenic and its compounds as reported here are exclusive of arsenical insecticides as such, nor are returns from the mining and metallurgical industries included. Arsenic compounds originate with the sulphide ores, arsenical pyrites, orpiment or related ores, which when roasted give a sublimate of the oxide (white arsenic or arsenious acid anhydride), which may be (a) reduced

to the metal, (b) combined directly with hydrogen sulphide in acid solution with or without oxidizing agents to form the sulphide pigments, (c) combined directly with copper acetate to form copper acetoarsenite, (d) combined with a soluble salt of sodium to form sodium arsenite or, under oxidizing conditions, sodium arsenate, (e) which latter salts are further treated with soluble salts of metals to form calcium lead, copper or zinc arsenic compounds. The principal value of arsenic compounds is as germicides and insecticides.

As the oxide, white arsenic, derived from the sulphide ore by roasting, is the basis for many arsenic salts, naturally large quantities were reported as made and consumed. All plants making the oxide also produced calcium and lead arsenates and altogether 16 plants in 11 states were engaged in making arsenical products. Michigan, Illinois, Indiana, Maryland, California, and Wisconsin each produced more than 1,000,000 pounds of lead arsenate or together about 84 per cent of the total amount of 11,514,275. Indiana, Illinois, and Wisconsin each turned out over 200,000 pounds of calcium arsenate. Some of the arsenical products reported in "other" were in large amounts, copper acetoarsenite, the acid anhydrides, sodium arsenate, and zinc arsenite comprising 95 per cent of the entire value of this item.

The total value of *bismuth* salts was \$1,235,502, eight establishments in four states—New Jersey, Missouri, Pennsylvania, and New York—which claimed nearly equal amounts, reporting the subnitrate, metal, subgallate, nitrate, and oxide, in order as named. As over 9 per cent of miscellaneous, unenumerated salts were included, however, the order is uncertain. All of the companies, except one mining concern, were manufacturers of fine chemicals in grades suitable for medicinal purposes.

Inasmuch as *chromium* compounds are valuable in all combinations for their chromium content, the total as shown in the table may be extended to include chromic acid, and chromates and bichromates of sodium and potassium. Chromates of sodium, potassium, chromium alum, chromium sulphate, chromic acid, and unspecified chromium compounds altogether amounted to 54,774,818 pounds, valued at \$7,122,230, and were made by 11 establishments in 7 states—New Jersey, Maryland, New York, Illinois, Massachusetts, Missouri, and Pennsylvania. Chromium metal and its alloys are not included.

Sodium chromate or bichromate, obtained by fusion of chrome iron ore with soda, is the basis of all other chromium salts which as a class are used principally as textile mordants, for tanning leather, printing, bleaching, making inks, varnishes, for medicinal purposes, photography, fireworks, and minor applications.

Some sodium chromate, about 4 per cent, was reported as made and reused in the same establishment, but not in sufficient amounts for the derived salts. Potassium chromate was made by establishments reporting the sodium salt.

Chromium sulphate and the double salt, ammonium-chromium sulphate or chrome alum, are closely related to each other in composition and to the chromates, so far as their applications are concerned, although the metal as stated above exists as a relatively basic element in the former and as an acidic one in the latter salts.

The most important compound of *cobalt* is the oxide, which is used as a component of driers for paints and as a blue coloring agent for materials that are subjected to high temperatures while in preparation, such as metals and products of the ceramic industries. A peculiar trade fashion has obtained, which is to name several compounds of cobalt, the carbonate, phosphate, and arsenate as the "oxide," with letters to designate or differentiate them. All are used for about the same purpose. It is not known how much of the oxide reported in 1919 consisted of these other compounds. Four establishments reported cobalt salts, \$217,689, two of which employed the original ore, while the chloride, nitrate, sulphate, acetate, linoleate, resinate, and others were produced from the oxide, purchased as such.

Statistics of *copper* chemicals should include blue vitriol or copper sulphate, which is the basis of many of the other salts, but is produced as a by-product of the smelting and refining industries. Five concerns were reported by the Geological Survey as making bluestone, of copper content 7,882,574 pounds, which sold for \$2,825,557. Using a factor for conversion, this amounted to 31,081,289 pounds of crystallized sulphate and has been included in the totals on the table. All copper compounds aggregated 39,197,000 pounds and \$4,671,656 and consisted of the sulphate, arsenic compounds, cyanide, carbonate, nitrate, chloride, acetate, oxides, and miscellaneous unenumerated salts. The first five mentioned equaled over 99 per cent and the sulphate alone nearly 70 per cent of the total value.

As with copper, the great bulk of *iron* compounds was not reported by chemical manufacturers, but as products of metallurgical industries.

Ferroalloys reported by the chemical industry formed but a portion of the total production, blast-furnace alloys not being included. Separate figures are not given, but the kinds were ferrosilicon, ferrochrome, ferrovanadium, ferromolybdenum, ferrotungsten, and ferromagnesite, in the order named.

Iron chloride, crystalline and liquid, made by manufacturers of fine chemicals, amounted to 1,894,982 pounds and \$136,431. Twelve establishments in six

states, Michigan, New York, Pennsylvania, Missouri, Ohio, and New Jersey, reported; seven of these, in Michigan and Pennsylvania, made 70 per cent of the total.

Iron oxide was made by six plants in six states—Illinois, New Jersey, Pennsylvania, California, New York, and Ohio. Two of these produced "iron sponge" for gas purification from iron borings and shavings; two used pyrites for making sulphuric acid and reported gas ore or burnt pyrites, desulphurized; and two produced refined oxide.

Ferrous sulphate or copperas figures were collected from steel works, rolling mills; and wire mills and from the chemical industries. Thirty-two plants in 12 states made 59,393 tons of copperas, which sold for \$993,939. Five states—Pennsylvania, Illinois, Rhode Island, Ohio, and Massachusetts—made 50,646 tons, or 85 per cent. Thirteen wire mills reported 36,747 tons at an average of \$18.20 a ton, seven steel works and mills returned 9,738 tons averaging \$12.40 a ton, and chemical establishments reported 12,907 tons at \$15.60 a ton. Part of the ferrous sulphate of the chemical industry was made by refining crude salts, part from pyrite and waste pickling liquor, and a part from metallic iron with acid.

Other iron compounds included ferro-alloys, ferrocyanide, iron mix, the vanadate, ferric sulphate, the sulphide, iron by hydrogen, the acetate, nitrate, valerate, oxalate, ferrous chloride, and miscellaneous unspecified salts. Excepting the first three, all were made in grades classed as fine chemicals. Metallic iron and pyrite with the respective acids were used very largely as materials.

Lead salts from the purely chemical industries were apparently reported in less quantity in 1919 than in 1914. Large amounts of acetate, nitrate, and monoxide were made and consumed in further processes. A total of 5,131,133 pounds of the acetate were reported by nine establishments in six states. Other salts included the peroxide, nitrate, monoxide, sulphate, resinate, and miscellaneous salts, which totaled 3,697,892 pounds, having a value of \$335,906. If amounts made and reused in the same establishments are considered the total weight manufactured was 20,343,300 pounds, with an assigned value of \$2,978,682.

The largest use for *manganese* is in metallic form alloyed with iron. Exclusive of this, a variety of manganese compounds were reported in 1919, the borate, resinate, carbonate, dioxide, hypophosphite, sulphate and other salts and driers, making in all 549,891 pounds and \$99,395. Seven plants in five states—Pennsylvania, Missouri, Ohio, New Jersey and New York—made these salts of a quality used for varnish and oil driers, or of medicinal grade. They

were derived mainly from the hydroxide which is precipitated by caustic alkali from solution of a soluble salt derived from the oxide ore.

A total of 1,145,500 pounds with a value of \$1,775,018 represents *mercury* salts for 1919, including in addition to the two chlorides, calomel and corrosive sublimate, the oxide, white precipitate (ammonium mercury chloride), nitrate, blue mass, iodide, cyanide, and miscellaneous mercurials. Eight establishments in four states—New Jersey, New York, Pennsylvania, and Missouri—produced these mercury salts, all being manufacturers of fine chemicals.

The production of *nickel* salts since 1914 has increased greatly. The hydrate, refined salts, sulphate, oxide, cyanide and carbonate were produced in order of value as named, by eight plants in four states, making a total of 1,062,047 pounds valued at \$641,645. A very large part consisting of the hydrate is employed for the production of catalysts.

Ten companies in four states—New Jersey, Pennsylvania, Ohio, and Massachusetts—produced *tin* compounds in the form of chlorides or as oxide. Grades and prices varied widely in both. A considerable proportion of the tin for the chlorides was derived from the detinning of scrap, using electrolytic chlorine in large quantity, either produced at the plant or purchased as liquid chlorine. For the oxide, flue dross or pig tin was employed. The distinction between so-called bichloride of tin and the other chlorides was not clearly made in the reports, so the figures for stannic chloride were made to include both "bichloride" and tetrachloride, while stannous chloride covers tin crystals only. The sum of all tin compounds was 10,351,761 pounds, valued at \$3,886,760.

Zinc, in common with many other metals included in Group X, has large uses outside of the chemical industries proper. Zinc oxide, produced directly from the sulphide ores, the carbonate, and the sulphide especially in combination as lithopone, are reported in large quantities by the paint and pigment industry. Almost half the composition of the best auto tires on the market to-day is said to be lead-free zinc oxide. This filler gives white color and resiliency and increases tensile strength and durability. The mining and smelting industries give returns for metallic zinc and zinc sulphate as a by-product of these industries but this is not included in this report. Zinc sulphate finds its largest use as a soluble salt for the precipitation of finely divided zinc pigments, and it is also the origin of a large proportion of the zinc salts. It is in fact the most important salt of zinc, being made and consumed in large quantities for further manufacture. Over 43 per cent of the total amount reported was made and reused but this does not account for all the purposes for which it was used.

The total for all zinc compounds reported to the chemical industries, not including returns from smelting, paint and pigments, amounted to 87,833,780 pounds and a value of \$5,449,710. In addition to the salts shown separately, this includes the stearate, cyanide, arsenate, silicate, sulphocarbonate, valerate, borate, resinate, and nitrate. The chloride formed about 78 per cent of the weight and 80 per cent of the total value of the entire group but this does not present a fair comparison with the sulphate, for which returns were not complete. The chloride is used largely as a wood preservative, in dyeing silks and as a dehydrating and condensing agent in the synthetic dye and organic chemicals industries. As dust, or in granular form zinc is used for the generating of nascent hydrogen in reduction processes. The great variety of zinc salts that are produced in smaller quantities are mainly of importance medicinally.

Rare metals.—Like the commoner metals, rare metals function in more than one relation, most of them appearing in alloys with more common metals to which they impart some special and valuable property, and also in salts in which they may be either positive or negative to other elements present. The metals usually classed as the precious metals, gold, silver, and platinum, as such, are not reported in chemical totals. Their salts show the metals as basic. Radium also is isolated only as basic salts. Molybdenum, titanium, tungsten, uranium, and vanadium, however, are found technically as metallic alloys, as the metal and its basic salts, which are primarily found in Group X, and in combinations as negative elements in molybdates, alkali titanium oxalates or acetates, tungstates, and phosphotungstates, uranates, and vanadates. These latter therefore are to be found in other groups in addition to Group X.

Gold chloride, cyanide, gold sodium chloride, the bromide and some refined metal were reported as a total of 14,844 ounces, valued at \$143,069 by six concerns in New Jersey, Missouri, and Pennsylvania.

Silver salts increased in weight 26 per cent from 1909 to 1914, and about 20 per cent in the subsequent five years. Besides the nitrate, the protein salts and cyanide were mainly the cause of this growth. The average price was slightly lower in 1914 but doubled in the later census. Ten establishments made silver salts, totaling 3,669,000 ounces, and \$2,441,773, in the four states of Pennsylvania, New Jersey, New York, and Missouri. Seven plants in four states—Pennsylvania, New York, Missouri, and New Jersey—made silver nitrate.

All of the other rare metals are employed in valuable alloys with iron and other commoner metals. Molybdenum, titanium, tungsten, uranium, and vanadium in conjunction with radium and the precious metals, have been classed as rare metals, although they are no

longer rare in the sense of being scarce and little known. They are in fact widely known and used, although in small quantities as yet because of the difficulty and cost of separating them from their ores. They are usually derived from the oxide or sulphide ores.

A statement of the quantity and value of 1919 production follows:

	Weight.	Value.
	<i>Pounds.</i>	
Molybdenum and compounds metal, oxide, alloys.....	605,094	\$886,166
Titanium and compounds salts, sulphate, oxalate.....	1,049,820	98,188
Tungsten and compounds metal, alloys, oxide.....	1,578,030	1,527,845
Uranium and compounds salts, acetate, uranate.....	2,572	6,233
Vanadium and compounds metal, alloys, oxide, salts.....	641,749	1,519,679
Radium salts, gold and silver.....		5,570,619
Total.....		9,608,730

Molybdenum and its compounds include the metal, its oxide or acid anhydride of molybdic acid, and alloys with tungsten and iron. Titanium figures include the salts, titanium sodium sulphate, and titanium potassium oxalate, which were made by three companies in Pennsylvania, Illinois, and New York. Titanium compounds are used as mordants and the metal in alloys, none of which were reported to the chemical industry. Rutile, a dioxide of titanium occurring as a mineral in several of the states, is the main source of titanium.

Tungsten and compounds were returned as the acid anhydride, as metal and as alloys with iron, chromium, and molybdenum. Uranium and its compounds, like titanium, appeared only as salts, sodium uranium acetate, sodium uranium nitrate, sodium uranate, and others. Vanadium reports covered the acid anhydride or oxide, the metal, alloys with iron and salts, such as iron vanadate.

Radium salts were reported by seven establishments, a total of 27,627 milligrams, with a value of \$2,985,777 from four states—Pennsylvania, Colorado, Illinois, and New Jersey. With the exception of the bromide, the kind of salts was not indicated. The unit value averaged about \$108 per milligram.

The total of "Unclassified," crude, commercial, and fine chemicals, may be subdivided into chemicals sold in bulk, usually about 5 cents a pound or less, valued at \$110,778, and fine chemicals at 25 cents a pound and above, which amounted to \$4,588,417 so far as could be determined from the class of products otherwise reported, and the general character of the establishment. The latter class consisted of a very large number of separate items which could not well be distributed by the manufacturer making the report, but is incomplete in that some manufacturers of corresponding grades of fine chemicals did make such separations.

CHEMICALS MADE BY THE AID OF ELECTRICITY.

Inasmuch as a classification of chemicals made by the aid of electricity depends upon methods of manu-

facture, and not upon the chemical composition of the product, they appear in the various groups of chemicals according to composition.

The electrolytic and electrothermic processes have developed greatly, especially within the period covered by the war. Bridgeport, Conn., is said to have installed 52 electric brass furnaces during 1919; 26,000 tons of electrolytic zinc were reported, and an electrolytic process for the deposition of iron in the form of tubes from a solution of iron in hydrochloric acid, was developed. These and other of the most important products made by the aid of electricity are not included within the chemical industry. Aluminum, which ranks fifth in importance among metals, being surpassed only by iron, copper, zinc, and lead, and some of the less important metals and alloys, abrasives, carbides, some of the ferroalloys, and a variety of purely chemical compounds, however, are within the chemical industry.

Table 34 presents the statistics for this class of products.

TABLE 34.—CHEMICALS PRODUCED BY THE AID OF ELECTRICITY: 1919.

	Number of establishments.	Quantity.	Value.
Total:			
1919.....	114		\$82,580,005
1914.....	36		29,661,949
1909.....	19		18,451,461
1904.....	21		7,068,246
1899.....	14		2,045,535
Chlorine bleaches (Group VI):			
Chlorine..... pounds.....	14	91,141,000	
For sale..... pounds.....		34,392,000	1,425,917
Made and consumed..... pounds.....		56,749,000	
Hypochlorites (calcium and sodium, chiefly calcium)..... pounds.....	16	252,850,000	4,781,348
Hydrogen (Group IX)..... cubic feet.....	40	137,082,000	851,397
Oxygen (Group IX)..... cubic feet.....	39	131,477,000	1,855,911
Potassium hydroxide ² (caustic, Group IV), pounds.....	3	7,460,000	1,892,438
Sodium hydroxide ² (caustic, Group III), pounds.....	15	189,686,000	6,228,682
Far sale..... pounds.....		173,021,000	
Made and consumed..... pounds.....		16,665,000	
Other commodities in order of value, with number of establishments: Aluminum, 4; abrasives (silicon carbide and aluminous, including firms) 9; ferroalloys, 7; sodium and sodium cyanide, 4; chlorates, 5; phosphorus, 2; carbon bisulphide, 8; vanadium, 1; tungsten and molybdenum, 3; hydrochloric acid, 3; magnesium metal, 4; bromine, 5; other metals and alloys, 4; and miscellaneous, 10.....			65,554,312

¹ Distribution, by states:

Total.....	114	EAST NORTH CENTRAL:	SOUTH ATLANTIC:
		Ohio.....	Maryland.....
		Indiana.....	Virginia.....
NEW ENGLAND:		Illinois.....	West Virginia.....
Maine.....	2	Michigan.....	North Carolina.....
New Hampshire.....	1	Wisconsin.....	WEST SOUTH CENTRAL
Massachusetts.....	1		WEST SOUTH CENTRAL
Rhode Island.....	1	WEST NORTH CENTRAL:	MOUNTAIN.....
Connecticut.....	1	Minnesota.....	2
MIDDLE ATLANTIC:		Iowa.....	PACIFIC:
New York.....	26	Missouri.....	Washington.....
New Jersey.....	8	Nebraska.....	Oregon.....
Pennsylvania.....	14		California.....
			5

² Total production:

	Sodium hydroxide.		Potassium hydroxide.	
	Tons.	Per cent.	Tons.	Per cent.
Total production.....	333,361	100.0	4,192	100.0
Electrolytic.....	94,843	28.5	3,730	89.0
Other processes.....	238,518	71.5	462	11.0

Electrolytic and electrothermic products may be subdivided into four principal groups: (1) Chlorine and its derivatives, together with caustic alkalis which are interdependent or by-products of great importance; (2) oxygen and hydrogen, which are also produced simultaneously; (3) elements or metals and their alloys, including carbides; and (4) organic products and salts other than the foregoing, including cyanides, chlorates, carbon bisulphide and persulphates. The first two are electrolytic, the third electrothermic, and the fourth may be either.

The value of the products produced by the aid of electricity in 1919, shows an increase of 178 per cent over the production as reported in 1914, the per cent of increase for the preceding periods being 61 per cent for 1909-1914, 161 per cent for 1904-1909, and 246 per cent for the period 1899-1904.

The nine leading states in 1919, in order of value of electro products, were New York, Michigan, North

Carolina, New Jersey, Tennessee, Pennsylvania, West Virginia, Virginia, and California, which altogether produced 96.3 per cent of the total value of products. The remaining 3.7 per cent was distributed among 24 states.

Chlorine and hypochlorites have been considered in detail under Group VI; hydrogen and oxygen under Group IX, and sodium and potassium hydroxide under their respective Groups III and IV.

The item of other commodities may be subdivided as follows: Metals and alloys or basic elements, including aluminum, iron, tungsten, molybdenum, sodium, vanadium, magnesium, copper, and manganese and their alloys, \$36,000,000; abrasives and carbides, \$22,000,000; salts and organic products such as cyanides, chlorates, persalts and carbon bisulphide, \$6,000,000; and negative elements and their derivatives, phosphorus, bromine, silicon, and hydrochloric acid, \$1,000,000.

GENERAL TABLES.

Comparative summary, by states.—Table 35 gives the comparative statistics for the principal items, number of establishments, average number of wage earners, primary horsepower, cost of materials, and

value of products for the census years 1919, 1914, and 1909.

Detailed statement, by states.—Table 36 is a detailed statement, by states, for the census of 1919.

TABLE 35.—COMPARATIVE SUMMARY, BY STATES: 1919, 1914, AND 1909.

STATE.	Census year.	Number of establishments.	Wage earners (average number).	Primary horsepower.	Wages. Cost of materials. Value of products.			STATE.	Census year.	Number of establishments.	Wage earners (average number).	Primary horsepower.	Wages. Cost of materials. Value of products.		
					Expressed in thousands.								Expressed in thousands.		
United States.....	1919	598	55,586	376,940	\$72,848	\$216,301	\$438,659	New York.....	1919	83	9,687	59,043	\$13,149	\$50,871	\$88,102
	1914	395	32,311	282,385	22,066	89,461	158,054		1914	70	7,780	131,928	5,350	26,252	42,877
	1909	359	23,729	208,657	14,090	64,140	227,741		1909	74	5,746	116,197	3,376	19,709	35,340
California.....	1919	49	1,466	15,950	1,974	6,131	10,539	Ohio.....	1919	37	3,670	35,049	5,473	15,296	32,719
	1914	20	287	1,521	184	933	1,524		1914	29	2,017	18,751	1,460	6,726	11,388
	1909	13	244	1,308	168	762	1,306		1909	33	1,132	11,715	749	4,748	7,742
Illinois.....	1919	33	3,004	23,393	3,836	12,003	22,061	Pennsylvania.....	1919	56	7,134	30,334	9,854	26,781	78,333
	1914	26	1,682	8,590	1,164	5,360	8,618		1914	39	4,748	16,570	2,028	12,615	22,388
	1909	22	843	5,917	530	2,915	4,683		1909	37	3,185	9,771	1,892	10,200	15,978
Massachusetts.....	1919	27	2,483	9,223	3,044	8,101	17,305	Washington.....	1919	8	90	1,165	123	536	1,363
	1914	24	1,395	5,405	955	3,355	6,685		1914	4	32	89	25	259	374
	1909	24	1,358	3,731	811	3,048	5,916		Wisconsin.....	1919	30	187	1,376	204	1,129	2,074
1914	36	4,509	45,044	3,405	6,373	13,891	1914	7		60	362	36	230	436	
1909	36	3,174	26,594	2,012	5,072	12,890	1909	5		76	495	41	242	513	
Michigan.....	1919	22	1,253	4,149	1,162	7,717	13,538	All other states.....	1919	134	8,428	85,478	10,175	26,818	55,740
	1914	22	842	1,764	498	4,164	6,936		1914	54	2,713	32,898	1,907	6,130	11,250
	1909	9	619	886	333	2,221	3,640		1909	56	2,308	18,163	1,283	2,909	6,903
Missouri.....	1919	78	12,472	36,807	14,904	45,174	84,034	New Jersey.....	1919	64	6,276	18,563	4,124	17,054	31,687
	1914	64	5,046	13,880	2,895	12,267	22,824		1914	50	5,046	13,880	2,895	12,267	22,824
	1909	50	5,046	13,880	2,895	12,267	22,824		1909	50	5,046	13,880	2,895	12,267	22,824

¹ Excludes statistics for 1 establishment, to avoid disclosure of individual operations.
² Excludes statistics for 2 establishments, to avoid disclosure of individual operations.

MANUFACTURES.

TABLE 36.—DETAILED STATEMENT.

STATE.	Number of establishments.	PERSONS ENGAGED IN THE INDUSTRY.							WAGE EARNERS DEC. 15, OR NEAREST REPRESENTATIVE DAY.					Capital. Dollars.	
		Total.	Proprietors and firm members.	Salaried officers, superintendents, and managers.	Clerks, etc.		Average number.	Wage earners.		Total.	16 and over.		Under 16.		
					Male.	Female.		Number, 15th day of—			Male.	Female.	Male.		Female.
								Maximum month.	Minimum month.						
1 United States.....	598	66,947	122	2,905	5,460	2,874	55,586	Ja 60,754	My 51,050	58,757	53,798	4,782	88	89	484,483,412
2 California.....	49	1,762	10	85	128	73	1,466	Ja 1,886	Je 1,273	1,288	1,266	21	1	.....	25,483,943
3 Colorado.....	7	138	3	16	14	7	98	Oc 125	Ja 89	105	104	1	.....	.....	1,337,606
4 Georgia.....	7	182	.....	11	52	12	107	Jy 126	Ja 90	92	90	2	.....	.....	1,169,583
5 Illinois.....	33	3,554	14	128	274	134	3,004	Oc 3,544	Ap 2,570	3,248	3,200	48	.....	.....	19,923,193
6 Indiana.....	9	1,305	.....	32	176	71	1,026	Ja 1,244	Je 827	1,008	990	14	4	.....	7,466,016
7 Iowa.....	5	103	.....	14	12	5	72	Je 109	Ap 32	104	100	4	.....	.....	1,081,227
8 Kentucky.....	4	29	1	3	6	6	13	Ja 14	Au 11	14	14	.....	.....	.....	157,778
9 Louisiana.....	5	87	2	6	16	9	54	Fe 62	Oc 47	63	60	2	1	.....	887,824
10 Maryland.....	8	950	.....	30	92	31	797	No 975	Ja 651	784	773	11	.....	.....	7,890,204
11 Massachusetts.....	27	3,054	10	142	235	184	2,483	De 2,729	Mh 2,329	2,731	2,150	571	2	8	16,319,388
12 Michigan.....	36	6,721	14	314	492	189	5,712	Ja 7,494	My 4,980	5,999	5,938	53	8	.....	62,841,234
13 Minnesota.....	9	281	.....	18	67	34	162	Je 195	Ja 98	185	185	.....	.....	.....	2,082,618
14 Missouri.....	22	1,826	5	112	255	201	1,253	Je 1,280	Mh 1,218	1,245	998	239	6	2	9,309,265
15 Nebraska.....	12	370	2	30	22	16	300	Ja 792	Jy 48	539	530	9	.....	.....	6,569,155
16 New Jersey.....	78	15,062	9	667	1,165	749	12,472	De 13,127	Ap 11,277	13,099	12,085	990	14	10	90,993,211
17 New York.....	88	11,780	17	581	1,042	453	9,687	Ja 11,461	Je 8,920	9,864	9,299	560	5	.....	91,909,454
18 Ohio.....	37	4,410	1	178	357	204	3,670	Oc 4,210	Ap 3,022	4,296	4,012	283	1	.....	26,764,288
19 Pennsylvania.....	56	8,167	5	214	539	275	7,134	De 7,633	Mh 6,602	7,656	6,065	1,508	27	56	52,354,068
20 Rhode Island.....	4	299	.....	9	1	2	287	Au 319	Ja 256	298	272	26	.....	.....	1,297,118
21 Texas.....	9	249	.....	22	60	17	150	Oc 169	Ja 123	165	149	4	12	.....	2,139,701
22 Utah.....	8	504	.....	19	22	9	454	Mh 547	Je 342	559	552	7	.....	.....	3,063,947
23 Virginia.....	12	2,040	1	78	72	42	1,847	No 2,118	Mh 1,544	1,996	1,602	382	1	11	13,385,365
24 Washington.....	8	164	.....	26	27	21	90	De 108	Ap 76	108	108	.....	.....	.....	1,461,509
25 West Virginia.....	7	599	.....	41	21	3	534	Oc 635	My 452	495	491	4	.....	.....	8,631,079
26 Wisconsin.....	30	317	19	42	49	20	187	Ja 219	Jy 169	204	191	12	1	.....	2,139,671
27 All other states.....	28	2,994	9	87	264	107	2,527	.....	.....	2,612	2,574	31	5	2	27,330,017

¹ Includes water wheels and turbines (irrespective of ownership of water supply) and water motors (operated by water from city mains).
² Chiefly electric motors operated by rented (or purchased) current; other power included (chiefly shaft-belt or transmitted power from neighboring power plants).
³ Same number reported for one or more other months.

CHEMICALS.

BY STATES: 1919.

EXPENSES.										POWER.							
Salaries and wages.			For contract work.	Rent and taxes.		For materials.		Value of products.	Value added by manufacture.	Primary horsepower.					Electric horsepower generated in establishments reporting.		
Officials.	Clerks, etc.	Wage earners.		Rent of factory.	Taxes, Federal, state, county, and local.	Principal materials.	Fuel and rent of power.			Total.	Owned.	Rented. ¹					
Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Steam engines (not turbines).	Steam turbines.				Internal-combustion engines.	Water power. ¹	
12,546,127	11,794,507	72,848,324	1,321,738	596,741	31,931,389	183,558,969	32,742,310	438,658,869	222,357,590	376,940	127,164	114,585	5,004	3,692	126,495	109,554	1
283,367	255,680	1,973,938	27,885	10,289	233,679	4,830,172	1,300,728	10,539,416	4,408,516	15,980	1,437	2,790	80		11,673	417	2
46,193	24,178	101,348	113,617	3,296	35,531	590,402	43,381	1,301,141	667,358	788	40		2		746		3
41,624	94,019	104,165		10,600	60,545	323,907	55,853	957,293	577,533	547	150				397	10	4
761,887	573,883	3,836,506	58,941	55,960	647,408	10,408,691	1,594,383	22,090,803	10,057,729	23,393	16,613	2,743	50	1	3,986	24,550	5
192,862	364,575	1,732,093		1,440	381,077	3,378,886	591,716	8,649,304	4,678,702	8,574	6,096	180	210		1,488	698	6
25,194	21,694	76,927			17,068	250,069	70,076	558,084	237,339	834	225				609		7
7,820	9,374	14,619		780	7,313	50,398	13,551	177,018	113,069	359	100				259		8
19,680	28,221	64,288	2,500	1,344	30,916	32,537	48,182	312,806	232,087	402	85				317		9
204,211	152,122	1,090,437		3,600	71,286	2,815,529	382,629	5,277,426	2,079,268	6,508	1,435	3,425	10		1,698	3,439	10
475,417	457,835	3,043,576	3,587	30,402	738,198	7,561,738	539,679	17,305,166	9,203,749	9,223	2,565	3,225	175	1	3,257	3,064	11
1,121,081	957,780	8,949,577	1,940	20,950	2,399,240	9,292,541	6,451,534	37,850,834	22,106,759	74,943	22,710	37,237	22	100	14,874	20,541	12
58,107	126,364	188,223		51,732	60,572	484,624	138,908	1,455,658	832,126	1,105	75		100		930	10	13
386,977	559,820	1,162,182		49,162	1,093,445	7,429,292	287,543	13,537,929	5,821,104	4,149	1,767				2,382	1,020	14
90,379	51,457	399,593		7,892	22,121	514,314	455,298	2,304,793	1,335,181	6,057	4,381	750	722		204	1,182	15
3,122,104	2,753,623	14,903,510	804,079	55,900	3,060,252	42,169,606	3,003,988	84,033,941	38,860,347	36,807	18,201	9,923	1,068		7,595	16,837	16
2,807,754	2,352,144	13,148,889	33,828	142,664	5,413,813	42,601,366	8,270,026	83,101,532	37,230,140	59,043	16,445	7,871	188	2,688	31,851	9,786	17
693,141	742,760	5,473,508	45,874	34,695	1,740,048	12,146,385	3,149,144	32,719,466	17,423,937	35,049	13,838	16,320	433	20	4,438	10,676	18
1,190,401	1,191,699	9,854,310	95,369	18,496	12,076,417	24,723,050	2,058,100	73,332,932	46,551,782	30,334	9,741	5,557	400		14,636	8,578	19
35,673	4,779	335,240		1,335	21,823	851,605	93,815	1,399,346	453,926		886	295			591	167	20
57,294	106,398	155,749	12,667	6,188	67,144	486,781	85,581	1,394,354	821,992	1,057	291				766	5	21
44,161	64,054	658,925	93,038	3,000	31,001	551,067	235,524	1,708,957	922,366	4,735	2,119	714	493	500	909	320	22
238,204	166,410	1,942,627		7,405	2,838,916	2,736,939	968,469	12,765,281	9,059,873	11,882	4,240	2,900			4,722	5,300	23
69,473	64,637	123,135		2,334	128,673	469,069	66,825	1,363,434	827,540		1,165	40	8		1,117		24
181,747	46,188	752,936		115,411	1,896,682	225,785	3,280,657	1,158,190	571,158	8,425	1,330	5,850	665		590	1,520	25
80,214	95,029	204,095	1,170	5,147	60,002	1,063,995	65,378	2,074,299	944,626	1,376	140		10		1,226	4	26
311,182	528,672	2,557,928	15,643	72,130	579,490	5,898,724	2,546,224	14,196,999	5,752,051	33,219	2,205	15,100	360	380	15,234	1,400	27

¹ All other states embrace: Alabama, 2 establishments; Arkansas, 2; Connecticut, 3; District of Columbia, 1; Kansas, 4; Maine, 2; Montana, 2; North Carolina, 1; Oklahoma, 2; Oregon, 1; South Dakota, 1; Tennessee, 5; West Virginia, 7; and Wyoming, 2.

SULPHURIC, NITRIC, AND MIXED ACIDS.

GENERAL STATISTICS.

General character of the industry.—The statistics for establishments engaged primarily in the manufacture of sulphuric, nitric, and mixed acids were first presented separately at the census of 1904. Prior thereto they were included in the general chemical industry. It is to a considerable extent a specialized branch of the chemical industry, and the statistics here presented embrace the establishments specializing in the production of these acids.

Comparative summary.—Table 37 presents the comparative statistics for the industry for the census years 1899 to 1919, inclusive, the reports for 1899 having been segregated from chemicals in general.

Principal states, ranked by value of products.—Table 38 shows the number of establishments, wage earners, value of products, and value added by manufacture, by states, ranked according to value of products in 1919.

Persons engaged in the industry.—The age classification of the average number of wage earners in Table 39 is an estimate obtained by the method described in the "Explanation of terms." Figures for states will be found in Table 47.

Wage earners, by months.—The statistics for wage earners, Table 40, are intended to show the steadiness of employment, or the reverse, in accordance with the industrial conditions existing during the year. A few females were reported as wage earners, but they constituted only one-half of 1 per cent of the total number.

Prevailing hours of labor.—The statistics in Table 41 show a relatively large per cent of the employees in establishments where the prevailing hours of labor per week were 60 and over, though the percentage has dropped from 88.7 per cent in 1909 and 79.8 in 1914 to 18 per cent in 1919. In 1914 and 1909 practically no establishments operated on less than a 54-hour per week schedule, the few reported in 1914 on a 48-hour

basis being negligible, but in 1919, 33 per cent were employed in establishments where the prevailing hours were 48 per week.

Size of establishments, by average number of wage earners.—The industry is one of relatively large units, as shown in Table 42, the average number of wage earners per establishment being 96 in 1914 and 127 in 1919, a moderate increase in average size. In 1919 the establishments employing over 100 wage earners included 64.1 per cent of the total number of establishments and reported 93.9 per cent of the wage earners, as compared with 53.1 per cent of the establishments and 85.4 per cent of the wage earners in 1914.

Size of establishments, by value of products.—The grouping by value of products as shown in Table 43, reflects the general increase in values. The average value of products per establishment increased from \$235,000 in 1909 to \$475,000 in 1914 and to \$807,000 in 1919, but the increase is to a large degree due to high prices. This condition accounts for the changes from lower to higher groups.

Character of ownership.—The establishments in this branch of the chemical industry were all owned by corporations in 1919, and likewise in 1914 and 1909.

Number and horsepower of types of prime movers.—Table 44 presents the power statistics for the industry for 1919, 1914, and 1909. Electric power is a growing factor, and of the total primary power 91.7 per cent was utilized in the form of electric power in 1919, this including electric motor equipment operated with purchased electric current, specified as rented, and secondary electric or that generated by the establishment, as compared with 52.1 per cent in 1914 and 34.3 per cent in 1909.

Fuel consumed.—Table 45 presents the statistics for fuel, by kinds and by states, for 1919 and 1914. The figures for gas include both natural and manufactured gas.

SULPHURIC, NITRIC, AND MIXED ACIDS.

TABLE 37.—COMPARATIVE SUMMARY: 1919, 1914, 1909, 1904, AND 1899.

	1919	1914	1909	1904	1899	PER CENT OF INCREASE. ¹			
						1914-1919	1909-1914	1904-1909	1899-1904
Number of establishments.....	39	32	42	32	34	21.9	-23.8	31.2	-5.9
Persons engaged.....	5,860	3,604	2,582	2,757	2,654	62.6	39.6	-6.3	3.9
Proprietors and firm members.....	899	540	330	2	(²)	66.5	63.0	7.1	3.4
Salaried employees.....	4,961	3,064	2,252	303	298	61.9	30.1	-8.0	3.9
Wage earners (average number).....				2,447	2,356				
Primary horsepower.....	30,637	24,927	6,494	5,416	(²)	22.9	284.5	19.9	.....
Capital.....	\$51,100,004	\$35,233,806	\$18,726,195	\$12,761,920	\$13,981,506	45.2	88.2	46.7	-8.7
Salaries and wages.....	10,096,048	3,082,747	2,045,894	2,061,512	1,715,895	228.0	50.7	-0.8	20.1
Salaries.....	2,179,517	870,200	551,000	556,106	388,346	150.0	57.9	-0.9	43.2
Wages.....	7,916,531	2,212,547	1,494,894	1,505,406	1,327,549	258.0	48.0	-0.7	13.4
Paid for contract work.....	47,867	6,315	212	7,839	(²)	658.0	.....	.....	.....
Rent and taxes.....	1,071,605	217,278	90,145	\$ 102,023	(²)	393.0	141.0	.....	.....
Cost of materials.....	15,857,361	6,734,428	5,385,828	4,972,838	4,033,238	138.0	25.0	8.3	23.3
Value of products.....	31,470,480	15,215,474	9,884,057	9,052,646	8,586,390	107.0	53.9	9.2	5.3
Value added by manufacture ⁴	15,613,119	8,481,046	4,498,229	4,079,808	4,563,152	84.1	88.5	10.3	-10.6

¹ A minus sign (-) denotes decrease. ² Figures not available. ³ Exclusive of internal revenue. ⁴ Value of products less cost of materials.

TABLE 38.—PRINCIPAL STATES, RANKED BY VALUE OF PRODUCTS: 1919.

STATE.	Number of establishments.	WAGE EARNERS.			VALUE OF PRODUCTS.			VALUE ADDED BY MANUFACTURE.		
		Average number.	Per cent distribution.	Rank.	Amount (expressed in thousands).	Per cent distribution.	Rank.	Amount (expressed in thousands).	Per cent distribution.	Rank.
United States.....	39	4,961	100.0	.....	\$31,470	100.0	.....	\$15,613	100.0	.....
California.....	4	576	11.6	3	5,440	17.3	1	3,381	21.7	1
Illinois.....	3	875	17.6	1	5,057	16.1	3	2,829	18.1	2
New Jersey.....	5	561	11.3	4	2,804	8.9	4	1,208	7.7	6
New York.....	3	398	8.0	5	2,670	8.5	5	1,416	9.1	4
All other states.....	24	2,551	51.4	.....	15,499	49.2	.....	6,779	43.4	.....

TABLE 39.—PERSONS ENGAGED IN THE INDUSTRY: 1919, 1914, AND 1909.

CLASS.	Census year.	Total.	Male.	Female.	PER CENT OF TOTAL.		CLASS.	Census year.	Total.	Male.	Female.	PER CENT OF TOTAL.	
					Male.	Female.						Male.	Female.
All classes.....	1919	5,860	5,627	233	96.0	4.0	Clerks and other subordinate salaried employees.	1919	605	407	198	67.3	32.7
	1914	3,604	3,528	76	97.9	2.1		1914	405	330	75	81.5	18.5
	1909	2,582	2,547	35	98.6	1.4		1909	224	190	34	84.8	15.2
Proprietors and officials ¹	1919	294	285	9	96.9	3.1	Wage earners (average number).....	1919	4,961	4,935	26	99.5	0.5
	1914	135	135	.....	100.0	.....		1914	3,064	3,063	1	100.0	(²)
	1909	108	106	.....	100.0	.....		1909	2,252	2,251	1	100.0	(²)
Salaried officers of corporations....	1919	40	40	.....	100.0	.....	16 years of age and over.....	1919	4,959	4,933	26	99.5	0.5
	1914	35	35	.....	100.0	.....		1914	3,064	3,063	1	100.0	(²)
	1909	27	27	.....	100.0	.....		1909	2,249	2,248	1	100.0	(²)
Superintendents and managers....	1919	254	245	9	96.5	3.5	Under 16 years of age.....	1919	2	2	.....	100.0	.....
	1914	100	100	.....	100.0	.....		1914	.....	.....	.....	100.0	.....
	1909	79	79	.....	100.0	.....		1909	3	3	.....	100.0	.....

¹ No proprietors; officials only.

² Less than one-tenth of 1 per cent.

TABLE 44.—NUMBER AND HORSEPOWER OF TYPES OF PRIME MOVERS: 1919, 1914, AND 1909.

POWER.	NUMBER OF ENGINES OR MOTORS.			HORSEPOWER.					
	1919	1914	1909	Amount.			Per cent distribution.		
				1919	1914	1909	1919	1914	1909
Primary power, total.....	938	312	254	30,637	24,927	6,494	100.0	100.0	100.0
Owned.....	143	155	184	14,452	18,021	5,454	47.2	74.7	84.0
Steam.....	127	137	176	12,672	17,096	5,083	41.4	68.6	78.3
Engines.....	107	(²)	(²)	8,737	(²)	(²)	28.5		
Turbines.....	20	(²)	(²)	3,935	(²)	(²)	12.8		
Internal-combustion engines.....	15	18	8	1,755	1,525	371	5.7	6.1	5.7
Water wheels and turbines.....	1			25			0.1		
Rented.....	795	157	70	16,185	6,306	1,040	52.8	25.3	16.0
Electric.....	795	157	70	16,381	2,381	878	52.8	9.6	13.5
Other.....					3,925	162		15.7	2.5
Electric.....	1,509	726	195	28,091	12,994	2,230		100.0	100.0
Rented.....	795	157	70	16,185	2,381	878	57.6	18.3	39.4
Generated by establishments reporting.....	714	569	125	11,906	10,613	1,352	42.4	81.7	60.6

¹ Figures for horsepower include for 1909 the amount reported under the head of "Other" owned power.

² Not reported separately.

TABLE 45.—FUEL CONSUMED, BY STATES: 1919.

STATE.		COAL.		Coke (tons, 2,000 pounds).	Fuel oils (barrels).	Gasoline and other volatile oils (barrels).	Gas (1,000 cubic feet).
		Anthracite (tons, 2,240 pounds).	Bituminous (tons, 2,000 pounds).				
United States.....	1919..	52,865	259,615	6,663	179,466	250	196,953
	1914..	69,645	184,393	1,547	32,709	(¹)	283,952
California.....					114,696		11,643
Illinois.....			59,405		12,834		
New Jersey.....		39,168	14,752	35	34,355		
New York.....		13,368	5,956	11	2,091		
All other states.....		329	179,502	6,617	15,490	250	185,310

¹Included in figures for fuel oils.

SPECIAL STATISTICS.

Establishments.—The special statistics for sulphuric, nitric, and mixed acids are given in detail in the section of this report pertaining to chemicals in Tables 15 to 22, which include figures for the entire industry.

There were 39 establishments in 1919 and 32 in 1914 that manufactured these acids as their chief product.

Materials.—The consumption of sulphur, pyrite, and nitrate of soda in the manufacture of these acids was not reported separately. The total consumption

of these materials by all chemical establishments is given in Table 13 of the section on chemicals.

Products.—In the acid industry the total production of sulphuric acid in 1919, expressed in terms of 50° Baumé was 5,552,581 tons, compared with 4,071,566 tons in 1914, an increase of 36.4 per cent. The production of nitric acid in 1919 amounted to 86,992 tons, as compared with 78,589 tons in 1914, an increase of 10.7 per cent; and mixed acid to 114,886 tons in 1919 and 112,124 tons in 1914, an increase of 2.5 per cent.

MANUFACTURES.

GENERAL TABLES.

Comparative summary, by states.—Table 46 gives the comparative statistics for the principal items, number of establishments, average number of wage earners, primary horsepower, cost of materials, and

value of products, for the census years 1919, 1914, and 1909.

Detailed statement, by states.—Table 47 is a detailed statement, by states, for the census of 1919.

TABLE 46.—COMPARATIVE SUMMARY, BY STATES: 1919, 1914, AND 1909.

STATE.	Cen- sus year.	Num- ber of estab- lish- ments.	Wage earn- ers (aver- age num- ber).	Primary horse- power.	Wages. Cost of mate- rials. Value of prod- ucts.			STATE.	Cen- sus year.	Num- ber of estab- lish- ments.	Wage earn- ers (aver- age num- ber).	Primary horse- power.	Wages. Cost of mate- rials. Value of prod- ucts.			
					Expressed in thousands.								Expressed in thousands.			
United States.....	1919	39	4,961	30,637	\$7,917	\$15,857	\$31,470	All other states.....	1919	34	4,400	29,486	\$7,041	\$14,261	\$28,666	
	1914	32	3,064	24,927	2,213	6,734	15,215		1914	26	2,155	21,518	1,516	4,574	10,144	
	1909	42	2,252	6,494	1,495	5,386	9,884		1909	36	1,818	4,919	1,213	4,324	7,756	
New Jersey.....	1919	5	561	1,151	876	1,596	2,804									
	1914	6	909	3,409	697	2,160	5,071									
	1909	6	434	1,575	282	1,062	2,128									

TABLE 47.—DETAILED STATEMENT, BY STATES: 1919.

STATE.	Num- ber of estab- lish- ments	PERSONS ENGAGED IN THE INDUSTRY.								WAGE EARNERS DEC. 15, OR NEAREST REPRESENTATIVE DAY.				EXPENSES.				
		Total.	Pro- pri- etors and firm mem- bers.	Sala- ried off- cers, super- inten- dents, and man- agers.	Clerks, etc.		Wage earners.			Total.	16 and over.		Under 16.	Capital.	Salaries and wages.			
					Male.	Fe- male.	Aver- age num- ber.	Number, 15th day of—			Male.	Fe- male.			Male.	Fe- male.	Officials.	Clerks, etc.
								Maximum month.	Minimum month.									
United States.....	39	5,860	.....	294	407	198	4,961	De	5,764	Jy	4,331	5,890	5,862	26	2	\$51,160,004	\$1,247,633	\$931,894
California.....	4	708	.....	40	63	29	570	Fe	670	No	494	498	497	1	.....	6,183,172	201,607	146,029
Illinois.....	3	1,032	.....	32	81	44	875	Oc	1,008	Ap	711	920	918	2	.....	7,577,182	182,464	181,271
New Jersey.....	5	621	.....	24	30	6	561	Ja	600	Je	534	575	574	1	.....	4,516,783	75,118	71,275
New York.....	3	468	.....	31	23	16	398	De	442	Jy	352	440	437	2	1	3,038,642	120,063	65,635
All other states ¹	21	3,031	.....	167	210	103	2,551	.....	.....	.....	.....	3,457	3,436	21	.....	29,844,225	608,381	467,674

STATE.	EXPENSES—continued.							Value of products.	Value added by manufac- ture.	POWER.					
	Salaries and wages— Con.	For con- tract work.	Rent and taxes.		For materials.		Total.			Primary horsepower.				Elec- tric horse- power gen- erated in estab- lish- ments report- ing.	
			Wage earn- ers.	Rent of factory.	Taxes, Federal, state, county, and local.	Principal materials.				Fuel and rent of power.	Owned.				
											Steam en- gines (not tur- bines).	Steam tur- bines.	Inter- nal- com- bus- tion en- gines.		Water power. ²	Rented electric.
United States.....	\$7,916,531	\$47,867	\$47,396	\$1,024,209	\$13,735,042	\$2,122,319	\$31,470,480	\$15,613,119	30,637	8,737	3,935	1,755	25	16,185	11,906
California.....	1,053,015	7,612	.....	298,087	1,798,416	260,682	5,440,334	3,381,236	5,254	25	1,115	.....	.....	4,114	109
Illinois.....	1,478,766	.....	.....	168,506	1,898,106	329,839	6,056,584	2,528,639	6,056	1,970	.....	.....	.....	4,086	.....
New Jersey.....	875,409	.....	.....	123,949	1,265,504	329,951	2,803,976	1,208,221	1,151	639	320	.....	.....	102	566
New York.....	574,293	32,255	.....	15,470	1,128,164	128,149	2,670,210	1,415,897	1,366	125	.....	.....	25	1,216	.....
All other states ¹	3,935,048	8,000	47,396	418,107	7,644,552	1,075,698	15,499,376	6,779,126	16,810	5,978	2,500	1,755	.....	6,577	11,231

¹ All other states embrace: Alabama, 1 establishment; Arkansas, 1; Colorado, 2; Connecticut, 1; Delaware, 1; Kansas, 1; Louisiana, 1; Maryland, 1; Massachusetts, 1; Ohio, 5; Oklahoma, 1; Pennsylvania, 4; Tennessee, 1; Texas, 1; Utah, 1; and Virginia, 1.

² Includes water wheels and turbines (irrespective of ownership of water supply).

COAL-TAR PRODUCTS.

GENERAL STATISTICS.

At prior censuses the coal-tar industry has been carried as a group of the general chemical industry. Comparative figures, therefore, with respect to the general statistics are not available, as the establishments at the census of 1914 and prior censuses were included with other chemical establishments.

Principal states, ranked by value of products.—Table 48 presents certain general statistics, namely, number of establishments, average number of wage earners, value of products, and value added by manufacture for states, ranked according to value of products. In this and other tables certain states which are substantial producers of these products can not be shown separately and are included in the group of "All other states."

Persons engaged in the industry.—The age classification of the average number of wage earners in Table 49 is an estimate obtained by the method described in the "Explanation of terms." Figures for states will be found in Table 57.

Wage earners, by months.—The statistics for wage earners by months, Table 50, are intended to show the steadiness of employment, or the reverse, in accordance with the industrial conditions existing during the year. Females constituted but 3.5 per cent of the total number of wage earners employed.

Prevailing hours of labor.—Comparative figures are not available to show the movement toward shorter hours of labor, but the distribution of the wage earners by hour groups in this branch of the chemical industry is in harmony with conditions in other lines of chemical products. In 1919, as shown in Table 51, only 11.3 per cent of the total number of wage earners were employed in establishments where the prevailing hours of labor per week were 60 or over, the corresponding percentage in the general chemical industry being 13.9 per cent. In like manner 40.4 per cent of

the wage earners were employed in establishments operating on a basis of 48 hours per week or less in this branch of the industry, as compared with 38.4 per cent in the general chemical industry.

Size of establishments, by average number of wage earners.—Table 52 shows that the industry includes some large units. The average number of wage earners per establishment was 86, but 56.6 per cent of the wage earners were reported by 8 establishments, each of which employed in excess of 500 wage earners.

Size of establishments, by value of products.—The average value of products per establishment, Table 53, was \$740,000, as compared with \$734,000 for establishments in the general chemical industry. The group, "\$1,000,000 and over," carrying 14.2 per cent of the establishments, reported 76.1 per cent of the wage earners and 76.1 per cent of the value of products.

Character of ownership.—Table 54 presents the general statistics for the establishments, classified by character of ownership. Corporations embraced 91.8 per cent of the establishments and accounted for 98.9 per cent of the wage earners and the value of products.

Number and horsepower of types of prime movers.—Table 55 presents the statistics concerning power. Of the total primary power, 40.1 per cent was purchased power, and of the owned power the bulk of the capacity was utilized in electric generation. As a result 78.6 per cent of the primary power rated capacity is represented by electric-power equipment, either operated with purchased or rented current or with generated current.

Fuel consumed.—Table 56 presents the statistics for fuel, by kind and by states. The gas reported includes both natural and manufactured gas.

TABLE 48.—PRINCIPAL STATES, RANKED BY VALUE OF PRODUCTS: 1919.

STATE.	Number of establishments.	WAGE EARNERS.			VALUE OF PRODUCTS.			VALUE ADDED BY MANUFACTURE.		
		Average number.	Per cent distribution.	Rank.	Amount expressed in thousands.	Per cent distribution.	Rank.	Amount expressed in thousands.	Per cent distribution.	Rank.
United States.....	183	15,663	100.0	.....	\$135,482	100.0	.....	\$71,485	100.0	.....
New York.....	46	3,758	24.0	2	45,792	33.8	1	31,409	44.0	1
New Jersey.....	48	6,495	41.5	1	44,741	33.0	2	20,460	28.6	2
Ohio.....	15	834	5.3	4	9,495	7.0	3	4,105	5.8	3
Pennsylvania.....	19	1,333	8.5	3	9,492	7.0	4	3,253	4.6	5
Wisconsin.....	5	827	5.3	5	4,833	3.7	6	2,737	3.8	6
Massachusetts.....	8	444	2.8	7	3,957	3.0	7	1,435	2.1	7
Illinois.....	9	186	1.2	10	2,075	1.6	8	1,028	1.4	8
All other states.....	33	1,786	11.4	.....	14,947	11.0	.....	6,958	9.7	.....

MANUFACTURES.

TABLE 49.—PERSONS ENGAGED IN THE INDUSTRY: 1919.

CLASS.	Total.	Male.	Fe-male.	PER CENT OF TOTAL.		CLASS.	Total.	Male.	Fe-male.	PER CENT OF TOTAL.	
				Male.	Fe-male.					Male.	Fe-male.
All classes.....	21,543	19,813	1,730	92.0	7.0	Clerks and other subordinate salaried employees.....	4,096	2,931	1,165	71.5	28.5
Proprietors and officials.....	1,784	1,762	22	98.7	1.3	Wage earners (average number).....	15,063	15,120	543	96.5	3.5
Proprietors and firm members.....	26	23	3	88.5	11.5	16 years of age and over.....	15,637	15,107	530	96.6	3.4
Salaried officers of corporations.....	235	230	5	98.0	2.0	Under 16 years of age.....	26	13	13	50.0	50.0
Superintendents and managers.....	1,523	1,509	14	99.1	0.9						

TABLE 50.—WAGE EARNERS, BY MONTHS, FOR STATES: 1919.

[The month of maximum employment is indicated by bold-faced figures and that of minimum employment by *italic* figures.]

STATE.	Average number employed during year.	NUMBER EMPLOYED ON 15TH DAY OF MONTH OR NEAREST REPRESENTATIVE DAY.												Per cent minimum is of maximum.
		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
United States.....	15,663	15,967	15,323	14,695	14,511	14,539	14,699	14,501	15,827	16,365	16,760	17,082	17,887	80.0
Males.....	15,120	15,319	14,742	14,173	13,794	14,040	14,193	14,027	15,312	15,815	16,192	16,507	17,328	79.6
Females.....	543	648	581	522	717	499	506	474	515	550	568	575	561	73.1
Illinois.....	186	180	170	169	175	182	198	196	206	194	187	189	186	82.0
Massachusetts.....	444	399	407	396	371	433	422	440	456	480	495	524	535	63.4
New Jersey.....	6,495	6,084	5,689	5,822	6,155	6,459	6,487	5,970	6,943	7,010	7,017	7,118	7,278	78.8
New York.....	3,758	4,377	4,440	4,067	3,411	3,428	3,282	3,374	3,432	3,601	3,814	3,889	4,181	72.7
Ohio.....	834	858	924	811	711	739	711	768	822	906	914	890	916	77.0
Pennsylvania.....	1,333	1,650	1,414	1,058	986	1,005	1,106	1,267	1,345	1,398	1,562	1,584	1,621	60.0
Wisconsin.....	827	413	408	449	493	619	770	957	1,029	1,118	1,109	1,160	1,399	29.1

TABLE 51.—AVERAGE NUMBER OF WAGE EARNERS, BY PREVAILING HOURS OF LABOR PER WEEK, FOR SELECTED STATES: 1919.

STATE.	Total.	IN ESTABLISHMENTS WHERE THE PREVAILING HOURS OF LABOR PER WEEK WERE—							STATE.	Total.	IN ESTABLISHMENTS WHERE THE PREVAILING HOURS OF LABOR PER WEEK WERE—								
		44 and under.	Between 44 and 48.	48.	Between 48 and 54.	54.	Between 54 and 60.	60.			Over 60.	44 and under.	Between 44 and 48.	48.	Between 48 and 54.	54.	Between 54 and 60.	60.	Over 60.
United States.....	15,663	941	182	5,205	1,589	3,805	2,171	742	1,028	New York.....	3,758	871	26	134	449	1,545	544	97	38
Illinois.....	186	7	.....	12	30	54	83	.....	.....	Ohio.....	834	80	26	483	3	306	16	.....	.....
Massachusetts.....	444	.....	132	217	10	.....	85	.....	.....	Pennsylvania.....	1,333	24	38	136	651	37	62	15	370
New Jersey.....	6,495	21	4,300	254	677	956	228	59	.....	Wisconsin.....	827	.....	7	767	.....	49	.....	4	

TABLE 52.—SIZE OF ESTABLISHMENTS, BY AVERAGE NUMBER OF WAGE EARNERS, FOR SELECTED STATES: 1919

STATE.	TOTAL.		ESTABLISHMENTS EMPLOYING—																	
	Establishments.	Wage earners (average number).	No wage earners.		1 to 5 wage earners, inclusive.		6 to 20 wage earners, inclusive.		21 to 50 wage earners, inclusive.		51 to 100 wage earners, inclusive.		101 to 250 wage earners, inclusive.		251 to 500 wage earners, inclusive.		501 to 1,000 wage earners, inclusive.		Over 1,000 wage earners.	
			Establishments.	Wage earners.	Establishments.	Wage earners.	Establishments.	Wage earners.	Establishments.	Wage earners.	Establishments.	Wage earners.	Establishments.	Wage earners.	Establishments.	Wage earners.	Establishments.	Wage earners.	Establishments.	Wage earners.
United States.....	183	15,663	3	42	142	63	745	28	922	23	1,632	12	2,051	4	1,300	1	3,862	2	5,003	
Illinois.....	9	186	1	1	1	4	54	2	68	1	63	.....	.....	.....	.....	.....	.....	.....	.....
Massachusetts.....	8	444	1	1	4	3	30	.....	.....	2	143	2	267	.....	.....	.....	.....	.....	.....
New Jersey.....	48	6,495	.....	9	45	17	197	6	183	8	604	5	839	1	37	1	702	1	3,555
New York.....	46	3,758	.....	15	51	15	182	6	203	5	337	3	427	.....	.....	2	1,110	1	1,448
Ohio.....	15	834	.....	5	12	1	8	4	134	3	197	1	168	1	315	.....	.....	.....	.....
Pennsylvania.....	19	1,333	1	3	5	6	125	3	99	1	89	1	370	1	645	
Wisconsin.....	5	827	1	4	2	21	1	35	1	767	

COAL-TAR PRODUCTS.

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TABLE 53.—SIZE OF ESTABLISHMENTS, BY VALUE OF PRODUCTS: 1919.

VALUE OF PRODUCT.	Number of establishments.	Average number of wage earners.	Value of products.	Value added by manufacture.	VALUE OF PRODUCT.	Number of establishments.	Average number of wage earners.	Value of products.	Value added by manufacture.
All classes.....	183	15,663	\$135,482,161	\$71,485,427	Per cent distribution.....	100.0	100.0	100.0	100.0
Less than \$5,000.....	13	17	34,260	1,555	Less than \$5,000.....	7.1	0.1	(¹)	(¹)
\$5,000 to \$20,000.....	12	52	129,907	41,853	\$5,000 to \$20,000.....	0.6	0.5		0.1
\$20,000 to \$100,000.....	51	484	2,916,966	1,067,874	\$20,000 to \$100,000.....	27.8	3.1	0.1	1.5
\$100,000 to \$500,000.....	21	1,453	14,076,538	5,229,609	\$100,000 to \$500,000.....	11.5	9.3	10.4	7.3
\$500,000 to \$1,000,000.....	60	1,740	15,259,506	6,146,674	\$500,000 to \$1,000,000.....	32.8	11.1	11.3	8.6
\$1,000,000 and over.....	26	11,917	103,064,984	58,997,882	\$1,000,000 and over.....	14.2	76.1	76.1	82.5

¹ Less than one-tenth of 1 per cent.

TABLE 54.—CHARACTER OF OWNERSHIP: 1919.

CHARACTER OF OWNERSHIP.	Number of establishments.	Average number of wage earners.	Value of products.	CHARACTER OF OWNERSHIP.	Number of establishments.	Average number of wage earners.	Value of products.
Total.....	183	15,663	\$135,482,161	Per cent of total:			
Individual.....	9	70	397,313	Individual.....	4.9	0.5	0.3
Corporation.....	168	15,490	133,976,720	Corporation.....	91.8	98.9	98.9
All other.....	6	97	1,108,128	All other.....	3.3	0.6	0.8

TABLE 55.—NUMBER AND HORSEPOWER OF TYPES OF PRIME MOVERS: 1919.

POWER.	Number of engines or motors.	HORSEPOWER.		POWER.	Number of engines or motors.	HORSEPOWER.	
		Amount.	Per cent distribution.			Amount.	Per cent distribution.
Primary power, total.....	2,549	68,342	100.0	Primary power, total—Continued.			
Owned.....	387	40,963	59.9	Rented.....	2,162	27,379	40.1
Steam.....	373	40,698	59.6	Electric.....	2,162	27,376	4.01
Engines.....	334	24,310	35.6	Other.....		3	
Turbines.....	39	16,388	24.0	Electric.....	5,507	53,693	100.0
Internal-combustion engines.....	14	265	0.3	Rented.....	2,162	27,376	51.0
				Generated by establishments reporting.....	3,345	26,317	49.0

TABLE 56.—FUEL CONSUMED, BY STATES: 1919.

STATE.	COAL.		Coke (tons, 2,000 pounds).	Fuel oils (barrels).	Gasoline and other volatile oils (barrels).	Gas (1,000 cubic feet).
	Anthracite (tons, 2,240 pounds).	Bituminous (tons, 2,000 pounds).				
United States.....	62,582	721,982	16,855	142,029	1,647	148,004
Illinois.....	10	15,223		12	230	
Massachusetts.....	802	10,965	2,861		43	3,167
New Jersey.....	45,472	265,140	195	76,647	205	22,951
New York.....	11,603	188,783	153	9,620	855	39,345
Ohio.....	958	46,864		811		7,268
Pennsylvania.....	3,597	52,925	305	23,379	114	17,962
Wisconsin.....		35,267	10,409	743		2,000
All other states.....	140	108,815	2,932	30,817	200	55,311

MANUFACTURES.

SPECIAL STATISTICS.

Materials and products.—The value of the products reported for this branch of the chemical industry, \$135,482,161, is the value of all products reported by the 183 establishments engaged primarily in the manufacture of coal-tar products. In addition there

was a considerable production by establishments classified under other industries. A detailed presentation of products has been given in the section on chemicals, Group VII, coal-tar chemicals.

GENERAL TABLE.

Detailed statement, by states.—Table 57 is a detailed statement, by states, for the census of 1919.

TABLE 57.—DETAILED STATEMENT, BY STATES: 1919.

STATE.	Number of establishments	PERSONS ENGAGED IN THE INDUSTRY.								WAGE EARNERS DEC. 15, OR NEAREST REPRESENTATIVE DAY.				Capital.	EXPENSES.			
		Total.	Proprietors and firm members.	Salaried officers, superintendents, and managers.	Clerks, etc.		Wage earners.			Total.	16 and over.		Under 16.		Salaries and wages.			
					Male.	Female.	Average number.	Number, 15th day of—			Male.	Female.			Male.	Female.	Officials.	Clerks, etc.
								Maximum month.	Minimum month.									
United States...	183	21,543	26	1,758	2,931	1,165	15,663	De 17,887	Ap 14,311	18,569	17,901	548	16	14	\$174,991,835	\$6,540,404	\$5,292,665	
Illinois.....	9	260	2	35	24	13	186	Au 206	Mh 169	212	205	7	.....	.....	1,535,599	163,273	45,544
Massachusetts.....	8	631	1	43	110	36	444	De 535	Mh 366	535	533	1	.....	.....	3,718,016	279,755	162,005
New Jersey.....	48	8,659	1	820	872	471	6,495	De 7,276	Fe 5,580	7,339	7,334	50	2	7	59,092,719	2,796,262	1,848,202	
New York.....	46	5,752	10	421	1,202	361	3,758	Fe 4,440	My 3,228	4,345	3,900	372	11	2	57,269,971	2,089,807	2,193,871	
Ohio.....	15	944	2	62	23	23	834	Fe 924	Je 711	919	912	7	.....	.....	6,698,570	211,077	44,872
Pennsylvania.....	19	1,928	6	105	297	137	1,333	Ja 1,650	Ap 986	1,622	1,573	47	2	.....	20,225,455	340,449	374,155
Washington.....	3	36	1	8	.....	1	26	Au ¹ 55	Ja 18	21	21	.....	.....	.....	235,988	16,441	5,475
Wisconsin.....	5	1,064	.....	44	165	28	827	De 1,399	Fe 408	1,399	1,399	.....	.....	.....	5,747,053	235,727	339,830
All other states ²	30	2,256	3	160	232	95	1,760	.....	.....	2,117	2,054	58	.....	5	20,472,864	407,613	278,711

STATE.	EXPENSES—continued.							Value of products.	Value added by manufacture.	POWER.							
	Salaries and wages—Continued.	For contract work.	Rent and taxes.		For materials.		Total.			Primary horsepower.				Electric horsepower generated in establishments reporting.			
			Wage earners.	Rent of factory.	Taxes, Federal, state, county, and local.	Principal materials.				Fuel and rent of power.	Owned.	Rented.	Total.		Steam engines (not turbines).	Steam turbines.	Internal-combustion engines.
United States...	\$23,402,140	\$896,830	\$782,370	\$4,659,741	\$59,855,701	\$4,141,033	\$135,482,161	\$71,485,427	68,342	24,310	10,388	265	27,379	26,317			
Illinois.....	269,271	.....	15,456	79,517	991,398	55,741	2,075,368	1,028,229	637	205	.....	35	397	40	
Massachusetts.....	572,177	1,282	12,757	149,836	2,355,083	118,443	3,956,975	1,485,449	1,019	191	.....	12	816	88		
New Jersey.....	10,812,566	235,025	493,347	1,113,444	22,783,812	1,477,061	44,740,496	20,479,623	26,977	8,093	10,080	32	8,772	8,491			
New York.....	4,765,306	627,033	136,859	1,562,711	13,314,115	1,069,220	45,792,118	31,408,783	18,349	9,126	4,275	156	4,792	12,040			
Ohio.....	1,046,539	33,490	23,042	625,693	5,184,305	204,960	9,494,586	4,105,321	4,899	2,337	.....	30	2,482	1,606		
Pennsylvania.....	2,384,077	.....	31,325	214,820	5,777,822	431,863	9,492,331	3,282,646	8,010	1,208	533	.....	6,869	250	
Washington.....	23,373	.....	2,710	4,715	222,218	14,946	367,588	130,424	115	100	.....	.....	15	.....		
Wisconsin.....	1,418,698	.....	5,419	85,058	2,042,606	203,575	4,983,214	2,737,033	3,094	723	1,500	.....	871	1,800	
All other states ²	2,104,833	.....	61,455	982,887	7,184,342	567,224	14,579,485	6,827,919	4,642	2,277	.....	.....	2,365	2,002

¹ Same number reported for one or more other months.
² All other states comprise: Alabama, 2 establishments; California, 1; Connecticut, 2; District of Columbia, 1; Georgia, 1; Indiana, 1; Michigan, 4; Minnesota, 2; Missouri, 5; Rhode Island, 2; Tennessee, 2; Utah, 1; Virginia, 3; West Virginia, 3.

COKE.

GENERAL STATISTICS.

General character of the industry.—This industry embraces the establishments engaged primarily in the carbonization of coal, subdivided into (1) the plants equipped with ovens other than retort or by-product ovens, known as beehive ovens, and (2) those using retort or by-product ovens—with a recovery of the products of distillation. The statistics refer to the industry as a whole, except as otherwise stated. It does not include the coke products of the manufactured gas industry, known as gas-house coke, which will be found in the report on manufactured gas.

Comparative summary.—Table 1 presents the statistics for the census years 1899 to 1919 inclusive, with percentages of increase for the census periods, and Table 2 the general statistics for the industry and the two groups, A and B, for the census of 1919.

Principal states, ranked by value of products.—Table 3 shows the number of establishments, wage earners, value of products, and value added by manufacture, by states, ranked according to the value of products in 1919.

Persons engaged in the industry.—The age classification of the average number of wage earners in Table 4 is an estimate obtained by the method described in the "Explanation of terms". Figures for states will be found in Table 15.

Wage earners, by months.—The statistics for wage earners, Table 5, are intended to show the steadiness of employment, or the reverse, in accordance with the industrial condition existing during the year. The wage earners employed in the industry are essentially males. Only 8 females were reported.

Prevailing hours of labor.—The comparative statistics for 1919, 1914, and 1909 in Table 6 indicate a movement toward shorter hours of labor per week. In 1909, 64.3 per cent of the wage earners were employed in plants where the prevailing hours of labor per week were 60 or over, and in 1914, 52.1 per cent, while in 1919 this proportion dropped to 45.8 per cent. On the other hand, in 1919, 32.8 per cent were reported for establishments where the prevailing hours of labor were 48 per week or less, compared with 7.5 per cent in 1914 and 6.8 per cent in 1909.

Size of establishments, by average number of wage earners.—The industry is one of relatively large units, the average number of wage earners per establishment being 106 in 1919 and 91 in 1914. In 1919, as

shown in Table 7, 10 establishments each employed over 500 wage earners, 33.5 per cent of the total number of wage earners, as compared with 5 establishments which employed 23.8 per cent in 1914.

Size of establishments, by value of products.—The classification by value of products in Table 8 necessarily reflects the general increase in values. The average value of products per establishment increased from \$304,000 in 1909 to \$430,000 in 1914 and to \$1,139,000 in 1919, but the increase in 1919 is due primarily to high prices, for on a quantity basis the production of coke in 1919 was but 28 per cent greater than in 1914 and the wage earners employed were but 39 per cent more than in 1914.

Table 9 shows the distribution of the establishments by value of products for the two industry groups, in 1919. The smaller value groups are confined to the beehive oven group. The average value of products per establishment for this group was \$505,000 and for the by-product oven group \$3,650,000.

Character of ownership.—Table 10 presents the statistics for establishments classified according to form of ownership. The corporation group employed 97.8 per cent of the wage earners and accounted for the same proportion of the value of products, a slight increase over the percentages for 1914, and the latter were in like manner slightly greater than the percentages for 1909. The 20 individual establishments and the 7 "All others" are beehive oven plants.

Number and horsepower of types of prime movers.—Table 11 presents the power statistics for the establishments. Electric power is employed very extensively, either purchased from hydroelectric companies or from other sources of supply, or generated at the plants. Of the total primary power, 93 per cent was utilized in the form of electric power in 1919, this including electric motor equipment operated with purchased current, specified as rented, and secondary electric or that generated by the establishment. In 1914 the ratio of total electric power to primary power was 73.5 per cent, and in 1909 it was 65.6 per cent.

Fuel consumed.—Table 12 presents the statistics for fuel, by kinds and by states. The figures for bituminous coal include the coal charged into the ovens and used as material, as well as that otherwise used at the plants.

TABLE 1.—COMPARATIVE SUMMARY: 1919, 1914, 1909, 1904, AND 1899.

	1919	1914	1909	1904	1899	PER CENT OF INCREASE, ¹			
						1914-1919	1909-1914	1904-1909	1899-1904
Number of establishments.....	278	231	315	278	241	20.3	-26.7	13.3	15.4
Persons engaged.....	32,882	23,463	31,226	20,440	17,062	40.1	-24.0	52.8	13.8
Proprietors and firm members.....	41	36	101	73	48	51.8	25.3	33.0	51.5
Salaried employees.....	3,522	2,320	1,852	1,386	915	38.9	27.9	54.2	11.7
Wage earners (average number).....	29,319	21,107	29,273	18,981	10,999				
Primary horsepower.....	224,870	120,327	62,002	66,669	34,767	02.0	87.1	-6.1	91.8
Capital.....	\$365,249,622	\$161,561,449	\$152,321,337	\$90,712,877	\$36,502,670	126.0	6.1	67.9	140.0
Salaries and wages.....	49,905,077	16,945,929	17,526,495	10,552,000	7,883,032	105.0	-3.3	66.1	33.7
Salaries.....	7,605,785	2,656,977	2,072,150	1,247,502	797,296	180.0	28.2	66.1	56.5
Wages.....	42,299,292	14,288,952	15,454,345	9,304,498	7,085,736	106.0	-7.5	66.1	31.3
Paid for contract work.....	81,127	.....	17,929	2,090	56,596				
Rent and taxes.....	9,302,264	1,746,308	579,827	515,369	428,774	433.0	.....	.....	.....
Cost of materials.....	224,266,674	69,138,328	64,024,527	29,884,532	19,065,032	224.0	8.0	114.0	62.0
Value of products.....	316,515,838	99,275,020	95,696,622	51,728,647	35,585,445	219.0	3.7	85.0	45.4
Value added by manufacture ²	92,249,164	30,136,692	31,672,005	21,844,115	15,919,913	206.0	-4.8	45.0	37.2

¹ A minus sign (-) denotes decrease.

² Exclusive of internal revenue.

³ Value of products less cost of materials.

TABLE 2.—THE COKE INDUSTRY, BY INDUSTRY GROUPS: 1919.

	Total for the industry.	Group A—Ovens other than by-product ovens (beehive).	Group B—By-product ovens.	PER CENT OF TOTAL.		Total for the industry.	Group A—Ovens other than by-product ovens (beehive).	Group B—By-product ovens.	PER CENT OF TOTAL.		
				A	B				A	B	
				Number of establishments.....	278				222	56	79.8	20.2	Salaries and wages.....	$49,905,077	$19,010,501	$30,894,576	38.1	61.9
Persons engaged.....	32,882	15,140	17,742	46.0	54.0	Salaries.....	7,605,785	2,771,731	4,834,054	36.4	63.6
Proprietors and firm members.....	41	41	.....	100.0	.....	Wages.....	42,299,292	16,238,770	26,060,522	38.4	61.6
Salaried employees.....	3,522	1,333	2,189	37.8	62.2	Paid for contract work.....	81,127	6,918	74,209	8.5	91.5
Wage earners (av. number).....	29,319	13,760	15,553	47.0	53.0	Rent and taxes.....	9,302,264	2,657,542	6,644,722	28.6	71.4
Primary horsepower.....	224,879	30,761	185,118	17.7	82.3	Cost of materials.....	224,266,674	78,155,895	146,110,779	34.8	65.2
Capital.....	\$365,249,622	\$137,906,875	\$227,342,747	37.8	62.2	Value of products.....	316,515,838	112,023,466	204,492,372	35.4	64.6
						Value added by manufacture ¹	92,249,164	33,807,571	58,381,593	30.7	69.3

¹ Value of products less cost of materials.

TABLE 3.—PRINCIPAL STATES, RANKED BY VALUE OF PRODUCTS: 1919.

STATE.	Number of establishments.	WAGE EARNERS.			VALUE OF PRODUCTS.			VALUE ADDED BY MANUFACTURE.			STATE.	Number of establishments.	WAGE EARNERS.			VALUE OF PRODUCTS.			VALUE ADDED BY MANUFACTURE.		
		Average number.	Per cent. distribution.	Rank.	Amount (expressed in thousands).	Per cent. distribution.	Rank.	Amount (expressed in thousands).	Per cent. distribution.	Rank.			Average number.	Per cent. distribution.	Rank.	Amount (expressed in thousands).	Per cent. distribution.	Rank.	Amount (expressed in thousands).	Per cent. distribution.	Rank.
United States..	278	29,319	100.0	....	\$316,516	100.0	....	\$92,249	100.0	....	New York.....	3	643	2.2	10	\$7,213	2.3	10	\$2,097	2.3	9
Pennsylvania.....	123	11,536	39.3	1	119,730	37.8	1	39,377	42.7	1	Minnesota.....	3	426	1.5	13	6,469	2.1	11	1,497	1.6	13
Ohio.....	13	3,407	11.6	3	46,514	14.7	2	13,342	14.5	2	Virginia.....	13	849	2.9	7	5,524	1.7	13	1,580	1.7	12
Alabama.....	26	5,533	12.1	2	24,669	7.8	3	6,041	6.5	3	Kentucky.....	4	568	1.9	12	4,453	1.4	15	974	1.1	14
Illinois.....	4	1,396	4.8	5	16,837	5.3	4	4,209	4.6	4	Tennessee.....	6	272	0.9	15	2,017	0.6	17	553	0.6	17
West Virginia.....	57	1,283	4.4	6	8,369	2.6	5	2,331	2.5	7	All other states ¹	24	5,406	18.4	.....	74,721	23.6	.....	20,239	21.9	.....

¹ Includes Indiana, rank 3, according to value of products; Wisconsin, rank 6; and New Jersey, rank 7.

TABLE 4.—PERSONS ENGAGED IN THE INDUSTRY: 1919, 1914, AND 1909.

CLASS.	Census year.	Total.	Male.	Female.	PER CENT OF TOTAL.		CLASS.	Census year.	Total.	Male.	Female.	PER CENT OF TOTAL.	
					Male.	Female.						Male.	Female.
All classes.....	1919	32,882	32,460	422	98.7	1.3	Clerks and other subordinate salaried employees.	1919	2,478	2,068	410	83.5	16.5
	1914	23,463	23,254	209	99.1	0.9		1914	1,746	1,540	206	88.2	11.8
	1909	31,226	31,112	114	99.6	0.4		1909	1,139	1,037	102	91.0	9.0
Proprietors and officials.....	1919	1,085	1,080	5	99.5	0.5	Wage earners (average number).....	1919	29,319	29,311	8	.....	(1)
	1914	610	610	.....	100.0	100.0		1914	21,107	21,104	3	.....	(1)
	1909	814	807	7	99.1	0.9		1909	29,273	29,268	5	.....	(1)
Proprietors and firm members.....	1919	41	40	1	97.6	2.4	16 years of age and over.....	1919	28,909	28,901	8	.....	(1)
	1914	36	36	.....	100.0	.....		1914	20,988	20,985	3	.....	(1)
	1909	101	96	5	95.0	5.0		1909	29,187	29,182	5	.....	(1)
Salaried officers of corporations....	1919	165	161	4	97.6	2.4	Under 16 years of age.....	1919	410	410	.....	100.0	.....
	1914	149	149	.....	100.0	.....		1914	119	119	.....	100.0	.....
	1909	174	172	2	98.8	1.2		1909	88	86	.....	100.0	.....
Superintendents and managers....	1919	879	870	.....	100.0	.....						
	1914	425	425	.....	100.0	.....						
	1909	530	530	.....	100.0	.....						

¹ Less than one-tenth of 1 per cent.

TABLE 5.—WAGE EARNERS, BY MONTHS, FOR STATES: 1919.

[The month of maximum employment is indicated by bold-faced figures and that of minimum employment by *italic* figures.]

STATE.	Average number employed during year.	NUMBER EMPLOYED ON 15TH DAY OF THE MONTH OR NEAREST REPRESENTATIVE DAY.												Per cent minimum is of maximum.
		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
United States:														
1919.....	29,319	34,557	32,159	30,479	28,452	26,579	<i>26,434</i>	27,917	30,418	30,378	26,817	28,186	29,452	76.5
Other than by-product ovens.....	13,766	16,686	15,579	14,658	13,012	11,778	11,810	12,584	13,704	14,057	13,847	13,390	14,087	70.6
By-product ovens.....	15,553	17,871	16,580	15,821	15,440	14,801	14,624	15,333	16,714	16,321	<i>12,970</i>	14,796	15,365	72.5
1914.....	21,107	22,339	22,845	24,205	23,257	22,072	21,476	21,886	20,759	20,255	19,077	17,903	17,710	73.2
1909.....	29,273	27,668	27,121	27,003	<i>26,461</i>	27,022	28,301	29,106	29,475	30,852	32,390	32,789	33,094	80.0
Alabama.....	3,533	3,773	3,785	3,545	3,511	3,297	<i>3,000</i>	3,202	3,545	3,876	3,785	3,573	3,424	77.4
Illinois.....	1,396	1,625	1,467	1,345	1,338	1,382	1,480	1,508	1,554	1,388	<i>710</i>	1,354	1,601	43.7
Kentucky.....	508	667	591	552	487	547	580	547	537	562	591	591	564	73.0
Minnesota.....	426	469	429	428	412	416	367	401	377	425	450	455	483	78.1
New York.....	643	898	731	727	780	606	612	676	665	613	<i>447</i>	488	473	52.7
Ohio.....	3,407	4,257	3,838	3,647	3,575	3,242	3,474	3,533	3,555	3,416	<i>2,256</i>	2,961	3,130	53.0
Pennsylvania.....	11,536	13,293	12,367	10,947	10,888	10,120	<i>9,859</i>	10,828	12,374	12,077	11,243	11,314	12,122	76.1
Tennessee.....	272	362	359	338	265	105	242	250	275	294	309	170	235	45.6
Virginia.....	849	929	907	870	797	774	845	794	821	840	826	803	892	83.3
West Virginia.....	1,283	2,073	1,947	1,572	1,219	1,082	1,075	1,022	1,260	1,248	916	<i>808</i>	1,076	43.7

TABLE 6.—AVERAGE NUMBER OF WAGE EARNERS, BY PREVAILING HOURS OF LABOR PER WEEK, FOR STATES: 1919 AND 1914.

STATE.	Total.	IN ESTABLISHMENTS WHERE THE PREVAILING HOURS OF LABOR PER WEEK WERE—							STATE.	Total.	IN ESTABLISHMENTS WHERE THE PREVAILING HOURS OF LABOR PER WEEK WERE—							
		44 and under.	Between 44 and 48.	48.	Between 48 and 54.	54.	Between 54 and 60.	60.			Over 60.	44 and under.	Between 44 and 48.	48.	Between 48 and 54.	54.	Between 54 and 60.	60.
United States.. 1919..	29,319	342	17	9,250	112	1,854	4,307	2,010	11,427	Minnesota.....	426	.....	.....	.....	.....	.....	.....	426
1914.....	21,107	(2)	(2)	1,582	86	6,637	1,809	4,762	6,231	New York.....	643	.....	.....	.....	.....	.....	.....	643
1909.....	29,273	(2)	(2)	1,987	359	7,965	1,149	11,629	7,184	Ohio.....	3,407	.....	.....	.....	.....	1,094	.....	2,313
Alabama.....	3,533	.....	.....	181	.....	.....	277	1,122	1,953	Pennsylvania.....	11,536	232	15	5,816	109	1,157	95	370
Illinois.....	1,396	.....	.....	28	.....	.....	1,036	.....	332	Tennessee.....	272	.....	.....	53	77	.....	35	107
Kentucky.....	508	55	.....	25	.....	94	304	.....	.....	Virginia.....	849	32	.....	706	.....	46	.....	15
										West Virginia.....	1,283	23	2	568	3	211	.....	160

¹ Includes 48 and under for 1914 and 1909.

² Corresponding figures not available.

MANUFACTURES.

TABLE 7.—SIZE OF ESTABLISHMENTS, BY AVERAGE NUMBER OF WAGE EARNERS, FOR STATES: 1919.

STATE.	TOTAL.		ESTABLISHMENTS EMPLOYING—																	
	Estab-lish-ments.	Wage earners (average number).	No wage earners.		1 to 5 wage earners, inclusive.		6 to 20 wage earners, inclusive.		21 to 50 wage earners, inclusive.		51 to 100 wage earners, inclusive.		101 to 250 wage earners, inclusive.		251 to 500 wage earners, inclusive.		501 to 1,000 wage earners, inclusive.		Over 1,000 wage earners.	
			Estab-lish-ments.	Wage earners.	Estab-lish-ments.	Wage earners.	Estab-lish-ments.	Wage earners.	Estab-lish-ments.	Wage earners.	Estab-lish-ments.	Wage earners.	Estab-lish-ments.	Wage earners.	Estab-lish-ments.	Wage earners.	Estab-lish-ments.	Wage earners.	Estab-lish-ments.	Wage earners.
United States 1919..	278	29,319	2	48	145	64	818	56	1,900	35	2,574	44	6,965	19	7,076	5	3,017	5	6,818	
1914..	231	21,107	.....	15	76	52	603	75	2,417	39	2,689	20	4,660	16	5,040	4	2,483	1	2,533
Alabama.....	28	3,533	.....	3	5	6	94	8	239	5	398	2	368	3	1,352	.....	.....	.....	.....
Illinois.....	4	1,396	.....	.....	.....	.....	.....	1	28	.....	.....	1	179	1	332	1	857	.....	1
Kentucky.....	4	568	.....	.....	.....	.....	.....	1	25	2	149	.....	.....	1	394	.....	.....	.....	.....
Minnesota.....	3	426	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	335	.....	.....	.....	.....	.....	.....
New York.....	3	643	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	119	2	524	.....	.....	.....	.....
Ohio.....	13	3,407	.....	.....	.....	.....	.....	.....	.....	3	214	4	745	5	1,944	1	504	.....	.....
Pennsylvania.....	123	11,536	1	24	78	32	426	25	897	17	1,232	16	2,476	5	1,701	.....	.....	3	4,726
Tennessee.....	6	272	.....	.....	.....	2	17	2	71	1	77	1	107	.....	.....	.....	.....	.....	.....
Virginia.....	13	849	.....	1	2	1	13	6	210	2	145	3	479	.....	.....	.....	.....	.....	.....
West Virginia.....	57	1,283	.....	20	60	21	248	11	359	2	136	3	480	.....	.....	.....	.....	.....	.....

TABLE 8.—SIZE OF ESTABLISHMENTS, BY VALUE OF PRODUCTS: 1919, 1914, AND 1909.

VALUE OF PRODUCT.	NUMBER OF ESTABLISHMENTS.			AVERAGE NUMBER OF WAGE EARNERS.			VALUE OF PRODUCTS.			VALUE ADDED BY MANUFACTURE.		
	1919	1914	1909	1919	1914	1909	1919	1914	1909	1919	1914	1909
All classes.....	278	231	315	29,319	21,107	29,273	\$316,515,838	\$99,275,020	\$95,696,022	\$92,249,164	\$30,136,692	\$31,672,095
Less than \$5,000.....	6	7	11	5	20	23	19,122	20,037	21,286	5,873	7,235	2,566
\$5,000 to \$20,000.....	31	18	40	93	129	530	387,294	238,346	1,262,249	129,838	89,853	393,912
\$20,000 to \$100,000.....	58	91	127	663	2,188	3,524	3,180,636	4,578,995	6,780,743	1,014,412	1,652,329	2,143,327
\$100,000 to \$500,000.....	80	70	120	2,545	8,045	13,460	19,048,517	16,074,023	36,845,740	5,288,741	9,119,321	10,901,357
\$500,000 to \$1,000,000.....	34	22	.....	3,462	.....	.....	25,206,933	14,211,972	.....	7,144,521	.....	.....
\$1,000,000 and over.....	69	23	17	22,551	10,725	11,736	268,673,336	64,151,647	50,789,598	78,665,779	19,267,954	18,230,933
PER CENT DISTRIBUTION.												
All classes.....	100.0	100.0	100.0	100.0	.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than \$5,000.....	2.2	3.0	3.5	(1)	(1)	0.1	(1)	(1)	(1)	1.3	(1)	(1)
\$5,000 to \$20,000.....	11.2	7.8	12.7	0.3	0.6	1.8	0.1	0.2	1.3	0.1	0.3	1.2
\$20,000 to \$100,000.....	20.9	39.4	40.3	2.3	9.3	12.0	1.0	4.7	7.1	1.1	5.5	0.8
\$100,000 to \$500,000.....	28.8	30.3	.....	8.7	34.3	46.0	6.0	16.2	38.5	5.7	30.3	34.4
\$500,000 to \$1,000,000.....	12.2	9.5	38.1	11.8	.....	.....	8.0	14.3	.....	7.7	.....	.....
\$1,000,000 and over.....	24.8	10.0	5.4	76.9	45.7	40.1	84.9	64.6	53.1	85.3	63.9	57.6

¹ Less than one-tenth of 1 per cent.

TABLE 9.—SIZE OF ESTABLISHMENTS, BY VALUE OF PRODUCTS, BY INDUSTRY GROUPS: 1919.

INDUSTRY AND VALUE OF PRODUCT.	Number of establishments	WAGE EARNERS.		VALUE OF PRODUCTS.		VALUE ADDED BY MANUFACTURE.		INDUSTRY AND VALUE OF PRODUCT.	Number of establishments	WAGE EARNERS.		VALUE OF PRODUCTS.		VALUE ADDED BY MANUFACTURE.	
		Average number.	Per cent of total.	Amount.	Per cent of total.	Amount.	Per cent of total.			Amount.	Per cent of total.	Amount.	Per cent of total.		
The coke industry.	278	29,319	100.0	\$316,515,838	100.0	\$92,249,164	100.0	Other than by-product ovens (beehive)—Continued.	.....	.....	.....	.....	.....	.....
Less than \$5,000.....	6	5	(1)	19,122	(1)	5,873	(1)	\$100,000 to \$500,000.....	73	2,435	17.7	\$18,081,640	16.1	\$5,082,314	15.0
\$5,000 to \$20,000.....	31	93	0.3	387,294	0.1	129,838	0.1	\$500,000 to \$1,000,000.....	30	3,087	22.4	22,253,566	19.9	6,321,243	18.7
\$20,000 to \$100,000.....	58	663	2.3	3,180,636	1.0	1,014,412	1.1	\$1,000,000 and over.....	23	7,539	54.8	68,262,994	60.0	21,358,526	63.1
\$100,000 to \$500,000.....	80	2,545	8.7	19,048,517	6.0	5,288,741	5.7	By-product ovens.....	56	15,553	100.0	204,492,372	100.0	58,381,593	100.0
\$500,000 to \$1,000,000.....	34	3,462	11.8	25,206,933	8.0	7,144,521	7.7	Less than \$5,000.....	.....	.....	.....	.....	.....	.....
\$1,000,000 and over.....	69	22,551	76.9	268,673,336	84.9	78,665,779	85.3	\$5,000 to \$20,000.....	2	56	0.4	161,756	0.1	44,635	0.1
Other than by-product ovens (beehive).	222	13,766	100.0	112,023,466	100.0	33,867,571	100.0	\$20,000 to \$100,000.....	4	110	0.7	993,877	0.5	206,427	0.4
Less than \$5,000.....	6	5	(1)	19,122	(1)	5,873	(1)	\$100,000 to \$500,000.....	4	375	2.4	2,953,367	1.4	823,278	1.4
\$5,000 to \$20,000.....	31	93	0.7	387,294	0.3	129,838	0.4	\$500,000 to \$1,000,000.....	4	15,012	96.5	200,410,372	98.0	57,307,258	98.2
\$20,000 to \$100,000.....	56	607	4.4	3,018,880	2.7	969,777	2.9	\$1,000,000 and over.....	46	.....	.....	.....	.....	.....

¹ Less than one-tenth of 1 per cent.

TABLE 10.—CHARACTER OF OWNERSHIP: 1919, 1914, AND 1909.

INDUSTRY AND STATE.	NUMBER OF ESTABLISHMENTS OWNED BY—			AVERAGE NUMBER OF WAGE EARNERS.						VALUE OF PRODUCTS.									
	Indi-vid-u-als.	Cor-pora-tions.	All oth-ers.	Total.	In establishments owned by—			Per cent of total.			Total.	Of establishments owned by—			Per cent of total.				
					Indi-vid-u-als.	Cor-pora-tions.	All oth-ers.	Indi-vid-u-als.	Cor-pora-tions.	All oth-ers.		Indi-vid-u-als.	Cor-pora-tions.	All oth-ers.	Indi-vid-u-als.	Cor-pora-tions.	All oth-ers.		
United States:																			
1919.....	20	251	7	29,319	507	28,064	148	1.7	97.8	0.5	\$316,515,838	\$0,037,170	\$309,441,015	\$1,037,653	1.9	97.8	0.3		
Other than by-product ovens (beehive).....	20	195	7	13,766	507	13,111	148	3.7	95.2	1.1	112,023,466	6,037,170	104,948,643	1,037,653	5.4	93.7	0.9		
By-product ovens.....		56		15,553		15,553		100.0		204,492,372		204,492,372		100.0					
1914.....	19	205	7	21,107	503	20,433	171	2.4	96.8	0.8	99,275,000	2,998,000	95,659,000	618,000	3.0	96.4	0.6		
1909.....	21	277	7	29,273	1,241	27,470	592	4.2	93.8	2.0	95,696,622	3,158,168	91,280,407	1,258,047	3.3	95.4	1.3		
Pennsylvania.....	17	99	7	11,536	494	10,894	148	4.3	94.4	1.3	119,730,689	5,975,411	112,717,525	1,037,653	4.0	94.2	1.8		
Other than by-product ovens (beehive).....	17	88	7	7,969	491	7,327	148	6.2	91.9	1.0	70,169,342	5,075,411	63,158,278	1,037,653	8.5	91.0	1.5		
By-product ovens.....		11		3,567		3,567		100.0		49,561,247		49,561,247		10.0					
All other states.....	3	152		17,783	13	17,770		0.1	99.9		109,785,249	61,759	196,723,490		0.3	99.7			
Other than by-product ovens (beehive).....	3	107		5,797	13	5,784		0.2	99.8		41,854,124	61,759	41,792,365		0.1	99.9			
By-product ovens.....		45		11,986		11,986		100.0		154,931,125		154,931,125		100.0					

TABLE 11.—NUMBER AND HORSEPOWER OF TYPES OF PRIME MOVERS: 1919, 1914, AND 1909.

POWER.	NUMBER OF ENGINES OR MOTORS.			HORSEPOWER.					
	1910	1914	1909	Amount.			Per cent distribution.		
				1919	1914	1909	1919	1914	1909
Primary power, total.....	2,897	1,766	1,002	224,879	120,327	62,602	100.0	100.0	100.0
Owned.....	947	755	496	150,328	82,687	47,903	66.8	67.9	76.6
Steam.....	941	743	486	148,478	80,567	44,591	66.0	66.1	71.2
Engines.....	786	(2)	(2)	75,256	(2)	(2)	33.5		
Turbines.....	155	(2)	(2)	73,222	(2)	(2)	32.6		
Internal-combustion engines.....	6	12	6	1,850	2,120	1,212	0.8	1.8	1.9
Water wheels, turbines, and motors.....			4			500			00.8
Rented, electric.....	1,950	1,011	506	74,551	37,640	14,699	33.2	32.1	23.4
Electric.....	5,919	2,735	1,538	209,163	88,409	41,064	100.0	100.0	100.0
Rented.....	1,950	1,011	506	74,551	37,640	13,754	35.6	42.6	33.5
Generated by establishments reporting.....	3,969	1,724	1,032	134,612	50,769	27,310	64.4	57.4	66.5

¹ Figures for horsepower include for 1909 the amount reported under the head of "Other" owned power.

² Not reported separately.

³ Includes 885 of "Other" rented power.

TABLE 12.—FUEL CONSUMED, BY STATES: 1919.

STATE.	COAL.		Coke (tons, 2,000 pounds).	Fuel oils (barrels).	Gasoline and other volatile oils (barrels).	Gas (1,000 cubic feet).
	Anthracite (tons, 2,240 pounds).	Bituminous (tons, 2,000 pounds).				
United States:						
1919.....	5,808	64,245,629	560,505	15,211	92,682	658,600
Ovens other than by-product ovens (beehive).....	2,231	30,639,638	187,249		80,349	6,175
By-product ovens.....	3,577	33,605,991	373,256	15,211	3,333	652,515
1914.....		50,457,454				
Alabama.....		5,281,552	45,041			
Illinois.....		2,457,626		8,086		
Kentucky.....		870,773				
Minnesota.....		849,288				2,288
New York.....		1,046,991	466	408		2,306
Ohio.....		7,995,889	53			37,951
Pennsylvania.....	5,308	30,512,831	500,182	6,717	3,333	606,885
Tennessee.....		447,003				
Virginia.....		1,482,814				
West Virginia.....		2,242,720				
All other states.....	500	11,082,142	14,773		89,337	9,200

SPECIAL STATISTICS.

Products.—Table 13 presents comparative statistics for products for 1919, 1914, and 1909, including figures for coking coal consumption. The products as compiled and reported by the Geological Survey represent total production inclusive of subsidiary coke and coke-oven by-products produced by establish-

ments not engaged primarily in the manufacture of coke, and exceed in the aggregate the value of the products reported for the establishments constituting the classified industry, to the amount of \$5,540,870 in 1919, \$6,338,285 in 1914, and \$2,381,761 in 1909.

TABLE 13.—PRODUCTS:¹ 1919, 1914, AND 1909.

[Tons, 2,000 pounds.]

	1919	1914	1909		1919	1914	1909
COAL.				PRODUCTS—continued.			
Coal used for coking, all establishments, tons.....	65,587,918	51,623,750	59,354,937	By-products from retort or by-product ovens:			
PRODUCTS.				Gas—			
The classified industry (establishments engaged primarily in the manufacture of coke), all products, value.....	\$316,515,838	\$99,275,020	\$95,606,622	Production, M cubic feet.....	415,642,265		
Coke and coking by-products, all establishments including subsidiary coke products of establishments in other industries, value ¹	\$322,056,708	\$105,863,305	\$98,078,383	Sales—			
Coke:				M cubic feet.....	103,073,970	61,364,375	15,701,220
Tons.....	44,180,557	34,555,914	30,315,065	Illuminating and household purposes.....	5,238,480		
Value.....	\$258,339,740	\$88,334,217	\$89,965,483	Industrial purposes.....	138,179,761		
Made in—				To public service corporations.....	49,655,732		
Beehive ovens—				Value.....	\$16,685,007	\$6,009,583	\$2,609,211
Tons.....	10,042,936	23,335,971	33,060,421	Tar—			
Value.....	\$98,094,972	\$50,254,050	\$69,530,794	Production, gallons.....	288,808,764		
Retort or by-product ovens—				Sales—			
Tons.....	25,137,621	11,219,943	6,254,644	Gallons.....	217,980,143	109,901,315	60,126,006
Value.....	\$160,244,768	\$38,080,107	\$20,434,689	Value.....	\$9,919,265	\$2,867,274	\$1,408,611
				Ammonia (sales)—			
				Sulphate—			
				Pounds.....	557,619,631	170,763,906	
				Value.....	\$21,075,718	\$4,696,590	
				Anhydrous or free ammonia ² —			
				Pounds.....	51,646,744		\$3,075,771
				Value.....	\$5,692,950	\$2,958,634	
				Benzol products (sales), value.....	\$12,078,886		
				Other coking products, value.....	\$965,142	\$997,007	\$419,307

¹ From report of Geological Survey.

² Includes liquor and sulphate sold on pound basis NIIa.

GENERAL TABLES.

Comparative summary, by states.—Table 14 gives comparative statistics for the principal items, number of establishments, average number of wage earners, primary horsepower, wages, cost of materials, and

value of products for the census years 1919, 1914, and 1909.

Detailed statement, by states.—Table 15 is a detailed statement, by states, for the census of 1919.

TABLE 14.—COMPARATIVE SUMMARY, BY STATES: 1919, 1914, AND 1909.

STATE.	Cen-sus year.	Num-ber of estab-lish-ments	Wage earners (aver-age num-ber).	Primary horse-power.	Wages. Cost of mate-rials. Value of prod-ucts.			STATE.	Cen-sus year.	Num-ber of estab-lish-ments	Wage earners (aver-age num-ber).	Primary horse-power.	Wages. Cost of mate-rials. Value of prod-ucts.		
					Expressed in thousands.								Expressed in thousands.		
All industries.....	1919	278	29,319	224,870	\$42,299	\$224,267	\$316,516	Pennsylvania.....	1919	123	11,536	72,752	\$15,654	\$90,354	\$119,730
	1914	231	21,107	120,327	14,280	69,138	99,275		1914	108	9,871	36,213	6,635	29,820	42,996
	1909	315	29,273	62,602	15,454	64,025	95,697		1909	146	15,331	20,091	8,436	33,762	51,816
Alabama.....	1919	28	3,533	13,147	3,484	18,628	24,669	Tennessee.....	1919	6	272	2,345	260	1,464	2,017
	1914	18	2,209	11,728	1,261	7,363	10,353		1914	5	170	493	74	513	605
	1909	35	2,560	5,766	1,283	6,371	8,843		1909	8	250	370	87	478	586
Illinois.....	1919	4	1,366	9,015	2,400	12,628	16,837	Virginia.....	1919	13	840	1,243	1,084	3,935	5,524
	1914	3	1,178	13,054	942	5,828	7,840		1914	11	852	2,057	384	1,070	1,607
	1909	4	1,178	13,054	942	5,828	7,840		1909	16	1,425	1,700	543	1,818	2,416
Kentucky.....	1919	4	568	3,308	760	3,470	4,453	West Virginia.....	1919	57	1,283	9,493	1,420	6,037	8,369
	1914	5	472	3,366	269	820	1,255		1914	54	1,392	2,020	692	1,893	2,978
Ohio.....	1919	13	3,407	43,119	6,559	33,172	46,514	All other states.....	1919	30	6,475	69,557	10,778	64,570	88,403
	1914	5	489	2,325	352	1,607	2,157		1914	22	4,474	48,171	3,680	20,224	29,484
	1909	4	246	1,250	120	640	851		1909	35	6,015	22,058	3,321	15,944	23,622

TABLE 15.—DETAILED STATEMENT, BY STATES: 1919.

STATE.	NUMBER OF ESTABLISHMENTS.			PERSONS ENGAGED IN THE INDUSTRY.							WAGE EARNERS DEC. 15 OR NEAREST REPRESENTATIVE DAY.				Capital.	EXPENSES.		
	Total.	A	B	Total.	Proprietors and firm members.	Clerks, etc.		Wage earners.			Total.	18 and over.		Under 16.		Salaries and wages.	Officials.	
						Male.	Female.	Average number.	Number, 15th day of—			Male.	Female.					Male.
									Maximum month.	Minimum month.								
United States.....	278	222	56	32 882	41	1 014	2 068	410	29 319	Ja 34 557	Je 26 434	30 857	30 404	8	445	\$365 249 622	\$3 669 708	
A—Other than by-product ovens (beehive).....	222	222	.....	15, 140	41	400	777	156	13, 766	Ja 16, 778	My 11, 778	15, 039	15, 032	1	6	137 906 875	1, 298, 081
B—By-product ovens.....	56	.....	56	17, 742	.....	644	1, 291	254	15, 553	Ja 17, 871	Oc 12, 970	15, 818	15, 372	7	439	227, 342, 747	2, 371, 627
Alabama.....	28	23	5	3, 830	2	103	179	13	3, 533	Se 3, 876	Je 3, 000	3, 632	3, 632	.....	.....	28, 927, 905	377, 236
Illinois.....	4	.....	4	1, 040	.....	89	119	36	1, 396	Ja 1, 625	Oc 710	1, 558	1, 558	.....	.....	25, 931, 172	237, 125
Kentucky.....	4	3	1	627	.....	22	31	6	568	Ja 667	Ap 487	564	564	.....	.....	4, 765, 766	46, 317
Minnesota.....	3	.....	3	510	.....	13	67	4	426	De 483	Je 367	483	481	2	.....	9, 508, 441	46, 406
New York.....	3	.....	3	683	.....	21	17	2	613	Ja 898	Oc 447	473	473	.....	.....	11, 573, 436	59, 534
Ohio.....	13	1	12	3, 847	.....	109	268	63	3, 407	Ja 4, 257	Oc 2, 250	3, 154	2, 713	2	439	48, 242, 369	425, 411
Pennsylvania.....	123	112	11	13, 050	38	366	935	175	11, 536	Ja 13, 293	Je 9, 859	12, 472	2, 403	3	6	125, 341, 038	1, 433, 768	
Tennessee.....	6	5	1	290	1	10	6	1	272	Ja 302	My 165	346	346	.....	.....	2, 035, 359	34, 009
Virginia.....	13	13	.....	922	.....	31	38	4	840	Ja 929	My 774	902	902	.....	.....	5, 152, 665	76, 892
West Virginia.....	57	53	4	1, 437	.....	86	60	8	1, 283	Ja 2, 073	No 906	1, 530	1, 530	.....	.....	12, 635, 737	158, 083
All other states ¹	24	12	12	6, 046	.....	104	348	98	5, 406	.....	.....	5, 742	5, 742	1	.....	91, 135, 734	774, 937

State.	EXPENSES—continued.							Value of products.	Value added by manufacture.	POWER.					Electric horsepower generated in establishments reporting.
	Salaries and wages—Continued.		For contract work.	Rent and taxes.		For materials.				Total.	Primary horsepower.				
	Clerks, etc.	Wage earners.		Rent of factory.	Taxes, Federal, state, county, and local.	Principal materials.	Fuel and rent of power.				Owned.			Rented electric.	
											Steam engines (not turbines).	Steam turbines.	Internal-combustion engines.		
United States.....	\$3,936,077	\$12,200,202	\$81,127	\$167,217	\$8,835,017	\$23,497,210	\$200,769,404	\$316,515,838	\$92,249,164	224,879	75,256	73,222	1,850	74,551	134,612
A—Other than by-product ovens (beehive).....	1,473,650	16,238,770	6,918	318,706	2,338,830	7,405,378	70,750,517	112,023,466	33,807,671	39,761	22,436	4,133	.....	13,192	19,254
B—By-product ovens.....	2,462,427	26,060,522	74,209	148,511	6,496,211	16,091,832	130,018,947	204,492,372	58,381,593	185,118	52,820	69,089	1,850	61,359	115,358
Alabama.....	201,631	3,483,825	.....	38,293	417,164	1,698,860	10,920,550	24,669,105	6,040,689	13,147	5,525	5,250	.....	2,372	3,951
Illinois.....	257,477	2,309,848	.....	3,567	1,195,591	851,561	11,773,154	16,837,024	4,209,309	9,915	4,815	5,100	.....	.....	13,991
Kentucky.....	71,116	759,581	.....	.....	24,175	441,009	3,037,337	4,453,285	974,039	3,308	2,650	468	.....	200	1,240
Minnesota.....	86,495	604,714	.....	.....	118,349	457,473	4,513,873	6,468,651	1,497,308	7,774	2,618	112	.....	5,044	420
New York.....	27,882	1,167,323	70,621	.....	258,840	520,455	4,586,226	7,212,747	2,097,066	8,475	2,341	2,379	980	2,775	1,533
Ohio.....	498,458	6,559,347	1,450	72	940,702	2,783,735	30,388,211	46,514,213	13,342,267	43,119	16,067	12,600	.....	870	13,582
Pennsylvania.....	1,808,628	15,553,532	0,918	127,519	1,195,330	10,560,096	69,793,625	119,730,589	39,376,868	72,752	17,435	40,608	.....	14,709	53,942
Tennessee.....	8,630	259,529	.....	4,719	22,166	646,027	817,612	2,016,858	553,219	2,345	2,220	125	.....	.....	1,242
Virginia.....	66,302	1,084,572	.....	61,751	67,265	100,992	3,744,428	5,524,215	1,588,795	1,243	233	.....	.....	1,010	201
West Virginia.....	67,604	1,419,567	.....	6,960	152,776	547,551	5,489,687	8,368,698	2,331,460	9,493	3,829	.....	.....	5,664	620
All other states ¹	776,445	8,917,454	2,138	224,324	4,442,620	4,786,545	49,695,761	71,720,450	20,238,144	53,308	17,523	6,500	.....	29,195	33,433

¹ All other states embrace: Colorado, 3 (A, 2; B, 1) establishments; Georgia, 1 (A); Indiana, 5 (B); Maryland, 1 (B); Massachusetts, 1 (A); Michigan, 2 (B); New Jersey, 2 (A, 1; B, 1); New Mexico, 2 (A); Oklahoma, 1 (B); Utah, 1 (A); Washington, 3 (A); and Wisconsin, 2 (A, 1; B, 1).

SALT.

GENERAL STATISTICS.

General character of the industry.—This industry embraces the establishments engaged primarily in the production of salt.

The major part of the salt industry pertains to manufacturing, although it is closely related to mining or the extraction of materials from the earth, which statistics of materials and products are collected annually by the Geological Survey. The production figures are as compiled by the Geological Survey and have been coordinated with the general statistics for the industry.

Comparative summary.—Table 1 presents the general statistics for the census years 1879 to 1919, inclusive.

Principal states, ranked by value of products.—Table 2 summarizes the more important statistics for the industry, number of establishments, average number of wage earners, value of products, and value added by manufacture, by states, ranked according to value of products.

Persons engaged in the industry.—The age classification of the average number of wage earners in Table 3 is an estimate obtained by the method described in the "Explanation of terms." Figures for states will be found in Table 13.

Wage earners, by months.—The statistics for wage earners, Table 4, are intended to show the steadiness of employment, or the reverse, in accordance with the industrial conditions existing during the year. Females constituted but 6.5 per cent of the average number of wage earners employed in 1919.

Prevailing hours of labor.—The figures in Table 5 show a movement toward shortening of the hours of employment. In 1919, 20.1 per cent of the wage earners were employed in establishments where the

prevailing hours of labor per week were 48 or less, whereas in 1914 but 6.7 per cent were in establishments of this character, and in 1909, 4.4 per cent. On the other hand, in 1909, 83.6 per cent of all wage earners were in establishments where the hours of labor were 60 or more per week, this percentage decreasing to 62.6 per cent in 1914, and to 33.1 per cent in 1919.

Size of establishments, by average number of wage earners.—In 1919 the average number of wage earners for all plants was 76 as compared with 52 in 1914. In 1919, as shown in Table 6, 22 establishments each employed over 100 wage earners, in the aggregate, 68.4 per cent of all wage earners, as compared with 15 establishments of the same class in 1914 with 56.9 per cent of all wage earners.

Size of establishments, by value of products.—The average value of products per establishment increased from \$144,000 in 1914 to \$436,000 in 1919, though this increase is largely due to enhanced values, and this condition accounts in the main for the changes from lower to higher groups shown in Table 7.

Character of ownership.—Table 8 presents statistics showing the character of ownership. Although a considerable number of establishments are owned by individuals or firms, yet the corporation group controls the bulk of the industry. These establishments reported 97.6 per cent of the value of all products in 1919, 97 per cent in 1914, and 91.3 per cent in 1909.

Number and horsepower of types of prime movers.—Table 9 presents the statistics concerning power.

Fuel consumed.—Table 10 presents statistics for fuel, by kinds and by states. The figures for gas include both natural and manufactured gas, chiefly natural gas.

TABLE 1.—COMPARATIVE SUMMARY: 1919, 1914, 1909, 1904, 1899, 1889, AND 1879.

	1919	1914	1909	1904	1899	1889	1879	PER CENT OF INCREASE. ¹									
								1914-1919	1909-1914	1904-1909	1899-1904	1889-1899	1879-1889				
Number of establishments.....	86	98	124	146	159	200	268										
Persons engaged.....	7,682	5,736	5,580	5,171	5,261	(2)	(2)	43.2	-3.8	7.9	-1.7						
Proprietors and firm members.....	40	60	74	87	81	(2)	(2)			-14.9	7.4						
Salaried employees.....	1,147	587	570	418	406	(2)	(2)	429.0	-61.9	36.4	3.0						
Wage earners (average number).....	6,495	5,089	4,936	4,666	4,774	4,255	4,289	27.6	3.1	5.8	-2.3	(*)	(*)				
Primary horsepower.....	43,187	20,007	27,263	19,434	23,865	11,552	8,470	48.9	0.4	40.3	-18.6	106.6	36.3				
Capital.....	\$47,725,231	\$33,151,134	\$20,011,793	\$25,586,282	\$27,123,364	\$13,437,749	\$8,225,740	44.0	14.3	13.4	-5.7	101.8	63.4				
Salaries and wages.....	9,909,506	4,009,703	3,250,176	2,553,824	2,410,888	11782,491	1,260,023	147.0	23.4	27.3	5.9	35.3	41.5				
Salaries.....	2,556,089	968,409	718,730	437,425	499,748	(2)	(2)	167.0	34.7	47.5	-2.5						
Wages.....	7,353,420	3,041,294	2,531,446	2,066,399	1,911,140	(2)	(2)	142.0	20.1	22.5	8.1						
Paid for contract work.....	31,496	59,563	122,407	26,313	25,277	(2)	(2)	-47.1	-51.3								
Rent and taxes.....	1,931,807	179,341	140,725	115,412	113,407	(2)	(2)	1,005.0	19.8								
Cost of materials.....	16,027,791	6,273,030	5,203,354	4,166,137	3,335,922	1,826,770	2,074,049	155.6	20.0	24.9	24.9	82.6	-11.9				
Value of products.....	37,613,821	14,070,333	11,327,834	9,437,662	7,906,897	5,484,618	4,820,566	167.0	24.2	20.0	18.5	45.3	13.6				
Value added by manufacture.....	21,486,030	7,797,303	6,124,480	5,271,525	4,630,975	3,657,848	2,755,517	176.0	27.3	16.2	13.8	26.6	32.7				

¹ A minus sign (-) denotes decrease.

² Figures not available.

³ Exclusive of internal revenue.

⁴ Value of products less cost of materials.

TABLE 2.—PRINCIPAL STATES, RANKED BY VALUE OF PRODUCTS: 1919.

STATE.	Number of establishments.	WAGE EARNERS.			VALUE OF PRODUCTS.			VALUE ADDED BY MANUFACTURE.			STATE.	Number of establishments.	WAGE EARNERS.			VALUE OF PRODUCTS.			VALUE ADDED BY MANUFACTURE.		
		Average number.	Per cent distribution.	Rank.	Amount (expressed in thousands).	Per cent distribution.	Rank.	Amount (expressed in thousands).	Per cent distribution.	Rank.			Average number.	Per cent distribution.	Rank.	Amount (expressed in thousands).	Per cent distribution.	Rank.	Amount (expressed in thousands).	Per cent distribution.	Rank.
United States..	86	6,495	100.0	....	\$17,514	100.0	....	\$21,486	100.0	...	Ohio.....	5	535	8.2	4	\$2,068	7.1	4	\$1,287	6.0	4
Michigan.....	12	2,063	31.8	1	4,054	37.5	1	7,715	35.9	1	California.....	24	446	6.0	5	2,283	6.1	5	1,201	5.6	5
New York.....	15	1,728	26.8	2	9,009	24.3	2	5,188	24.1	2	Texas.....	3	277	4.3	6	1,016	2.7	7	536	2.5	7
Kansas.....	12	1,072	16.5	3	6,193	16.5	3	3,986	18.6	3	West Virginia.....	4	71	1.1	9	213	0.6	9	92	0.4	9
											All other states.....	10	303	4.6	....	1,985	5.8	....	1,481	6.9	....

TABLE 3.—PERSONS ENGAGED IN THE INDUSTRY: 1919, 1914, AND 1909.

CLASS.	Census year.	Total.	Male.	Female.	PER CENT OF TOTAL.		CLASS.	Census year.	Total.	Male.	Female.	PER CENT OF TOTAL.	
					Male.	Female.						Male.	Female.
All classes.....	1919	7,682	7,012	670	91.3	8.7	Clerks and other subordinate salaried employees.	1919	830	595	235	71.7	28.3
	1914	5,736	5,256	480	91.6	8.4		1914	370	266	104	71.9	28.1
	1909	5,580	5,132	448	92.0	8.0		1909	353	276	77	78.2	21.8
Proprietors and officials.....	1919	357	341	16	95.5	4.5	Wage earners (average number).....	1919	6,495	6,076	419	93.5	6.5
	1914	277	257	20	92.8	7.2		1914	5,089	4,733	356	93.0	7.0
	1909	291	276	15	94.8	5.2		1909	4,936	4,580	356	92.8	7.2
Proprietors and firm members.....	1919	40	30	10	75.0	25.0	16 years of age and over.....	1919	6,470	6,060	410	93.7	6.3
	1914	60	42	18	70.0	30.0		1914	5,076	4,720	356	93.0	7.0
	1909	74	59	15	79.7	20.3		1909	4,929	4,575	354	92.8	7.2
Salaried officers of corporations....	1919	109	104	5	95.4	4.6	Under 16 years of age.....	1919	25	16	9	64.0	36.0
	1914	88	86	2	97.7	2.3		1914	13	13	0	100.0	0.0
	1909	94	94	0	100.0	0.0		1909	7	5	2	71.4	28.6
Superintendents and managers....	1919	208	207	1	99.5	0.5							
	1914	129	129	0	100.0	0.0							
	1909	123	123	0	100.0	0.0							

TABLE 4.—WAGE EARNERS, BY MONTHS, FOR STATES: 1919.

[The month of maximum employment is indicated by bold-faced figures and that of minimum employment by *italic* figures.]

STATE.	Average number employed during year.	NUMBER EMPLOYED ON 15TH DAY OF THE MONTH OR NEAREST REPRESENTATIVE DAY.												Per cent minimum is of maximum.		
		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.			
United States:																
1919.....	6,495	6,433	6,220	6,179	6,161	<i>5,994</i>	6,114	6,443	6,900	6,771	7,110	6,826	6,780	84.3		
Males.....	6,076	6,051	5,848	5,820	5,773	<i>5,628</i>	5,725	6,006	6,446	6,326	6,626	6,339	6,315	84.9		
Females.....	419	382	372	359	388	366	389	437	454	445	484	487	474	71.9		
1914.....	5,089	4,731	<i>4,664</i>	4,875	5,096	5,126	5,128	5,167	5,221	5,448	5,462	5,159	4,971	84.7		
1909.....	4,936	<i>4,540</i>	4,462	4,810	4,977	4,984	5,132	5,229	5,198	5,192	5,153	5,070	4,636	83.0		
California.....	446	407	412	424	423	436	418	404	507	510	522	515	473	78.0		
Kansas.....	1,072	1,051	1,081	1,070	1,068	1,044	1,048	1,021	1,127	1,123	1,154	1,082	986	85.4		
Michigan.....	2,063	2,017	1,964	1,923	1,981	1,925	2,016	2,060	2,178	2,125	2,143	2,169	2,755	69.8		
New York.....	1,728	1,630	<i>1,608</i>	1,668	1,668	1,615	1,617	1,811	1,917	1,866	1,793	1,799	1,814	83.4		
Ohio.....	535	575	521	484	460	459	503	530	564	551	604	604	570	74.5		
Texas.....	277	289	200	253	252	268	265	294	330	335	331	222	224	66.1		
West Virginia.....	71	84	39	43	64	71	75	83	96	94	90	50	58	40.6		

TABLE 5.—AVERAGE NUMBER OF WAGE EARNERS, BY PREVAILING HOURS OF LABOR PER WEEK, FOR SELECTED STATES: 1919.

STATE.	Total.	IN ESTABLISHMENTS WHERE THE PREVAILING HOURS OF LABOR PER WEEK WERE—							STATE.	Total.	IN ESTABLISHMENTS WHERE THE PREVAILING HOURS OF LABOR PER WEEK WERE—							
		44 and under.	Between 44 and 48.	48.1	Between 48 and 54.	54.	Between 54 and 60.	60.			Over 60.	44 and under.	Between 44 and 48.	48.	Between 48 and 54.	54.	Between 54 and 60.	60.
United States:									Michigan.....	2,063	2	541	411	587	428	94
1919.....	6,495	2	12	1,291	547	1,021	1,470	1,416	736	New York.....	1,728	.....	276	169	395	445	236
1914.....	5,089	(2)	(2)	340	.....	772	792	2,538	647	Ohio.....	535	.....	.....	378	66	.....	91
1909.....	4,936	(2)	(2)	214	.....	469	135	2,991	1,137	Texas.....	277	.....	227	.....	50	.....	.....
California.....	446	2	10	157	.....	185	.....	92	.....	West Virginia.....	71	.....	4	.....	30	.....	.....
Kansas.....	1,072	.....	.....	.....	.....	284	603	285	.....								

1 Includes 48 and under for 1914 and 1909.

2 Corresponding figures not available.

MANUFACTURES.

TABLE 6.—SIZE OF ESTABLISHMENTS, BY AVERAGE NUMBER OF WAGE EARNERS, FOR SELECTED STATES: 1919.

STATE.	TOTAL.		ESTABLISHMENTS EMPLOYING—													
	Estab-lish-ments.	Wage earners (average number).	No wage earners.	1 to 5 wage earners, inclusive.		6 to 20 wage earners, inclusive.		21 to 50 wage earners, inclusive.		51 to 100 wage earners, inclusive.		101 to 250 wage earners, inclusive.		Over 250 wage earners.		
			Estab-lish-ments.	Estab-lish-ments.	Wage earners.	Estab-lish-ments.	Wage earners.	Estab-lish-ments.	Wage earners.	Estab-lish-ments.	Wage earners.	Estab-lish-ments.	Wage earners.	Estab-lish-ments.	Wage earners.	
United States.....	1919..	86	6,495	6	15	35	10	103	13	438	20	1,479	16	2,423	6	2,017
	1914..	98	5,080	7	22	60	15	192	24	853	15	1,090	13	2,247	2	647
California.....		24	446	3	7	15	7	73	4	130	3	228				
Kansas.....		12	1,072				1	11	2	08	5	314	3	405	1	274
Michigan.....		12	2,063		1	3					4	320	4	602	3	1,072
New York.....		16	1,728		3	10	1	8	2	55	4	292	4	692	2	671
Ohio.....		5	535						1	49	2	157	2	329		
Texas.....		3	277						1	50			2	227		
West Virginia.....		4	71		1	4	1	11	2	56						

TABLE 7.—SIZE OF ESTABLISHMENTS, BY VALUE OF PRODUCTS: 1919 AND 1914.

VALUE OF PRODUCT.	NUMBER OF ESTABLISHMENTS.		AVERAGE NUMBER OF WAGE EARNERS?		VALUE OF PRODUCTS.		VALUE ADDED BY MANUFACTURE.	
	1919	1914	1919	1914	1919	1914	1919	1914
	All classes.....	86	98	6,495	5,080	\$37,513,821	\$14,070,333	\$21,486,030	$7,797,303
Less than \$5,000.....	12	22	8	44	26,520	55,168	22,721	46,497
\$5,000 to \$20,000.....	9	18	34	166	105,077	220,818	53,510	140,634
\$20,000 to \$100,000.....	15	20	249	553	819,554	1,167,780	403,831	678,957
\$100,000 to \$500,000.....	20	35	2,016		8,363,886		4,442,790	
\$500,000 to \$1,000,000.....	10	2	1,139	4,326	6,822,518	12,026,567	4,220,187	6,936,215
\$1,000,000 and over.....	11	1	3,049		21,376,260		12,246,991	
PER CENT DISTRIBUTION.								
All classes.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Less than \$5,000.....	14.0	22.4	0.1	0.9	0.1	0.4	0.1	0.6
\$5,000 to \$20,000.....	10.5	18.4	0.5	3.3	0.3	1.6	0.2	1.8
\$20,000 to \$100,000.....	17.4	20.4	3.8	10.9	2.2	8.3	2.3	8.0
\$100,000 to \$500,000.....	33.7	34.3	31.0		22.3		20.7	
\$500,000 to \$1,000,000.....	11.0	2.6	17.5	85.0	18.2	89.7	19.7	89.0
\$1,000,000 and over.....	12.8	1.0	47.0		57.0		57.0	

TABLE 8.—CHARACTER OF OWNERSHIP: 1919, 1914, AND 1909.

CHARACTER OF OWNERSHIP.	Cen-sus year.	Num-ber of estab-lish-ments.	Average number of wage earners.	Value of products.	CHARACTER OF OWNERSHIP.	Cen-sus year.	Num-ber of estab-lish-ments.	Average number of wage earners.	Value of products.
All classes.....	1919	86	6,495	\$37,513,821	Per cent distribution:	1919	10.5	0.8	0.3
	1914	98	5,080	14,070,333		1914	13.3	1.9	1.1
	1909	124	4,936	11,327,834		1909	20.1		5.6
Individual.....	1919	9	50	109,171	Corporation.....	1919	77.9	95.2	97.6
	1914	13	98	160,000		1914	71.4	95.5	97.0
	1909	25	(¹)	637,438		1909	67.8		91.3
Corporation.....	1919	67	6,180	36,604,513	All other.....	1919	11.6	4.1	2.1
	1914	70	4,860	13,655,000		1914	15.3	2.6	1.8
	1909	84	(¹)	10,345,414		1909	12.1		3.0
All other.....	1919	10	265	800,137					
	1914	15	131	255,000					
	1909	15	(¹)	344,082					

¹ Figures not available.

TABLE 9.—NUMBER AND HORSEPOWER OF TYPES OF PRIME MOVERS: 1919, 1914, AND 1909.

POWER.	NUMBER OF ENGINES OR MOTORS.			HORSEPOWER.					
	1919	1914	1909	Amount.			Per cent distribution.		
				1919	1914	1909	1919	1914	1909
Primary power, total.....	807	549	478	43,187	29,007	27,263	100.0	100.0	100.0
Owned.....	420	354	397	35,345	25,757	26,008	81.8	88.8	95.4
Steam ¹	370	309	345	34,309	24,900	25,118	79.4	85.8	92.1
Engines.....	320	300	345	29,309	24,900	25,118	68.1	85.8	92.1
Turbines.....	50	.....	.....	4,910	.....	(²)	11.4	.....	.....
Internal-combustion engines.....	49	42	51	981	779	782	2.3	2.7	2.9
Water wheels, turbines, and motors.....	7	3	1	55	78	108	0.1	0.3	0.4
Rented.....	381	195	81	7,842	3,250	1,255	18.2	11.2	4.6
Electric.....	381	195	81	6,706	3,250	1,241	15.5	11.2	4.5
Other.....	.....	.....	.....	1,136	.....	14	2.6	.....	0.1
Electric.....	1,120	553	239	2,842	7,742	3,425	100.0	100.0	100.0
Rented.....	381	195	81	6,706	3,250	1,241	85.5	42.0	36.2
Generated by establishments reporting.....	745	358	158	1,136	4,492	2,184	14.5	58.0	63.8

¹ Figures for horsepower include for 1909 the amount reported under the head of "Other" owned power.² Not reported separately.

TABLE 10.—FUEL CONSUMED, BY STATES: 1919.

	COAL.					Gas (1,000 cubic feet).		COAL.					Gas (1,000 cubic feet).
	Anthra-cite (tons, 2,240 pounds).	Bitumi-nous (tons, 2,000 pounds).	Coke (tons, 2,000 pounds).	Fuel oils (barrels).	Gasoline and other volatile oils (barrels).			Anthra-cite (tons, 2,240 pounds).	Bitumi-nous (tons, 2,000 pounds).	Coke (tons, 2,000 pounds).	Fuel oils (barrels).	Gasoline and other volatile oils (barrels).	
United States. 1919..	81,251	957,447	6,920	126,581	17,046	45,085	New York.....	81,251	153,640	16	3	44	.....
1914..	85,894	714,402	535	55,443	(¹)	899,339	Ohio.....	.....	119,210	1,800	2	2	900
California.....	.....	162	.....	35,038	947	100	Texas.....	.....	63,456	4,571	60,000	5	.....
Kansas.....	.....	128,035	533	31,538	.....	35,927	West Virginia.....	.....	15,970	.....	.....	.....	8,158
Michigan.....	.....	471,402	.....	.....	.....	.....	All other states.....	.....	5,532	.....	.....	16,048	.....

¹ Included in figures for fuel oils.

SPECIAL STATISTICS.

Products.—Table 11 presents comparative statistics of products for 1919, 1914, and 1909.

TABLE 11.—PRODUCTS: 1919, 1914, AND 1909.

	1919	1914	1909		1919	1914	1909
Number of establishments.....	86	98	124	Bromine:			
Products, total value.....	\$37,513,821	\$14,070,333	\$11,327,834	Pounds.....	1,854,071	576,991	569,725
Salt:				Value.....	\$1,234,969	\$203,094	\$57,600
Tons (2,000 pounds).....	6,882,002	14,872,650	4,195,628	Average value, pound.....	\$0.67	\$0.35	\$0.10
Value.....	\$27,074,694	\$10,271,358	\$8,311,729	Calcium chloride: ²			
Average value, ton.....	\$3.93	\$2.11	\$1.89	Tons (2,000 pounds).....	26,123	19,403	12,853
				Value.....	\$321,596	\$121,766	\$63,198
				Average value, ton.....	\$12.31	\$6.28	\$4.92
				All other products, value.....	\$8,882,562	\$3,474,115	\$2,895,307

¹ Includes solar salt, Porto Rico.² Calcium-magnesium chloride marketed in the United States, production from natural brine; not including that obtained in the manufacture of soda.

GENERAL TABLES.

Comparative summary, by states.—Table 12 gives comparative statistics for the principal items, number of establishments, average number of wage earners, primary horsepower, wages, cost of materials and

value of products for the census years 1919, 1914, and 1909.

Detailed statement, by states.—Table 13 is a detailed statement, by states, for the year 1919.

MANUFACTURES.

TABLE 12.—COMPARATIVE summary, BY STATES: 1919, 1914, AND 1909.

STATE.	Cen- sus year.	Num- ber of estab- lish- ments.	Wage earn- ers (aver- age num- ber).	Primary horse- power.	Wages.			Cost of mate- rials.	Value of prod- ucts.	STATE.	Cen- sus year.	Num- ber of estab- lish- ments.	Wage earn- ers (aver- age num- ber).	Primary horse- power.	Wages.			Cost of mate- rials.	Value of prod- ucts.
					Expressed in thousands.										Expressed in thousands.				
United States.....	1919	86	6,495	43,187	\$7,353	\$16,028	\$37,514	Ohio.....	1919	5	535	8,259	\$675	\$1,380	\$2,668				
	1914	98	5,089	29,007	3,041	6,273	14,070		1914	4	813	4,937	441	1,204	2,197				
	1909	124	4,936	27,263	2,531	5,203	11,328		1909	8	648	4,034	361	1,090	1,807				
California.....	1919	24	446	2,976	537	1,084	2,286	Texas.....	1919	3	277	1,656	307	480	1,016				
	1914	22	347	2,079	262	397	1,215		1914	3	140	809	75	227	425				
	1909	19	402	1,228	212	242	746		1909	6	162	447	82	21	407				
Kansas.....	1919	12	1,072	8,719	1,145	2,207	6,193	West Virginia.....	1919	4	71	1,092	66	121	213				
	1914	9	467	4,791	274	661	1,334		1914	3	117	515	51	94	169				
	1909	10	451	3,387	188	519	1,106		1909	3	110	335	46	60	131				
Michigan.....	1919	12	2,063	10,321	2,539	6,339	14,054	All other states.....	1919	10	303	2,945	300	505	1,985				
	1914	15	1,434	8,316	991	2,667	4,421		1914	12	261	1,025	131	253	755				
	1909	27	1,363	6,628	745	1,643	3,653		1909	18	275	1,281	132	220	581				
New York.....	1919	16	1,728	7,219	1,784	3,911	9,099												
	1914	26	1,510	6,540	816	1,365	3,554												
	1909	33	1,525	9,023	765	1,195	2,897												

TABLE 13.—DETAILED STATEMENT, BY STATES: 1919.

STATE.	Num- ber of estab- lish- ments	PERSONS ENGAGED IN THE INDUSTRY.							WAGE EARNERS, DEC. 15, OR NEAR- EST REPRESENTATIVE DAY.						EXPENSES.		
		Total.	Prop- ri- etors and firm mem- bers.	Sala- ried offi- cers, ¹ super- in- tend- ents, and man- agers.	Clerks, etc.		Wage earners.			Total.	16 and over.		Under 16.		Capital.	Salaries and wages.	
					Male.	Fe- male.	Aver- age num- ber.	Maximum month.	Minimum month.		Male.	Fe- male.	Male.	Fe- male.		Officials.	Clerks, etc.
United States.....	86	7,682	40	317	595	235	6,495	Oct 7,110	My 5,994	7,023	6,514	481	17	11	\$47,725,231	\$1,344,648	\$1,211,432
California.....	24	540	20	37	25	12	446	No 509	Je 393	482	434	43	2	3	4,068,367	94,605	38,395
Kansas.....	12	1,331	1	60	142	56	1,072	Oct 1,154	De 986	994	939	55	.....	.....	5,807,406	238,071	255,114
Michigan.....	12	2,513	.....	95	237	98	2,063	De 2,255	Mh 1,923	2,274	2,110	154	10	.....	12,804,398	413,813	490,017
New York.....	16	1,851	5	56	118	44	1,728	Au 1,917	Fe 1,598	1,851	1,739	109	.....	3	15,307,008	338,291	320,623
Ohio.....	5	591	.....	26	16	14	535	Oct 604	Ap 450	570	505	65	.....	.....	4,525,920	139,147	46,275
Texas.....	3	308	5	13	12	1	277	Se 336	No 222	333	298	35	.....	.....	1,040,991	32,590	17,742
West Virginia.....	4	92	.....	12	4	5	71	Au 96	Fe 39	98	98	.....	.....	.....	847,944	28,770	8,196
All other states ²	10	356	0	18	21	5	303	.....	.....	421	391	20	5	5	3,257,137	59,361	35,076

STATE.	EXPENSES—continued.						Value of products.	Value added by manufac- ture.	POWER.						Elec- tric horse- power gen- erated in estab- lish- ments report- ing.
	Salaries and wages— Con.	For con- tract work.	Rent and taxes.		For materials.				Total.	Primary horsepower.					
			Wage earn- ers.	Rent of factory.	Taxes, Federal, county, and local.	Princ- ipal materials.				Fuel and rent of power.	Owned.	Rent- ed. ⁴			
Steam engines (not tur- bines).	Steam tur- bines.	Inter- nal- com- bus- tion en- gines.	Water power. ³	.....										
United States.....	\$7,353,420	\$31,496	\$171,416	\$1,810,391	\$11,339,924	\$4,687,867	\$37,513,821	\$21,486,030	43,187	29,300	4,910	981	55	7,842	8,065
California.....	537,358	4,771	38,905	53,715	959,415	125,045	2,285,927	1,201,467	2,076	755	240	783	5	1,103	410
Kansas.....	1,144,736	24,000	610	500,097	1,540,197	666,322	6,192,933	3,950,174	8,719	6,533	744	.....	.....	1,442	845
Michigan.....	2,539,083	.....	1,360	511,348	4,207,499	2,131,420	14,053,799	7,714,850	10,321	5,538	1,743	2	.....	6,038	1,582
New York.....	1,784,269	.....	5,690	460,575	2,877,244	1,033,258	9,098,775	5,188,273	7,219	6,298	650	66	50	155	2,551
Ohio.....	675,204	.....	.....	109,421	932,947	447,442	2,867,780	1,287,391	8,259	6,930	950	5	.....	374	2,039
Texas.....	307,094	500	4,019	28,732	310,544	169,915	1,016,031	535,572	1,656	990	433	33	.....	200	308
West Virginia.....	65,802	.....	.....	3,364	68,538	52,583	212,832	91,711	1,092	875	150	67	.....	.....	85
All other states ²	299,871	2,225	120,752	131,169	443,540	61,882	1,985,984	1,480,562	2,945	1,480	.....	25	.....	1,440	295

¹ Same number reported for one or more other months.
² All other states embrace: Louisiana, 2 establishments; Nevada, 1; New Mexico, 1; and Utah, 6.
³ Includes water wheels and turbines (irrespective of ownership of water supply), and water motors (operated by water from city mains).
⁴ Chiefly electric motors operated by rented (or purchased) current; other power included (chiefly shaft-belt or transmitted power from neighboring power plants).