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Volume Author/Editor: Solomon Fabricant, assisted by Julius Shiskin

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## Chapter 14

### Chemical Products

THE chemical products group comprises all industries manufacturing chemicals, as ordinarily defined, and industries using chemical processes in their operations. There are a few exceptions which are classified in other groups: baking powder and corn products, placed in the foods group; and beverages and petroleum and coal products, which are classified separately. The chemical group is rather heterogeneous in respect of the use made of its products. Numbered among them are industrial materials, construction materials, fertilizers, and such final consumer goods as drugs.

The chemical industries have grown in relative importance, as measured by value added; in 1899 this group was exceeded by eight others, in 1937 by six.

#### TRENDS IN THE PHYSICAL OUTPUT OF THE CHEMICAL PRODUCTS INDUSTRIES

Of the 30 industries included in the chemicals group, we have adequate quantity statistics for 15. For only eight, however, do the indexes extend over the entire period 1899-1937 (Table 40 and Chart 16).

*Chemicals, not elsewhere classified*, the most important industry in the group, consists of establishments producing acids, nitrogen compounds, sodium and potassium compounds, aluminum compounds and alum, coal-tar products, and plastics. Prior to 1923 this classification included also rayon manufacture, and prior to 1927, compressed and liquefied gases. The growth of the industry has been phenomenal.

TABLE 40

## CHEMICAL PRODUCTS\*

Physical Output: Indexes and Percentage Changes<sup>b</sup>

YEAR	Chemicals, n.e.c. <sup>c</sup> (including Compressed Gases and Rayon)										Soap	Carbon Black	Linsed Products	Wood-Distillation Products		
	Total	Chemicals, n.e.c. <sup>c</sup> (excl. gases and rayon)	Gases, Compressed	Rayon	Cottonseed Products	Linsed Products	Carbon Black	Soap	Wood-Distillation Products							
	INDEX OF PHYSICAL OUTPUT (1929:100)															
1899	6.6	17	..	..	51	..	..	..	..	..	..	..	..	..	28	
1904	8.3	22	..	..	74	..	..	..	..	..	..	..	..	..	40	
1909	12	30	3.3	..	73	..	..	..	..	..	..	..	..	..	54	
1914	20	29	9.2	2.0	134	..	..	..	..	..	10.0	..	..	..	58	
1919	36	48	33	6.7	111	..	..	..	..	..	23	..	..	..	75	
1921	27	34	31	12	80	..	..	..	..	..	24	..	..	..	31	
1923	55	64	52	28	70	83	..	..	..	..	47	..	..	..	80	
1925	56	65	55	40	108	100	..	..	..	..	70	..	..	..	85	
1927	70	74	68	60	121	95	..	..	..	..	67	..	..	..	92	
1929	100	100	100	100	100	100	..	..	..	..	100	..	..	..	100	
1931	92	81	82	138	86	67	..	..	..	..	75	..	..	..	56	
1933	102	80	71	201	94	..	..	..	..	..	74	..	..	..	..	
1935	130	105	95	253	66	63	..	..	..	..	94	..	..	..	73	
1937	172	141	138	310	83	86	..	..	..	..	133	..	..	..	101	
	NET PERCENTAGE CHANGE IN PHYSICAL OUTPUT															
PERIOD																
1899-1937	+2,500	+741	..	..	+63	..	..	..	..	..	..	..	..	..	+259	
1899-1909	+89	+78	..	..	+45	..	..	..	..	..	..	..	..	..	+92	
1909-1919	+190	+61	+906	+235 <sup>d</sup>	+51	..	..	..	..	..	..	..	..	..	+38	
1919-1929	+176	+108	+201	+1,393	-10	..	..	..	..	..	+337	..	..	..	+34	
1929-1937	+72	+41	+38	+210	-17	-14	..	..	..	..	+9	..	..	..	+1	

YEAR	Charcoal	Explosives	Fertilizers	Glue and Gelatin	Paints and Varnishes	Salt	Tanning and Dye Materials	Total	
								Unadjusted	Adjusted
INDEX OF PHYSICAL OUTPUT (1929:100)									
1899	..	25	30	..	22	53	26	17	19
1904	..	45	37	..	28	57	38	20	23
1909	..	62	60	..	38	67	54	30	31
1914	..	70	88	..	41	72	79	42	42
1919	..	94	80	..	52	88	82	54	52
1921	192	61	60	..	45	71	69	42	42
1923	132	94	76	..	67	87	95	66	64
1925	238	92	87	..	76	88	87	70	70
1927	144	96	90	96	87	92	88	82	83
1929	100	100	100	100	100	100	100	100	100
1931	39	67	78	85	69	91	78	85	87
1933	..	58	60	..	62	84	74	87	84
1935	46	68	78	110	87	87	100	106	101
1937	43	93	106	139	109	97	101	135	124
NET PERCENTAGE CHANGE IN PHYSICAL OUTPUT									
1899-1937	..	+267	+248	..	+391	+82	+292	+696	+566
1899-1909	..	+143	+97	..	+69	+26	+107	+80	+69
1909-1919	..	+52	+34	..	+39	+31	+52	+79	+64
1919-1929	..	+7	+24	..	+92	+13	+22	+84	+94
1929-1937	-57	-7	+6	+39	+9	-3	+1	+35	+24

<sup>a</sup> Industries for which there are no adequate quantity data for any period listed above are: druggists' preparations; patent medicines; toilet preparations; drug grinding; oils; essential; ammunition; fireworks; blackings; bluing; candles; cleaning preparations; grease and tallow; ink, printing; ink, writing; and mucilage. These industries are covered by the adjusted total.

<sup>b</sup> The indexes have been constructed from basic data in the U. S. Census of Manufactures; reports of the U. S. Bureau of Mines and other sources, by methods described briefly in Chapter 2 and in detail in Appendix A. Appendix B pre-

sents these data, together with the indexes derived from them. The indexes cited here for individual industries have been adjusted to take account of changes in the coverage of the respective samples, except when such adjustment was impossible.

The percentage changes are not always entirely consistent with the indexes given above because the changes were computed from the indexes in Appendix B, which are carried to one decimal place.

<sup>c</sup> N.e.c. denotes not elsewhere classified.

<sup>d</sup> Percentage change from 1914 to 1919.

Chart 16

CHEMICAL PRODUCTS

Indexes of Physical Output

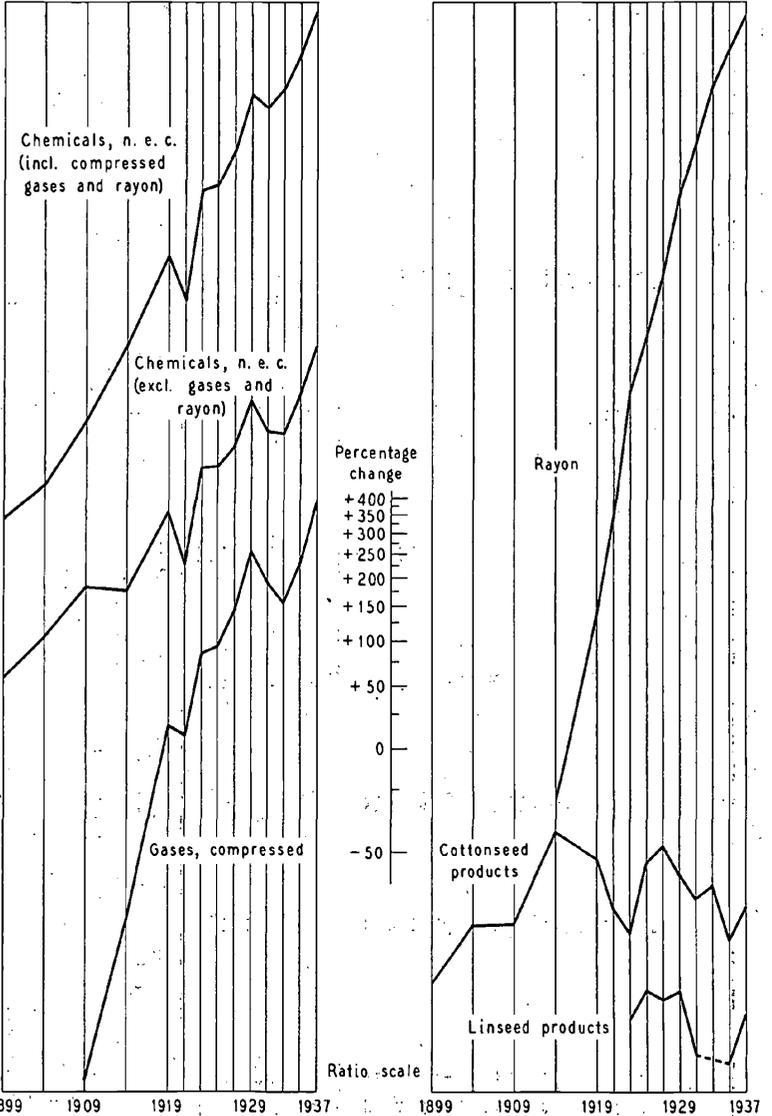
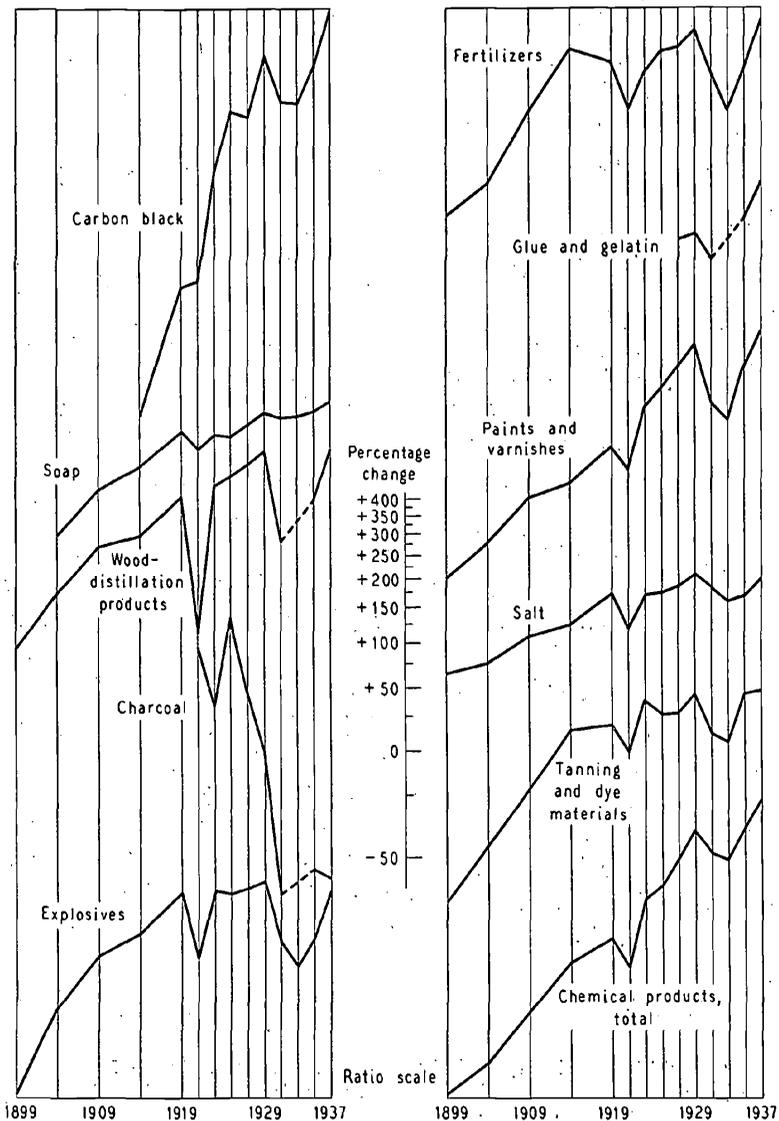


Chart 16 (concl.)

CHEMICAL PRODUCTS

Indexes of Physical Output



Between 1899 and 1937 chemicals, not elsewhere classified (including the two branches separated out in 1923 and 1927), increased production by 2,500 percent. In the first decade output almost doubled, in the second and third decades it almost tripled, and even in the last period, 1929-37, it rose more than 70 percent. If rayon and gases are excluded, the industry's rise is less rapid, but the rate is nevertheless exceedingly high and the total gain over the long period approaches 750 percent.<sup>1</sup>

Especially outstanding were the rises in the output of phosphoric acid, sulphuric acid, anhydrous ammonia, borax, sodium silicate, coal-tar dyes, butyl acetate, carbon bisulphide, ethyl ether, and ethyl acetate. Among the products which appear to have been constant or declining in output for some length of time are oleic acid, sodium bicarbonate, sodium sulphate (niter cake), cream of tartar, aluminous abrasives, pyroxylin plastics, and refined sulphur.

*Rayon and Compressed Gases*, the two branches of the industry which were treated separately in the Censuses of 1923 and 1927, respectively, grew more rapidly than the other branches of chemicals, not elsewhere classified. Indeed, it was because of their rapid and sustained growth that they were promoted by the Census to the status of independent industries. Rayon output, for which data are available from 1914, was more than 150 times greater in 1937 than it had been 23 years earlier. The extent of the gain has already been indicated by the great increase in the output of rayon fabrics in the textile industry. The ascent of the charted line for rayon production (Chart 16) is so steep that it is difficult to comprehend the magnitude of the rise. In terms of volume, rayon production increased from 2.4 million pounds in 1914 to 321.7 million in 1937. There was no absolute decline be-

<sup>1</sup> It should be noted that the index is unadjusted, except for 1927-37, and is therefore subject to error arising from changes in coverage. The index for chemicals, including rayon and gases, is adjusted throughout.

tween any two Census years, although very recently a slackening in the rate of growth has been apparent.

The rapid increases in the quantity of rayon produced were accompanied by improvements in the quality of rayon yarn. The average denier spun fell from 151 in 1929 to 137 in 1938,<sup>2</sup> indicating a trend to a finer product. Tensile strength, dry, increased from 1.5 grams per denier for commercial 150-denier viscose yarn rayon in 1922, to 2.0 grams per denier in 1932; wet tensile strength increased from 0.5 grams to 1.0 grams. In addition, delustering processes have been developed, dyeing properties have been improved, and greater uniformity in many respects has been effected.<sup>3</sup>

Compressed and liquefied gases also increased at a phenomenal rate, though not as rapidly as rayon. Output in 1937 was 42 times as great as it had been in 1909. The growth has been subject to some retardation, as is apparent from the chart. Even in the most recent period, however, there was a substantial increase of 38 percent.

*Cottonseed and Linseed Products.* The cottonseed products industry comprises establishments which crush cottonseed and produce from it oil, cake and meal. The further processing of cottonseed oil in the manufacture of lard substitutes and cooking oils is treated as a food manufacturing process. The output of oil, cake and meal rose by less than two thirds from 1899 to 1937. The peak in the series came in 1914, but 1927 output was only 10 percent lower. Two by-products of the industry, cotton linters, and cottonseed cake and meal, increased more rapidly than the output of cottonseed oil; and a third, cottonseed hulls, changed but slightly between 1899 and 1937.

Linseed products are made by methods similar to those employed in the processing of cottonseed. The output of the lin-

<sup>2</sup> *Rayon Organon* (January 23, 1939), p. 19.

<sup>3</sup> Department of Agriculture, mimeographed "Report on Development and Use of Rayon and Other Synthetic Fibers," by a committee appointed by the Secretary of Agriculture (October 1938), pp. 28-29.

seed products industry rose 20 percent between 1923 (the first year for which adequate data are available) and 1929: From 1929 to 1937 output fell 14 percent.

*Carbon Black.* In addition to carbon black, this industry manufactures bone black, and lampblack from natural gas, bone, petroleum, etc. Almost half of its chief product, carbon black, is used in the manufacture of rubber products, particularly tires and tubes, a fact which helps to explain the rapid rise in the output of the industry: between 1914 and 1937 there was a 13-fold increase. From 1914 to 1919 the rise exceeded 100 percent; from 1919 to 1929, 300 percent; and from 1929 to 1937, 33 percent. Although today carbon black is the major product of the industry, in 1914 bone black was the principal product. Since 1914 the output of bone black has declined, as has also that of lamp black.

*Soap.* This industry, one of the most important in the entire chemicals group in terms of value added, includes establishments manufacturing soap and soap products, such as granulated soap and cleansers. The output of the industry moved upward at a comparatively slow rate: from 1904 to 1937 the increase was 140 percent. Data on the products of the industry are supplied in detail beginning with 1923. Since that year decreases have occurred in the output of foots soap, white and yellow laundry soap, miscellaneous hard soaps, soap powders, and soft soap. There are large rises in the series for soap chips, and for granulated and powdered soap.

*Wood-Distillation Products.* This classification covers establishments engaged in distilling wood for methanol, acetate of lime, turpentine and rosin, etc. Charcoal is the principal by-product of the industry. The total output of the industry rose 259 percent from 1899 to 1937, but the rate of increase slowed down from decade to decade. In the first period there was a rise of 92 percent, in the second 38 percent, in the third 34 percent and in the last only 1 percent. The hardwood-distillation branch of the industry fell off in relation to the soft-

wood-distillation branch, effecting declines in the output of the hardwood products (methanol and acetate of lime) in relation to the softwood products (turpentine, rosin, pine oil, tar, and tar oils). Charcoal, a by-product of both branches, rose less rapidly than all the primary products combined.

*Charcoal.* The only products of the charcoal industry proper are charcoal and wood tar. The volatile substances, which constitute the chief products of the wood-distillation industry, are driven off and lost in the manufacture of charcoal. The output of the charcoal industry declined at a rapid pace. After a rise from 1921 to 1925, it fell sharply from 1925 to 1929, and again from 1929 to 1937 by more than 50 per cent.

*Explosives.* Among the products of the explosives industry are gunpowder, dynamite and nitroglycerine. Ammunition and fireworks are classified in other industries. The output of the explosives industry increased 267 percent between 1899 and 1937, but retardation in its rate of growth is shown by the record of declines in the percentage increases in successive decades. There were large rises in the output of permissible explosives (approved by the Bureau of Mines for use in mines), and decreases in the output of blasting and pellet powder, and gun powder.

*Fertilizers.* This category encompasses the manufacture of commercial fertilizers, not including fertilizer materials for use in the natural state, or unprocessed tankage from meat-packing plants. The industry's physical output rose 250 percent between 1899 and 1937.<sup>4</sup> Most of the rise occurred from 1899 to 1914.

*Paints and Varnishes,* a very important industry when judged by value added, increased its output almost five times in the years 1899-1937. Even in the most recent period, 1929-37, production increased by 9 percent. Among the in-

<sup>4</sup>The index for the industry is affected, though only slightly, by duplication arising from intra-industry sales of superphosphates. See Appendix B.

dustry's individual products relatively small increases or even declines are found in the output of dry white lead pigments, zinc oxide, iron oxides, pulp colors, paints in paste form, japans and fillers. The output of water paints and calcimine, spirit varnishes, and pyroxylin products (lacquer and lacquer enamels) rose substantially.<sup>5</sup>

*Salt*, a laggard industry in the chemical group, increased in output only 82 percent in the 38 years between 1899 and 1937. From the detailed data available since 1921, it appears that there have been changes in the relative importance of each type of salt-making process. The amount of salt produced by evaporation in open pans or grainers has declined, but the amount produced by evaporation in vacuum pans has increased. The output of salt in brine, sold as such, advanced more rapidly than that of any other salt product.

*Tanning and Dye Materials*, the last industry in the group for which we have quantitative data, comprises establishments engaged in the production of tanning extracts and solutions, natural dyestuffs, mordants, assistants, and sizes. Artificial dyestuffs are classed with "chemicals not elsewhere classified." The output of the tanning and dye materials industry rose almost 4-fold between 1899 and 1937. The greater part of the rise occurred in the first 15 years, when output increased by over 200 percent. In contrast, the increase from 1914 to 1937 was less than 30 percent. Natural dyes and extracts all declined in absolute output: logwood, from 39 million pounds in 1899 to 8 million in 1937; fustic, from 4.5 million pounds in 1914 to 1.2 million in 1937; and quercitron, from 3.8 million pounds in 1914 to 2.4 million in 1929. On the other hand, the output of artificial dyestuffs rose.

*Summary of Changes in Individual Chemical Industries.* In only one period, 1929-37, did more than one chemical industry decline in output (Table 41). Even in that period,

<sup>5</sup> Intra-industry sales of dry colors and pigments result in duplication of part of the industry's output. See Appendix B.

however, ten out of the fifteen industries for which we have data increased their output. Over the long period 1899-1937 all but one of the chemical industries reported increases in output more rapid than the growth of population. For 1899-1909 all eight industries for which we have data surpassed population growth, and for 1909-19, all ten. In the third pe-

TABLE 41

## CHEMICAL PRODUCTS

Summary of Changes in Physical Output<sup>a</sup>

	<i>Number of Industries</i>				
	1899- 1937	1899- 1909	1909- 1919	1919- 1929	1929- 1937
Industries for which there are indexes of physical output	8	8	10	12	15
Industries with rising output	8	8	10	11	10
Industries with falling output	0	0	0	1	5
Industries with output rising in relation to population	7	8	10	8	7
Industries with output falling in relation to population	1	0	0	4	8
Industries with output rising in relation to total manufacturing output	3	6	6	5	8
Industries with output falling in relation to total manufacturing output	5	2	4	7	7

<sup>a</sup> Derived from data in Table 40 and from figures on changes in population and in total manufacturing output given in footnote a, Table 14.

riod, 1919-29, eight out of twelve industries increased output more rapidly than population grew; the exceptions were soap, explosives, salt, and cottonseed products. In the last period, only seven out of fifteen industries managed to exceed the rise in population.

Between 1899 and 1937 only three out of the eight individual industries covered increased their output more rapidly than did total manufacturing; these were chemicals, n.e.c., paints and varnishes, and tanning and dye materials. Never-

theless, the increase in the output of the first was so great, and the combined importance of the three industries so considerable, that the group total, discussed below, advanced in relation to the grand total.

*The Group Total.* The index of physical output of the entire chemical products group, based on the sample of industries given in Table 40, rose almost 700 percent between 1899 and 1937. The rise exceeded 75 percent in each of the first three decades and came to about 35 percent for the period 1929-37. Unfortunately, the sample is incomplete. Data are lacking on the physical output of several important chemical products industries—drugs, patent medicines, and toilet preparations. If we may judge from the movements of the value added by the sample in relation to the value added by the entire group, which includes industries for which no quantity data are available, the sample increased in relative importance. Using the differential movement revealed by value added to correct the unadjusted group index, we obtain an adjusted index that rose somewhat less rapidly in three of the four subperiods, increasing by 566 percent for the entire 38-year span.

#### CHANGES IN THE INDUSTRIAL PATTERN OF CHEMICAL PRODUCTION

We have already noted the divergence of trends in the output of several industries in this group. That divergence reflects a far-reaching transformation in the character of the total group output (Table 42). The industry producing chemicals, rayon and gases, which contributed only 10 percent to the group output in 1899, accounted for 42 percent in 1937. The relative contributions of all other industries declined; among these we may mention the drop in cottonseed products, from 8 to 2 percent, and in fertilizers, from 7 to 4 percent. Even paints and varnishes contributed a declining share to the total, al-

TABLE 42

## CHEMICAL PRODUCTS

Relative Contributions of Component Industries to the Physical Output of the Entire Group<sup>a</sup>

Industry	Percentage Distribution, Comparable Pairs of Years									
	1899	1937	1899	1909	1909	1919	1919	1929	1929	1937
Chemicals, n. e. c. <sup>b</sup>	10.4	42.2	13.2	14.9	15.0	26.7	24.1	34.2	22.2	25.4
Gases, compressed									2.1	2.4
Rayon									5.4	13.5
Cottonseed products	8.4	2.1	7.8	6.6	7.7	7.1	6.7	3.1	3.3	2.2
Wood-distillation products	1.3	0.7	1.1	1.2	1.2	1.0	1.1	0.8	0.9	0.7
Explosives	3.2	1.8	3.3	4.7	4.4	4.0	4.1	2.2	2.4	1.8
Fertilizers	6.9	3.7	7.8	9.1	9.6	7.9	7.4	4.7	4.2	3.6
Paints and varnishes	14.2	10.8	12.2	12.2	12.2	10.4	11.8	11.6	13.8	12.1
Salt	3.3	0.9	2.2	1.7	2.0	1.6	2.0	1.2	1.4	1.1
Tanning and dye materials	1.2	0.7	1.3	1.6	1.7	1.6	1.5	0.9	0.9	0.7
Soap					8.4	7.5	9.3	5.3	7.4	6.5
Carbon black							0.3	0.6	0.6	0.7
Linseed products	51.1	36.9	51.1	47.9					1.2	0.8
Charcoal					37.7	32.2			*	*
Glue and gelatin							31.7	35.3	0.8	0.9
Other chemical products									33.4	27.6
TOTAL <sup>c</sup>	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

<sup>a</sup> Less than half of one percent.<sup>b</sup> N. e. c. denotes not elsewhere classified.<sup>c</sup> Derived from Table 40. For an explanation of the derivation of the measurements see footnote 10, Chapter 4.

The columns do not add up to 100.0 in every instance because they contain rounded percentages.

TABLE 43

## CHEMICAL PRODUCTS

Relative Contributions of Component Industries to the Value Added by the Entire Group<sup>a</sup>

Industry	Percentage Distribution				
	1899	1909	1919	1929	1937
Chemicals, n.e.c. <sup>b</sup>	13.0	15.1	26.7	21.6	27.1
Gases, compressed				2.2	2.4
Rayon				6.7	9.9
Druggist preparations	6.0	6.8	5.1	4.7	16.1
Patent medicines	20.8	14.8	10.4	13.0	
Toilet preparations	2.0	2.2	2.8	7.8	4.4
Drug grinding	0.5	0.7	0.4	0.2	0.2
Cottonseed products	6.9	7.3	7.4	2.9	2.6
Linseed products	1.4	1.5	1.7	1.1	0.9
Oils, essential	0.1	0.1	0.2	0.2	0.1
Ammunition	2.8	2.8	4.3	1.4	1.4
Fireworks	0.6	0.4	0.2	0.2	
Blackings	1.2	1.1	1.0	0.9	0.6
Bluing	0.2	0.2	0.1	0.1	0.1
Carbon black	0.2	0.2	0.3	0.6	0.7
Candles	10.2	0.3	0.1	0.2	0.2
Soap		10.2	6.7	7.5	6.6
Charcoal	0.4	0.1	*	*	*
Wood-distillation products	1.3	1.0	1.1	0.9	0.8
Cleaning preparations	0.6	0.9	1.2	1.8	1.9
Explosives	3.5	4.5	4.0	2.4	1.9
Fertilizers	8.0	9.0	8.2	4.2	3.7
Glue and gelatin	0.8	1.6	1.1	0.8	1.0
Grease and tallow	1.6	2.1	1.6	1.2	1.1
Ink, printing	0.8	1.2	1.0	1.4	1.3
Ink, writing	0.4	0.4	0.3	0.2	0.1
Mucilage	0.5	0.4	0.4	0.2	0.1
Paints and varnishes	12.6	12.0	10.5	13.6	12.8
Salt	2.3	1.6	1.8	1.4	1.2
Tanning and dye materials	1.3	1.6	1.6	0.8	0.7
TOTAL <sup>c</sup>	100.0	100.0	100.0	100.0	100.0

\* Less than half of one percent.

<sup>a</sup> Basic data are given in Appendix C.<sup>b</sup> N.e.c. denotes not elsewhere classified.<sup>c</sup> The columns do not add up to 100.0 in every instance because they contain rounded percentages.

though in physical output this industry rose more rapidly than all but one other in the group. In the latest period,

1929-37, the contribution of rayon went up spectacularly, from 5 to 13 percent.

The data on value added, expressed in terms of percentage contributions, indicate changes in the relative standing of industries for which no data on physical output are available (Table 43). Outstanding declines are to be noted in drugs and patent medicines, which fell from 26.8 percent in 1899 to 16.1 in 1937. The contribution of toilet preparations rose from 2.0 percent in 1899 to 7.8 in 1929, then dropped to 4.4 in 1937. Ammunition reached a peak in 1919 and declined in the ten years following.