

II. ELIMINATION OF DUPLICATIONS IN MATERIAL COSTS

Material costs and gross value of products.—The gross value of the manufactured output of the 210,959 industrial establishments in 1929 was in excess of \$70,000,000,000 (Table 10). This sum covered payments by the manufacturers for salaries, wages, materials and containers, and fuel and purchased electric energy, with nearly \$17,000,000,000 left after deducting the sum of the above items from the gross value. Out of this remainder must come numerous expenses, such as those for rent, shop and office supplies, taxes, interest, and in some cases, advertising, as well as reserve funds and manufacturing profits. The returns to the Census are not such as to give any indication of the size of these individual items.¹

No indication of the amount of investment in plant and equipment can be gained from the manufacturers' returns, except such as might be suggested by the volume of production. At recent censuses no inquiry concerning capital investment has been carried on the schedules. Although such interest charges as may be required to meet obligations for plant extensions, new machinery, etc., are included in the miscellaneous group of expenditures, arrived at by deduction, their amounts are not reported separately by the manufacturers.

The large item of approximately \$17,000,000,000 is composed, therefore, of such a multitude of payments to the various contributors to the manufacturing processes that it is not very useful for purposes of cost analysis. In part, the sum is a return on capital invested. On the other hand, that portion which goes for taxes may be translated quite directly into wage and salary budgets for public offices and for other governmental projects. Another increment destined for the purchase of shop and office supplies is closely related to the cost of the larger body of materials which enter directly into the products of industry and which are included in the "materials and containers" item in Table 9.

¹ Annual income returns made by manufacturing corporations to the Bureau of Internal Revenue show profits or losses for the year. All manufacturing and nonmanufacturing operations of the companies are covered by the income statements. Of the manufacturing corporations (incorporated concerns accounted for 92.1 per cent of the gross value of output of manufactures in 1929) which submitted corporate income statements to the Treasury covering the year 1929, 55,488 reported combined "statutory net income" of \$5,216,016,000, while 36,742 corporations having no net income reported a total deficit of \$810,243,000. For further details, see *Statistics of Income for 1929*, Bureau of Internal Revenue.

Figures showing the distribution of the gross value of products among the various component items for 1929 and for 1899 follow:

TABLE 9.—DISTRIBUTION OF GROSS VALUE OF MANUFACTURED PRODUCTS AMONG FIVE COMPONENT ITEMS: 1929 AND 1899

	1929		1899	
	Amount	Per cent of gross value	Amount	Per cent of gross value
Gross value of products, total.....	\$70,434,863,000	100.0	\$11,406,927,000	100.0
Salaries ¹	4,195,501,000	6.0	380,771,000	3.3
Wages.....	11,620,973,000	16.5	2,008,361,000	17.6
Materials and containers.....	36,683,414,000	52.1	6,368,712,000	55.8
Fuel and purchased energy.....	1,866,166,000	2.6	207,140,000	1.8
Other expenses, interest, and profits ²	16,068,809,000	22.8	2,441,943,000	21.4

¹ Data for employees of central-administrative offices are included in the figures both for 1929 and for 1899. The salaries of such employees as reported for 1929 amount to \$600,437,000 and exceed salary figures published in other reports of the Census by that amount. The figures are generally omitted from the published totals because in many cases the salaries paid to central-administrative employees who serve establishments classified in a number of industries can not be accurately apportioned among the several industries.

² The addition of \$600,437,000 to the "salaries" figure, as explained in note 1, reduces "other expenses, interest, and profits" by a like amount.

The above method of distributing the items, while commonly resorted to, may be quite misleading. It does not disclose the real comparative importance of the several factors which make up the value of products, because both the gross value itself and the cost of materials and containers are exaggerated on account of the use of the products of some manufacturing plants as materials in others. The cost item for materials and containers comprises both the cost of certain raw materials and that of semimanufactures, which latter, in turn, includes the cost of the raw materials entering into the semimanufactures, as well as the other costs which went into their production. To compare the size of this group of costs with the other relatively clear-cut, unduplicated items for salaries, wages, and other expenses conveys an inaccurate idea of the respective sizes of the several shares. Differences in the percentages of the five items as between the two years will not be commented upon until later in the report, when the duplications of value will have been eliminated and a more nearly accurate basis of comparison established.

TABLE 10.—DISTRIBUTION OF GROSS VALUE OF MANUFACTURED PRODUCTS AMONG COMPONENT ITEMS, BY INDUSTRY GROUPS: 1929

INDUSTRY GROUP	Gross value of products	Salaries ¹	Wages	MATERIALS AND CONTAINERS		Fuel and purchased electric energy	Other expenses, interest, and profits
				Raw materials and imported manufactures	Domestic semi-manufactures		
All groups, total ²	\$70,484,863,000	\$3,595,064,000	\$11,620,973,000	\$14,531,000,000	\$22,152,000,000	\$1,866,166,000	\$16,669,246,000
Food and kindred products.....	12,023,539,000	316,144,000	902,143,000	6,156,000,000	2,315,600,600	161,444,000	2,173,020,000
Textiles and their products.....	9,243,303,000	410,623,000	1,733,031,000	1,907,000,000	3,075,000,000	121,106,000	1,995,802,000
Forest products.....	3,591,765,000	216,713,000	939,333,000	295,000,000	1,255,000,000	35,811,000	849,486,000
Paper and paper products.....	1,892,251,000	94,235,000	287,331,000	319,000,000	1,692,000,000	81,696,000	417,913,000
Printing, publishing, and allied industries.....	3,170,140,000	501,714,000	636,371,000	157,000,000	584,000,000	25,735,000	1,265,570,000
Chemicals and allied products.....	3,759,405,000	201,556,000	354,383,000	821,000,000	1,050,000,000	99,437,000	1,232,942,000
Products of petroleum and coal.....	3,647,748,000	86,236,000	229,050,000	1,895,000,000	248,000,000	408,229,000	785,622,000
Rubber products.....	1,117,460,000	55,353,000	207,306,000	211,000,000	348,000,000	19,677,000	276,124,000
Leather and its products.....	1,905,977,000	84,359,000	339,413,000	343,000,000	775,000,000	13,778,000	330,263,000
Stone, clay, and glass products.....	1,561,415,000	107,156,000	452,817,000	219,000,000	150,000,000	157,531,000	495,102,000
Iron and steel and their products, not including machinery.....	7,137,928,000	310,072,000	1,380,987,000	760,000,000	2,640,000,000	463,128,000	1,583,985,000
Nonferrous metals and their products.....	3,597,058,000	143,719,000	443,467,000	825,000,000	1,576,000,000	64,785,000	544,423,000
Machinery, not including transportation equipment.....	7,043,380,000	562,518,000	1,634,166,000	54,000,000	2,530,000,000	110,297,000	2,152,317,000
Transportation equipment, air, land, and water.....	9,177,299,000	137,029,000	933,222,000	4,000,000	3,625,000,000	53,957,000	1,253,811,000
Railroad repair shops.....	3,984,617,000	34,395,000	697,351,000	-----	517,000,000	31,384,000	2,697,000
Miscellaneous industries.....	3,426,313,000	236,156,000	500,352,000	564,000,000	772,000,000	23,376,000	1,330,184,000

¹ Salaries for employees of central-administrative offices, amounting to \$600,437,000, are not included. See Table 9, footnote 1.

² Each total is the sum, expressed to the nearest thousand, of the individual items expressed in units. For this reason, the totals in some cases may differ slightly from the sums of the items.

TABLE 11.—PER CENT DISTRIBUTION OF GROSS VALUE OF MANUFACTURED PRODUCTS AMONG COMPONENT ITEMS, BY INDUSTRY GROUPS: 1929

[In dividing the gross value of products into the cost of raw materials and the cost of semimanufactures, both divisor and dividend were rounded to the nearest million dollars. The sums of the percentages for some of the groups do not, therefore, equal exactly 100. See Table 10]

INDUSTRY GROUP	Gross value of products	Salaries	Wages	MATERIALS AND CONTAINERS		Fuel and purchased electric energy	Other expenses, interest, and profits
				Raw materials and imported semimanufactures	Domestic semimanufactures		
All groups.....	100.0	16.0	16.5	20.6	31.5	2.6	22.8
Food and kindred products.....	100.0	2.6	7.5	51.2	19.3	1.3	18.1
Textiles and their products.....	100.0	4.4	18.7	20.6	33.3	1.3	21.6
Forest products.....	100.0	6.0	26.2	8.2	34.9	1.0	23.7
Paper and allied products.....	100.0	5.0	15.2	16.9	36.6	4.3	22.1
Printing, publishing, and allied industries.....	100.0	15.8	20.1	4.9	18.4	0.8	39.9
Chemicals and allied products.....	100.0	5.4	9.4	21.8	27.9	2.6	32.8
Products of petroleum and coal.....	100.0	2.4	6.3	52.0	6.8	11.1	21.5
Rubber products.....	100.0	5.0	18.6	18.9	31.2	1.8	24.7
Leather and its manufactures.....	100.0	4.4	18.9	18.0	40.7	0.7	17.3
Stone, clay, and glass products.....	100.0	6.9	27.7	14.1	9.5	10.1	31.7
Iron and steel and their products, not including machinery.....	100.0	4.3	19.3	10.6	37.0	6.5	22.2
Nonferrous metals and their products.....	100.0	4.0	12.3	23.0	43.8	1.8	15.1
Machinery, not including transportation equipment.....	100.0	8.0	23.2	0.8	35.9	1.6	30.6
Transportation equipment, air, land, and water.....	100.0	3.1	15.6	0.1	60.0	0.9	20.4
Railroad repair shops.....	100.0	6.4	50.2	-----	40.7	2.5	0.2
Miscellaneous industries.....	100.0	6.9	14.6	16.5	22.5	0.7	35.8

¹ Basic figure for "All groups" includes salaries paid to central-administrative-office employees; that for each of the 16 groups below does not. See footnotes to Table 9.

The gross value of manufactures exceeds by a considerable margin the amount of wealth created by the manufacturing processes. In the first place, as already pointed out, the gross includes a large amount of duplication due to the use of the products of some establishments as materials by others, and in the second place, it includes the cost of the raw materials derived from farms, mines, and other natural sources of basic materials. To manufacturing industries should be credited only the share of the gross value which is represented by the sum of salaries, wages, and other expenses and profits, an amount referred to in Census reports as "value added by manufacture." This value is calculated by subtracting the cost of materials, containers for products, fuel, and purchased electric energy from the gross value of products. It amounted in 1929 to \$31,885,284,000, or 45.3 per cent of the gross value of products; in 1899 to \$4,831,075,000, or 42.4 per cent of the gross. Value added by manufacture is a figure which contains very little, if any, duplication of value. It measures approximately the contribution of the factory processes to the value of manufactured commodities. This figure falls short of the final, unduplicated sales value of the finished goods by an amount equal to the cost of the raw materials which enter into the goods.

It is highly desirable to know the value, at f. o. b. factory prices, of those manufactured products, and those only, which are made for sale to ultimate consumers. This figure for industry as a whole should equal the value of the raw materials and imported semimanufactures consumed, plus the value added

by the processes of manufacture. Neither of the two values just considered, namely, gross value and value added by manufacture, represents the desired amount, the first being too large and the second too small.

Indirectness of manufacture.—If each manufacturing plant in the country consumed only raw materials and turned out only products ready for ultimate consumption, the figures for the combined output of all plants would give the amount desired (net value). Manufacture, under this hypothetical condition, would consist simply in adding value to given raw materials within a single establishment, and the report made for such an establishment would cover only the value of products made for sale to ultimate consumers. Data for such a hypothetical organization of industry are shown in Figure 2, using figures for the year 1929.

In few industries, however, is the route from the raw-material to the final-product state so direct. Manufacturers tend to specialize, many considering it more profitable to produce one or at most a few kinds of materials or parts on a mass-production basis to be sold to other producers as semimanufactures than to carry the items through to their finished form. In the manufacture of an automobile, for example, one plant may produce wheels, another the engine, a third the body, etc., the processes carried on in the final plant consisting largely in the assembly of component parts furnished by a number of specialized establish-

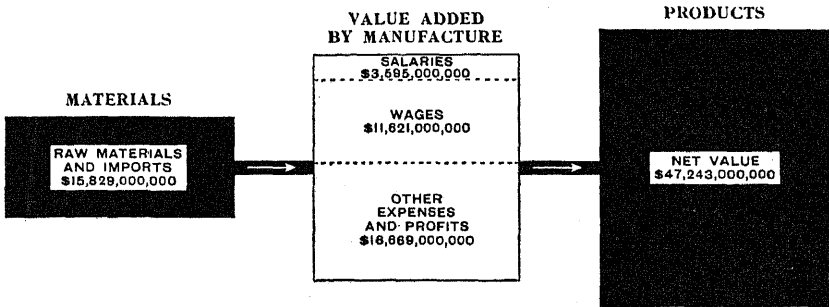


FIGURE 2.—NET VALUE AND COMPONENT ITEMS, BASED ON AN ASSUMED RAW-MATERIAL-TO-FINISHED-PRODUCT ORGANIZATION FOR EACH PLANT: 1929

ments. (In many cases, especially in the motor-vehicle industry, all these plants may be under the same ownership.) Examples of this indirectness of modern manufacture are available in practically all industries.² We speak of this wide distribution of processes among many plants, but we have no conclusive measure of its extent. It would seem that one of the bases for determining its amount would be the change shown from census to census in the volume of semimanufactured materials consumed relative to total production.

The tendency to separate the stages of manufacture, which results in the materials passing from one establishment to another until the production cycle is finally completed, is counteracted to some extent by an opposing trend. The development in some industries of series of semiautomatic machines, thus tele-

² The choice between buying or manufacturing certain required items constitutes a major problem for every industrialist able to finance a vertical organization of his concern or to accomplish the same purpose by a merger. To control all the processes from the raw-material stage to final assembly theoretically insures the manufacturer against many uncertainties and delays resulting from conditions beyond his immediate control. In general, coordination of industrial processes is best attained by complete vertical organization of an enterprise. Some manufacturers who have adopted the plan, however, have decided against it after discovering that it is most profitable in the long run to concentrate their efforts on a few processes, requiring the other manufacturers who furnish materials and parts to share the hazards of the business cycle and other vicissitudes of the market.

scoping processes heretofore separately performed, tends to concentrate the manufacture of a given product in fewer plants.

The passage of a material from the plant where it first enters in a raw state successively through other plants in each of which certain operations are performed upon it and further value added may be illustrated by a simplified hypothetical series of stages in manufacture of wool into clothing.

PLANT NO. 1 (MEAT-PACKING PLANT)

Process: Wool pulling.

Cost of pelts purchased.....	\$1, 000
Value added by manufacture.....	300
Value of pulled wool produced (sold to plant No. 2).....	1, 300

PLANT NO. 2 (WOOLEN MILL)

Processes: Scouring, sorting, blending, picking, carding, combing, spinning, and weaving.

Cost of pulled wool purchased.....	\$1, 300
Value added by manufacture.....	1, 200
Value of cloth produced (sold to plant No. 3).....	2, 500

PLANT NO. 3 (MEN'S-CLOTHING FACTORY)

Processes: Cutting and stitching.

Cost of cloth purchased.....	\$2, 500
Value added by manufacture.....	2, 200
Value of garments produced.....	4, 700

SUMMARY

Gross value of products of plants No. 1, 2, and 3.....	\$8, 500
Cost of materials:	
1. Raw (pelts).....	\$1, 000
2. Semimanufactured (pulled wool and cloth).....	3, 800
Value added by manufacture.....	\$3, 700
Net value of products (gross value less cost of semimanufactured materials).....	\$4, 700
Per cent of duplication in gross value.....	44. 7

These three stages required to convert a sheep pelt into a finished garment, while typical, are not universally followed. Wool pulling is rarely done except in pullery departments of meat-packing plants and none of the processes assigned in the table to woolen mills would be likely to be performed by the packers. On the other hand, the grouping of processes shown for woolen mills may be modified considerably. For example; Scouring, sorting, blending, and picking may be done in a specialized establishment, and the wool may then be sold to the woolen mill, which may complete the manufacture of it into cloth. Or the wool may be carried only through the spinning stage, to be sold thereafter as yarn to woolen mills engaged solely in weaving. Clothing shops would perform none of the processes required to produce finished cloth, their functions being limited to cutting and stitching. Those of the large clothing manufacturers who spin and weave their own cloth conduct those processes in specialized woolen mills for which separate returns covering mill operations are made to the Bureau of the Census.

The number of different industries required for the complete processing of a given manufactured product varies from a single one, as in the fabrication of some of the simpler clay products, to half a dozen or more. The conversion of copper

ingots into automobile parts is a type of production which is broken up into many stages and which consequently results in a great amount of duplication in reported value of output. To illustrate: Copper ingots made in the copper smelting and refining industry are sold to copper-rolling mills, which roll them into rods. The rods are sold to copper-wire mills, which draw them into wire. Wire made by these mills is sold to establishments in the "Electrical machinery, apparatus, and supplies" industry, which use it in the manufacture of ignition apparatus for internal-combustion engines. These establishments sell the ignition apparatus to manufacturers of automobile engines. The engines in turn are sold to automobile manufacturers, who install them in complete automobiles. The value of the automobiles, as reported by the automobile manufacturers, includes, of course, the value of the engines; similarly, the value of the engines includes the value of the ignition apparatus; and so on. Thus in the aggregate of the values of products reported by the copper smelters and refiners, the rod mills, the wire mills, the manufacturers of ignition apparatus, the engine manufacturers, and the automobile manufacturers, the value of the copper ingots is included six times, of the rods five times, of the wire four times, of the ignition apparatus three times, and of the engines twice; and corresponding duplications occur in the aggregate cost of materials.

This duplication in the aggregate value of products of all industries appears also in the value of products reported for a given State, industrial area, county, or city, its amount depending in each instance upon the extent to which the products of certain establishments become the materials for remanufacture in other establishments in the same political division or industrial area. There is probably no city of any industrial importance in which the total value of products reported for its industries represents the actual value of output ready for ultimate consumption.

Determination of net value of products.—The next step is to measure for all industries the amount of this duplication of value and to arrive at the aggregate net value of output. Three general methods of approach are possible:

1. Compute the aggregate value of those products which are completely manufactured and are therefore ready for ultimate consumption.
2. From the gross value of products deduct the cost of semimanufactures used as materials in manufacturing establishments. The remainder is net value.
3. Add to the computed cost of raw materials and fuel consumed the value added by manufacture (equal to the total of salaries, wages, other expenses, except materials and fuel, and profits).

The first method is impracticable. To go over the list of thousands of manufactured items and to select those which will not become materials for further manufacture would be extremely laborious, and the results would be of uncertain value. Consider the many items such as paint, hardware, glass, fabrics, and chemicals, which, though in a sense finished, are nevertheless used in considerable quantities as materials for further manufacture. To compute, with any close approximation of accuracy, the value of those only which are destined for household and other nonmanufacturing uses would be impossible.

The second method calls for the summation of the costs of thousands of semi-manufactured materials consumed by factories, a procedure closely related to the one described in the preceding paragraph. Many of these materials are specified on the manufacturers' returns; many more are not. When it is realized how many are the component parts, often purchased from numerous vendors, required for the assembly, for example, of any complex piece of machinery, the magnitude of such a task is evident. To illustrate: According to the classification of units which appears on the engineering releases of one of the large automotive manufacturers, the number of parts required for the assembly of a current model of a standard

sedan automobile is 10,118. The total number of *different kinds* of parts on this same car, exclusive of parts purchased from vendors, is 1,993. A second type of standard sedan made by the same company is composed of 9,363 parts, a third of 8,926, and a fourth of 7,582. These figures cover parts made by the company which assembles the finished car, but not those purchased from outside manufacturers, such as generators, carburetors, distributors, gages, instruments, locks, etc. The purchased items, if separately listed, might equal in number those made by the manufacturer of the car.

TABLE 12.—COST OF MATERIALS AND CONTAINERS, FUEL, AND PURCHASED ELECTRIC ENERGY, BY INDUSTRY GROUPS: 1929

INDUSTRY GROUP	Total	MATERIALS AND CONTAINERS		FUEL AND ENERGY	
		Raw	Semimanufactured	Coal, natural gas, and purchased energy	Manufactured fuels
All groups, total.....	\$38,549,579,732	\$12,676,402,000	\$24,007,012,000	\$1,298,319,367	\$567,846,352
Food and kindred products.....	8,632,282,857	5,677,515,000	2,793,324,000	134,218,841	27,224,952
Textiles and their products....	5,103,845,724	1,578,341,000	3,404,400,000	109,173,933	11,930,830
Forest products.....	1,586,182,953	236,593,000	1,313,779,000	31,219,400	4,591,249
Paper and allied products.....	1,092,722,103	223,178,000	787,848,000	75,131,224	6,564,587
Printing, publishing, and allied industries.....	766,483,548	-----	740,748,000	22,147,106	3,588,053
Chemicals and allied products.	1,970,713,269	564,629,000	1,306,647,000	84,474,662	14,962,658
Products of petroleum and coal.	2,546,840,193	1,895,299,000	248,318,000	294,764,176	108,461,352
Rubber products.....	578,677,681	210,234,000	348,767,000	19,067,788	609,587
Leather and its manufactures...	1,131,941,963	293,511,000	824,653,000	13,181,407	596,494
Stone, clay, and glass products.	526,339,979	206,145,000	162,664,000	138,813,844	18,716,826
Iron and steel and their products, not including machinery	3,862,873,486	647,917,000	2,751,828,000	166,994,501	296,133,346
Nonferrous metals and their products.....	2,465,444,198	576,971,000	1,823,689,000	43,503,460	21,281,525
Machinery, not including transportation equipment.....	2,694,379,629	49,508,000	2,534,575,000	78,113,499	32,183,361
Transportation equipment, air, land, and water.....	3,683,148,078	3,781,000	3,625,410,000	41,153,215	12,803,903
Railroad repair shops.....	548,343,565	-----	517,160,000	26,678,923	4,504,808
Miscellaneous industries.....	1,359,360,506	512,780,000	823,204,000	19,683,338	3,692,841

¹ Includes \$38,263,293, cost of crude oil used as fuel.

The third method for eliminating duplication in cost of materials and value of products entails the segregation of the cost of all raw materials and of imported semimanufactured materials consumed from that of domestic semimanufactured materials. It requires that the reported or estimated cost of raw materials and of imported semimanufactures be determined, industry by industry, and then deducted from the total cost of materials, in order to arrive at a figure representing the cost of domestic semimanufactured materials used. The cost of materials divided in this manner discloses wide differences in materials usage in the 16 industry groups.

Before arranging the data so as to permit the computation of the net value of output for each of the 16 groups of industries, figures have been brought together in Table 13 to bring out merely the nature of the materials consumed by the several groups, regardless of whether they are of domestic or of foreign origin. The basic statistics for this classification appear in Table 23.

TABLE 13.—PER CENT DISTRIBUTION OF COST OF RAW MATERIALS, SEMI-MANUFACTURED MATERIALS, UNMANUFACTURED FUEL, AND MANUFACTURED FUEL, BY INDUSTRY GROUPS: 1929

INDUSTRY GROUP	Total	MATERIALS AND CONTAINERS		FUEL AND PURCHASED ELECTRIC ENERGY	
		Raw	Semi-manufactured	Coal, natural gas, and purchased energy	Manufactured fuels
	Per cent 100.0	Per cent 32.9	Per cent 62.3	Per cent 3.4	Per cent 1.5
All groups, total.....	100.0	32.9	62.3	3.4	1.5
Food and kindred products.....	100.0	65.8	32.4	1.6	0.3
Textiles and their products.....	100.0	30.9	66.7	2.1	0.2
Forest products.....	100.0	14.9	82.8	2.0	0.3
Paper and paper products.....	100.0	20.4	72.1	6.9	0.6
Printing, publishing, and allied industries.....	100.0	-----	96.6	2.9	0.5
Chemicals and allied products.....	100.0	28.7	66.3	4.3	0.8
Products of petroleum and coal.....	100.0	74.4	9.7	11.6	4.3
Rubber products.....	100.0	36.3	60.3	3.3	0.1
Leather and its manufactures.....	100.0	25.9	72.9	1.2	0.1
Stone, clay, and glass products.....	100.0	39.2	30.9	26.4	3.6
Iron and steel and their products, not including machinery.....	100.0	16.8	71.2	4.3	7.7
Nonferrous metals and their products.....	100.0	23.4	74.0	1.8	0.9
Machinery, not including transportation equipment.....	100.0	1.8	94.1	2.9	1.2
Transportation equipment, air, land, and water.....	100.0	0.1	98.4	1.1	0.3
Railroad repair shops.....	100.0	-----	94.3	4.9	0.8
Miscellaneous industries.....	100.0	37.7	60.6	1.4	0.3

¹ The figures from which this percentage was computed include \$38,283,000, representing cost of crude oil used as fuel.

Two groups, "Food and kindred products" and "Products of petroleum and coal" lead all others by wide margins in the percentages which the cost of raw materials forms of the cost of all materials (65.8 per cent and 74.4 per cent, respectively). The question at once arises why these groups of industries consume greater proportions of raw materials than do other groups of basic industries, such as "Forest products" and "Stone, clay, and glass products." The answer in brief is that comparatively little semimanufactured material, obtained either from the same or from other industry groups, is required for production in either the food group or the petroleum group.

For example: In five industries in the food group—those engaged in the manufacture of butter, livestock feed, flour and other grain-mill products, and meat products, and in the roasting and grinding of coffee and spice—the raw material costs averaged about 87 per cent of the total material costs. In these industries the amount of fabrication required to prepare raw materials for ultimate consumer use is relatively small. Containers are required, and of course some semimanufactured materials, but in general the raw materials which enter a given plant are themselves processed, but combined to only a slight extent with other materials, and they then leave the plant approximately ready for distribution to ultimate consumers. This is the type of fabrication which was often carried on in small local plants before the advent of modern, centralized, mass production.

The processes employed in manufacture in the "Products of petroleum and coal" group are, in general, more complex. They are, however, like those of the food group, largely analytical; in other words, they consist primarily in breaking down raw materials into component products, not in assembling them with other materials.

The "Forest products" group, with only 14.9 per cent of its material cost expended for raw commodities offers a striking contrast to the other two groups. The reason that the cost of its raw materials is so small a percentage of the total material cost is that the processes required to convert the logs into finished products are divided among two or more industries. The sequence is approximately as follows: Standing timber is the material from which logs are made in the first manufacturing process in the "Lumber and timber products" industry. The logs as materials then enter the sawmills (in the same industry), where they are cut into boards. The boards in turn pass to the "Planing-mill products" industry for planing,³ after which they may be purchased by furniture plants and other establishments in the finishing industries for conversion into furniture, etc. The result is that only in the first stage of manufacture in the "Lumber and timber products" industry is there any raw material consumed; the logs and boards consumed by the sawmill, the planing mill, and the furniture plant, having once been reported as products, have become semimanufactures for consumption in the second and subsequent stages.

It will be noted that the printing and publishing industries, two groups of industries in which machinery and transportation equipment are manufactured, and finally, the group composed of railroad repair shops, consume practically no raw materials whatever, except unmanufactured fuels. The materials and component parts required for their production and assembly operations are first processed in pulp and paper mills, in blast furnaces, in foundries, in textile mills, etc., before they enter the plants of these four industry groups.

It appears, therefore, that the distribution of the cost of materials among raw commodities and semimanufactures in any industry group depends upon the plan of classification, but that that plan generally follows the practice of industry in distributing processes among specialized lines of manufacture. The industries engaged in the basic analytical processes have comparatively high raw-material costs; those which carry manufacture through the intermediate and final stages of production engage in synthesis or assembly, which requires the collection of semimanufactured materials and parts from numerous other specialized industries.

³ In many cases planing mills are operated in conjunction with sawmills, and these combined mills are classified in the "Lumber and timber products" industry.

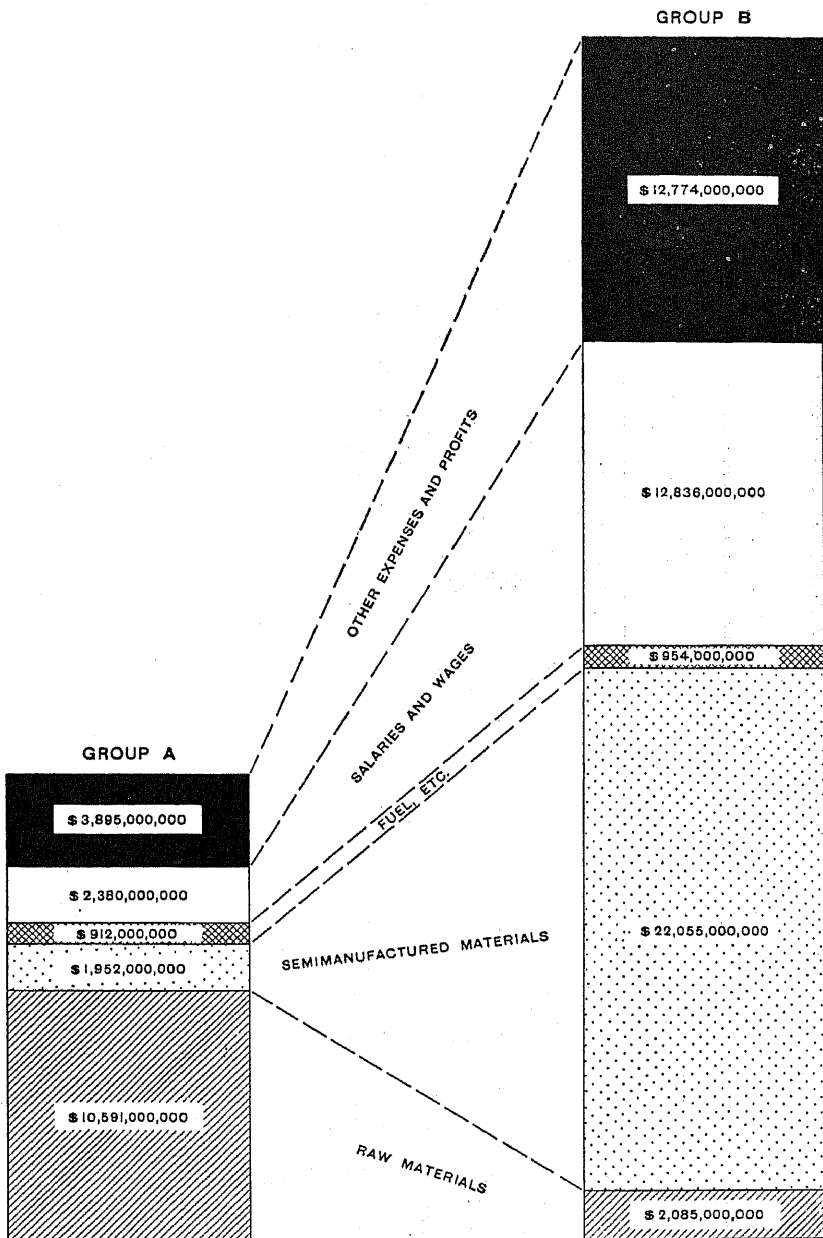


FIGURE 3.—GROSS VALUE OF PRODUCTS AND COMPONENT ITEMS FOR 68 RAW-MATERIAL-CONSUMING INDUSTRIES (GROUP A) AND FOR 258 SEMIMANUFACTURED-MATERIAL-CONSUMING INDUSTRIES (GROUP B): 1929

TABLE 14.—VALUE OF PRODUCTS AND COMPONENT ITEMS FOR 68 RAW-MATERIAL-CONSUMING INDUSTRIES, BY INDUSTRY GROUPS: 1929

[For list of industries included, see p. 57]

INDUSTRY GROUP	Num-ber of in-du-s-tries	Gross value of products	Salaries and wages	Cost of fuels and purchased energy	Cost of raw materials ¹	Cost of semi-manufactured materials ¹	Other expenses, interest and profits
68 Industries, total.....	68	\$19, 730, 045, 335	\$2, 379, 674, 748	\$912, 106, 900	\$10, 591, 246, 000	\$1, 951, 935, 000	\$3, 895, 082, 733
Food and kindred products.....	19	8, 387, 590, 174	602, 617, 732	76, 939, 152	5, 522, 681, 000	1, 039, 356, 000	1, 145, 996, 672
Textiles and their products.....	11	2, 785, 658, 585	647, 680, 601	65, 210, 265	1, 175, 283, 000	361, 186, 000	507, 317, 589
Forest products.....	4	267, 654, 773	31, 699, 522	1, 174, 698	23, 307, 000	9, 674, 000	21, 309, 079
Paper and paper products.....	4	637, 823, 679	36, 823, 708	14, 330, 410	104, 829, 000	29, 594, 000	51, 651, 842
Chemicals and allied products.....	0	637, 823, 679	36, 823, 708	15, 982, 734	383, 588, 000	70, 588, 000	95, 148, 469
Products of petroleum and coal.....	2	3, 589, 665, 054	306, 830, 858	2 400, 133, 267	1, 894, 449, 000	206, 768, 000	760, 785, 175
Leather and its manufactures.....	1	481, 340, 269	49, 652, 960	6, 740, 653	283, 511, 000	37, 346, 000	64, 679, 475
Stone, clay, and glass products.....	8	692, 877, 571	354, 032, 309	122, 118, 477	174, 037, 000	17, 987, 000	323, 922, 830
Iron and steel and their products, not including machinery.....	1	771, 435, 464	48, 204, 633	193, 671, 870	400, 449, 000	16, 172, 000	112, 326, 835
Nonferrous metals and their products.....	3	245, 236, 091	39, 704, 354	12, 612, 869	131, 106, 000	24, 621, 000	47, 191, 793
Miscellaneous industries.....	8	1, 568, 355, 968	173, 730, 303	3, 193, 025	487, 995, 000	138, 664, 000	764, 752, 974

¹ The total is the sum, expressed to the nearest thousand, of the individual items expressed in units. For this reason, the totals differ slightly from the sums of the items below.

² Includes \$38,263,293, cost of crude oil used as fuel.

TABLE 15.—VALUE OF PRODUCTS AND COMPONENT ITEMS FOR 258 SEMIMANUFACTURED-MATERIAL-CONSUMING INDUSTRIES, BY INDUSTRY GROUPS: 1929

INDUSTRY GROUP	Num-ber of indus-tries	Gross value of products	Salaries and wages	Cost of fuels and purchased energy	Cost of raw mate-rials ¹	Cost of semiman-ufactured mate-rials ¹	Other expenses, interest, and profits
258 industries, total.....	258	\$50,704,818,108	\$12,836,362,567	\$954,059,299	\$2,085,156,000	\$22,055,076,000	\$12,774,163,663
Food and kindred products.....	13	3,635,999,115	615,668,936	84,504,641	154,834,000	1,763,968,000	1,027,023,092
Textiles and their products.....	42	6,486,645,938	1,495,973,930	55,894,548	403,078,000	3,043,215,000	1,488,484,779
Forest products.....	16	3,504,600,317	1,124,396,653	34,635,951	213,286,000	1,304,105,000	828,176,883
Paper and paper products.....	9	1,653,922,869	343,092,251	67,365,381	118,350,000	1,768,284,000	366,261,244
Printing, publishing, and allied industries.....	13	3,170,139,651	1,138,085,787	25,735,159	740,748,000	1,265,570,316	1,265,570,316
Chemicals and allied products.....	24	3,137,600,563	499,202,303	83,454,586	181,071,000	1,286,079,000	1,137,793,622
Products of petroleum and coal.....	2	79,081,903	8,754,967	3,092,741	41,547,000	41,547,000	1,24,836,764
Rubber products.....	3	1,117,460,252	262,658,438	19,677,375	850,000	348,767,000	276,124,133
Leather and its manufactures.....	9	1,424,036,476	364,708,673	7,037,268	210,234,000	787,307,000	265,583,708
Stone, clay, and glass products.....	12	568,537,019	185,270,918	35,412,193	32,048,000	144,677,000	171,178,694
Iron and steel and their products, not including machinery.....	25	6,366,502,594	1,642,284,255	269,456,977	247,468,000	2,735,656,000	1,471,698,544
Nonferrous metals and their products.....	20	3,341,821,626	547,481,288	52,172,616	445,864,000	1,799,068,000	497,235,854
Machinery, not including transportation equipment.....	16	7,043,850,390	2,196,683,792	110,296,860	46,508,000	2,534,575,000	2,152,316,969
Transportation equipment, air, land, and water.....	10	6,047,209,390	1,130,250,459	53,957,118	3,781,000	3,625,410,000	1,233,810,853
Railroad repair shops.....	2	1,269,916,839	171,806,127	31,183,731	517,100,000	517,100,000	2,067,137
Miscellaneous industries.....	42	1,857,963,166	563,023,790	20,183,154	24,785,000	684,540,000	565,431,061

¹The total is the sum, expressed to the nearest thousand, of the individual items expressed in units. For this reason, the total cost of raw materials differs slightly from the sum of the items below.

When the 326 industries are divided into two groups according to the percentage which the cost of raw materials forms of the total cost of materials and containers, 68 industries stand out as the principal consumers of crude materials. They are the ones in which more than half the total expenditure for materials goes for raw commodities. In fact, almost 54 per cent of the gross value of output of these industries is represented by outlays for crude materials consumed, in comparison with only about 10 per cent for purchased semimanufactures. (See Tables 14 and 15 and Figure 3.) In the remaining 258 industries the cost of semimanufactures, as a percentage of the value of products, amounts to about 44 per cent, that of raw materials 4 per cent. The relatively large expenditure for fuels in the raw-material-consuming industries is noteworthy.

The next step in determining net value is so to combine the cost of raw and semimanufactured materials consumed as to make possible the calculation of the net figure.

To the cost of raw materials must be added the cost of imported semimanufactures consumed in domestic factories.⁴ The latter may be determined in part from the returns of certain of the industries, on which imported as well as domestic semimanufactures are specified, and in part from estimates based upon import statistics. The cost of *old* scrap materials consumed should also be added to the raw-material expenditures, but new scrap is treated as a semimanufactured material (see page 10). The sum of these three items plus the cost of unmanufactured fuels is next combined with the value added by manufacture (or, now that the cost of domestic semimanufacture has been found by deduction, this item may be subtracted from the gross value of products) (Table 16). The process of arriving at net value is then complete, except for the deduction of receipts for contract work to the amount of \$471,957,935 from the results for two industry groups. This is done because payment for contract work represents clear duplication of value. (Since the concern doing the work reports the receipts from contract work as the value of its products and the manufacturer for whom the work is done adds it to the cost of his materials and is paid for it in receipts from his production, the amount appears twice in value of products.)

⁴ Imported semimanufactures, like raw materials, are in the condition in which they enter for the first time into manufacturing operations in this country.

TABLE 16.—ESTIMATED NET VALUE OF MANUFACTURED PRODUCTS, BY INDUSTRY GROUPS: 1929

[While the net-value figure in the final column for "All groups" represents the value of all the finished products of industry, the 16 items for the individual-industry groups which together make up the total net value of products do not represent exactly the value of completely manufactured products for the respective groups. For example, to arrive at the value of "Food and kindred products" ready for ultimate consumption it would be necessary to add to the \$9,682,000,000 item an estimated cost of containers obtained from other industry groups. On the other hand, for the "Rubber products" group it would be necessary to deduct from the gross-value figure the estimated value of rubber semi-manufactures, such as tires sold for initial installation on motor vehicles.]

INDUSTRY GROUP	COST OF MATERIALS, CONTAINERS, FUEL, AND PURCHASED ELECTRIC ENERGY					VALUE OF PRODUCTS	
	Total	Fuel and purchased electric energy		Raw materials and imported semimanufactures ¹	Domestic semi-manufactures ¹	Gross	Net ¹
		Coal, natural gas, and purchased energy	Manufactured fuels				
All groups, total.....	\$38,549,579,732	\$1,298,319,367	\$567,846,352	\$14,581,000,000	\$22,152,000,000	\$70,434,868,443	\$47,248,000,000
Food and kindred products.....	8,632,282,857	134,218,841	27,224,952	6,156,000,000	2,315,000,000	12,023,589,280	9,682,000,000
Textiles and their products.....	3,438,785,753	99,173,463	14,530,830	1,937,000,000	3,245,000,000	3,243,302,523	3,525,000,000
Forest products.....	1,036,782,753	71,119,294	6,584,587	310,000,000	1,692,000,000	1,892,251,148	2,194,000,000
Paper and paper products.....	1,002,272,403	22,137,294	3,588,457	157,000,000	884,000,000	3,179,439,651	3,412,000,000
Chemicals and allied products.....	766,482,543	87,474,662	14,962,658	821,000,000	1,050,000,000	3,759,404,640	2,692,000,000
Products of petroleum and coal.....	1,970,719,963	424,764,176	108,461,362	1,895,000,000	248,000,000	3,647,747,957	2,291,000,000
Rubber products.....	2,546,847,193	10,067,788	609,587	1,211,000,000	348,000,000	1,117,460,252	2,769,000,000
Leather and its manufactures.....	1,136,841,063	13,181,407	598,494	343,000,000	775,000,000	1,905,976,775	1,130,000,000
Stone, clay, and glass products.....	520,830,970	138,813,844	18,716,826	219,000,000	150,000,000	1,561,414,590	1,393,000,000
Iron and steel and their products, not including machinery.....	3,862,873,486	466,904,501	296,133,346	760,000,000	2,640,000,000	7,137,928,058	4,202,000,000
Nonferrous metals and their products.....	2,465,444,798	43,503,480	21,281,525	825,000,000	1,576,000,000	3,597,057,717	2,000,000,000
Machinery, not including transportation equipment.....	2,694,379,629	78,113,499	32,183,361	64,000,000	2,530,000,000	7,043,380,390	4,481,000,000
Transportation equipment, air, land, and water.....	3,683,148,078	41,153,215	12,803,903	4,000,000	3,625,000,000	6,047,209,390	2,409,000,000
Railroad repair shops.....	548,343,563	26,678,923	4,504,808	4,000,000	517,000,000	1,269,916,839	748,000,000
Miscellaneous industries.....	1,359,360,800	19,683,338	3,692,841	594,000,000	772,000,000	3,426,319,134	2,651,000,000

¹ The total is the sum, expressed to the nearest million, of the individual items expressed in units. For this reason, the total cost of raw materials and imported semimanufactures differs slightly from the sum of the items below.
² Amount deducted, \$302,059,330, representing receipts for contract work.
³ Amount deducted, \$169,898,605, representing receipts for contract work.
⁴ Contains \$38,263,263, which represents the cost of crude oil used as fuel.

The net value was 67 per cent of gross value in 1929; in other words, one-third of the gross value represented duplication. (See Fig. 4.)

In a strict sense, the term *net value* as here used does not measure precisely the cost of raw materials plus the value created in manufacturing establishments. Fixed capital assets, represented by plant, machinery, and equipment, undergo more or less wear and tear in the process of manufacture. Some share of the factory output is required, therefore, to cover the costs of obsolescence and depreciation of capital equipment before there can be said to be a genuine net product. Since census data afford no exact knowledge of the amount of the output required for replacement of worn-out capital assets, this item was left out of consideration in the net-value calculations.

For those purposes which require an estimate for *net value added to existing wealth*, rather than one for *net value of transactions or sales*, probably the best procedure for revising the estimate made in this study would be to deduct the sum which the Bureau of Internal Revenue permits manufacturing corporations to charge off for depreciation and depletion. The amount thus allowed was \$2,017,754,000 for the year 1929, which, if deducted from the net-value figure

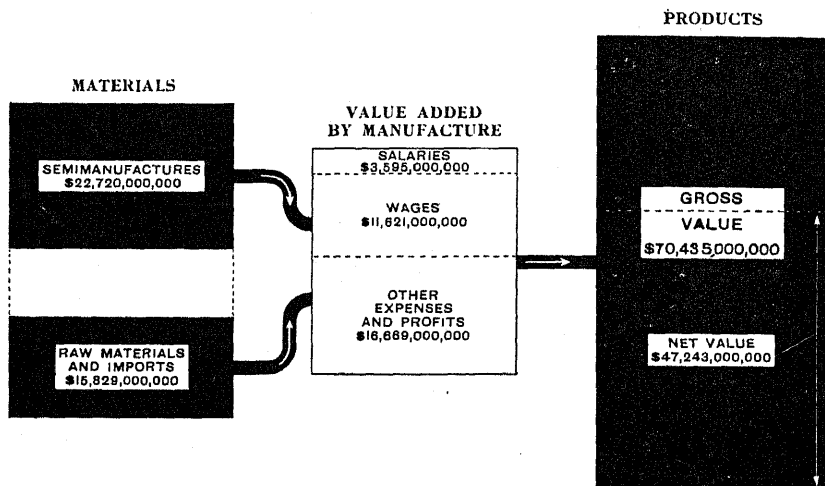


FIGURE 4.—GROSS VALUE OF PRODUCTS, NET VALUE, AND COMPONENT ITEMS: 1929

shown herein, would leave approximately \$45,225,000,000 as the corrected estimate for 1929.⁵

The estimated cost of domestic semimanufactures, \$22,152,000,000—the principal duplicated item—measures the volume of transactions among manufacturers themselves; that is, it represents the amount paid by manufacturers for materials which had been processed previously by other manufacturers. It is not meant to imply that all these transactions were made direct from manufacturer to manufacturer; in fact, a large though indeterminable share of them was made through middlemen. On the other hand, these figures do not cover all transactions between manufacturers, since the cost of machinery and major equipment purchased by manufacturers for use in their plants is not embraced in the total cost of materials, containers, etc. In fact, no canvass of such purchases is made as part of the census of manufactures, although an inventory of certain items of machinery and equipment is called for from a few industries. The other item for semimanu-

⁵ See *Statistics of Income for 1929*, Bureau of Internal Revenue, p. 267.

factures, that for "manufactured fuels" consumed in manufacturing establishments, is first the product of several industries in the "Products of petroleum and coal" group.

The original plan for this study called for an itemization of the major items of semimanufactures consumed in somewhat the way that raw materials are specified in Table 23. However, since that step is not required in order to arrive at an estimate for the net value of products, it was thought best not to attempt it at this time. Such an analysis should throw considerable light on the interdependence of manufacturing industries by further examining the nature of the interchange of materials and products between manufacturers and the flow of semi-manufactured goods from plant to plant and from industry to industry in the course of manufacture. For example, the \$22,152,000,000 which represents the cost of domestic semimanufactures, if distributed by industries and by commodities, would give some indication of the extent to which the steel industry is dependent upon a market for semiprocessed steel in the automotive industry and the plants engaged in shoe manufacture sustain those of the tanning industry. It is this industrial interdependence, born of a highly specialized form of organization, which constitutes one of the principal obstacles to the attainment of stability of manufacturing operations.

It should be pointed out also that while the net total for all groups is the estimated net value of all finished products, the net items for the respective groups differ somewhat from the actual values of finished products made therein. To illustrate: The net value of products of the group "Products of petroleum and coal" was \$3,291,000,000 in 1929. Some of this output was sold to manufacturers in other industry groups who purchased it as "manufactured fuels" and for whom it became a semimanufactured material for further use in manufacture. Also, fabrics produced by manufacturers in the textile group are purchased by automotive manufacturers in the transportation-equipment group for use in motor-vehicle assembly. It would have been desirable, but altogether impracticable, to estimate the net values of *all finished products* made in the respective groups.

TABLE 17.—CONSUMPTION OF FUEL, BY KIND, QUANTITY, AND COST, AND OF PURCHASED ELECTRIC ENERGY, BY QUANTITY AND COST, BY INDUSTRY GROUPS: 1929

INDUSTRY GROUPS	Total cost of fuel and purchased electric energy (dollars)	COAL				CORE		FUEL OILS (INCLUDING CRUDE OIL AND GAS OILS USED AS FUEL)	
		Anthracite		Bituminous		Tons (2,000 lbs.)	Cost (dollars)	Gallons	Cost (dollars)
		Tons (2,240 lbs.)	Cost (dollars)	Tons (2,000 lbs.)	Cost (dollars)				
All industries, total.....	1,973,803,329	9,281,416	43,543,316	214,024,754	754,509,376	52,391,839	243,619,015	6,583,198,995	212,639,372
1. Food and kindred products.....	161,443,793	1,287,545	8,680,005	13,144,380	46,702,044	623,348	5,411,507	331,619,432	11,403,673
2. Textiles and their products.....	121,100,813	1,296,725	5,922,404	7,642,549	37,110,515	39,151	84,358	273,438,314	9,490,392
3. Forest products.....	35,810,649	126,577	776,284	2,998,064	12,301,873	29,093	110,007	163,537,717	2,259,256
4. Paper and allied products.....	81,695,791	1,181,761	5,292,763	10,247,091	42,728,436	3,198	18,861	136,831,638	4,571,267
5. Printing, publishing, and allied industries.....	25,735,159	101,395	806,980	402,842	2,223,373	7,173	54,795	17,189,760	651,732
6. Chemicals and allied products.....	99,437,420	738,958	3,469,898	10,440,086	37,410,769	290,267	1,596,980	265,888,621	8,854,457
7. Products of petroleum and coal.....	510,923,138	587,953	2,590,164	95,886,128	324,437,827	3,193,941	14,731,200	3,698,786,710	51,639,557
8. Rubber products.....	19,677,375	84,299	389,987	2,303,542	8,279,167	472	2,666	19,993,678	543,440
9. Leather and its manufactures.....	13,777,901	78,993	485,262	1,494,015	6,284,347	4,062	19,347	10,253,045	353,879
10. Stone, clay, and glass products.....	157,530,670	709,745	3,701,227	22,045,960	73,968,001	154,105	807,684	344,495,539	11,965,101
11. Iron and steel and their products, not including machinery.....	463,127,847	685,004	2,533,013	20,151,562	87,168,774	45,270,251	198,158,259	1,181,165,911	47,015,826
12. Nonferrous metals and their products.....	64,784,985	4,074,917	4,298,113	3,547,241	13,767,132	729,552	5,937,936	299,807,072	12,395,034
13. Machinery, not including transportation equipment.....	110,296,860	400,611	2,061,943	5,989,924	24,745,430	1,830,182	14,972,293	190,413,278	9,122,904
14. Transportation equipment, air, land, and water.....	53,957,118	97,711	443,181	3,991,008	14,878,691	184,913	1,272,221	141,159,919	6,289,895
15. Railroad repair shops.....	31,883,731	638,054	1,302,244	7,125,779	14,886,160	29,084	1,151,126	159,670,176	4,001,376
16. Miscellaneous industries.....	23,376,179	147,505	1,968,139	1,732,084	7,536,885	50,207	392,186	46,936,860	1,798,733

INDUSTRY GROUPS	GASOLINE AND KEROSENE		GAS				OTHER FUELS		PURCHASED ELECTRIC ENERGY	
	Gallons	Cost (dollars)	Natural		Manufactured		Cost (dollars)	Kilowatt-hours	Cost (dollars)	
			M cubic feet	Cost (dollars)	M cubic feet	Cost (dollars)				
All industries, total.....	46,473,195	7,556,341	2,422,826,799	86,369,465	3,128,450,089	3,127,571,114	22,391,453	37,393,833,046	475,633,577	
1. Food and kindred products.....	4,149,554	648,193	34,752,338	8,664,105	5,572,968	6,610,633	3,150,941	4,171,254,936	70,170,686	
2. Textiles and their products.....	1,468,447	217,594	1,750,325	364,202	1,536,455	1,536,455	632,121	4,832,919,344	65,776,859	
3. Forest products.....	5,177,410	977,970	2,492,916	522,400	1,493,761	1,506,570	926,546	820,277,136	17,568,741	
4. Paper and allied products.....	1,773,735	297,795	12,411,249	1,092,428	164,323	95,265	1,852,389	2,979,395,234	26,047,597	
5. Printing, publishing, and allied industries.....	474,321	75,489	1,705,525	711,855	2,085,372	1,794,528	708,509	686,333,145	18,404,898	
6. Chemicals and allied products.....	1,631,208	225,869	11,973,193	2,318,331	1,473,869	1,090,956	3,284,387	6,965,135,933	41,235,664	
7. Products of petroleum and coal.....	530,504	71,390	129,902,410	17,545,308	298,213,785	54,842,325	3,117,803	1,128,874,465	11,957,564	
8. Rubber products.....	172,719	30,000	1,296,559	167,059	32,152	32,585	906	882,449,734	10,240,575	
9. Leather and its manufactures.....	99,080	14,140	95,579	38,363	133,044	128,957	80,191	227,718,474	6,373,415	
10. Stone, clay, and glass products.....	2,953,680	461,898	121,038,585	24,452,853	2,900,370	1,913,389	3,568,754	2,845,260,065	36,691,763	
11. Iron and steel and their products, not including machinery.....	3,565,192	554,949	68,298,915	20,013,680	925,688,163	47,708,452	2,695,860	4,986,174,297	57,268,434	
12. Nonferrous metals and their products.....	1,826,395	259,976	24,609,575	4,099,339	3,022,557	2,185,461	503,118	2,147,087,553	21,368,871	
13. Machinery, not including transportation equipment.....	11,464,833	1,450,297	9,004,736	3,797,719	8,103,422	5,275,651	1,362,216	2,822,563,455	47,508,407	
14. Transportation equipment, air, land, and water.....	11,987,431	2,174,035	3,316,274	1,135,248	4,503,938	2,837,818	229,994	1,625,101,980	24,696,095	
15. Railroad repair shops.....	1,063,258	188,097	6,345,839	1,083,068	137,965	118,913	45,296	618,311,793	9,397,461	
16. Miscellaneous industries.....	1,133,469	176,644	532,776	351,517	1,251,626	1,092,355	232,422	454,942,503	10,826,847	

¹The difference between the total cost of fuel and purchased energy as shown in this table, \$1,973,863,329, and the corresponding total as given in other tables, \$1,869,165,719, is found in the fact that the figure given here represents the total cost of all fuel actually consumed in manufacturing industries, including that produced and consumed in the petroleum-refining, manufactured-gas, and coke industries, whereas the figure in other tables covers only the cost of fuel purchased.

²The figures for natural gas do not include data for 25,836,328 M cubic feet used in mining and quarrying nor for considerable quantities consumed in the so-called "service industries," which are not covered by the census of manufactures. To determine the total consumption of natural gas in manufactures it would be necessary to add to the total shown in this report the quantity used as a material in the "Bone black, carbon black, and lampblack" industry, but census data therefor are incomplete, some of the manufacturers having failed to report their consumption of gas. The Bureau of Mines reports the consumption of 261,107,000 M cubic feet in this industry in 1929.

³The amount of manufactured gas as reported for certain States, industry groups, and industries, appears abnormal in comparison both with the published figures for manufactured gas produced and sold by commercial gas companies and with those for gas consumption reported by the census of manufactures for 1919. The reason for the first condition is found in the inclusion of data for blast-furnace, coke-oven, and petroleum gases, the consumption in 1929 of these gases in steel works and rolling mills, coke and gas plants, cast-iron pipe plants, and structural and ornamental iron manufacturing establishments having aggregated 1,215,451,289 M cubic feet, at a cost of \$97,431,850. This cost—in many instances merely a transfer charge between plants or departments—reduced the average unit price of the aggregate amount consumed in manufactures to a point far below the usual market rate for manufactured gas. The reasons for the increase in reported gas consumption for 1929 as compared with 1919 are found largely in improved methods of recovering, purifying, and utilizing what were formerly waste by-product gases, permitting the transfer of greatly increased quantities of gas from coke ovens and blast furnaces to steel works and rolling mills and to other steel-fabricating plants, and by the inclusion in the recent figures of data for gases produced and consumed in the same plants, or in plants under the same ownership.

Material costs and net value.—Now that the amount of duplication in the cost of materials has been determined and an estimated net value of products found, the several components of product value bear a different relation to one another from that shown in Tables 10 and 11, in which they are proportioned on the basis of gross value. In the former table the figure labeled "Materials and containers" is not truly that, for in addition to the cost of the raw materials there is included in the item a considerable amount covering labor and other

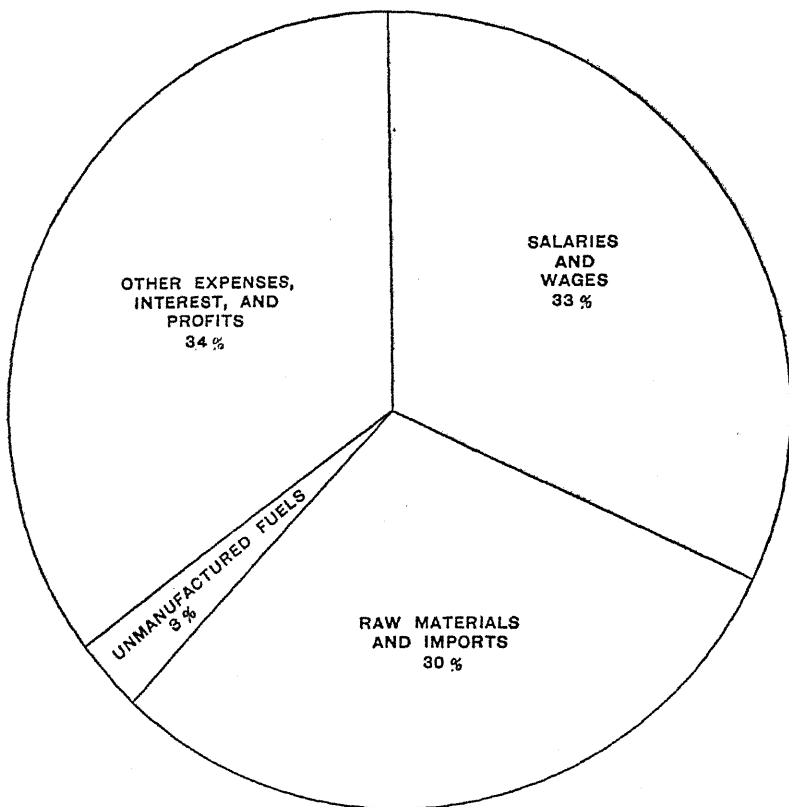


FIGURE 5.—PER CENT DISTRIBUTION OF ELEMENTS IN NET VALUE OF PRODUCTS: 1929

manufacturing costs. The relationship between the several unduplicated items of cost and value may be seen in the percentages in Table 18. It should be pointed out, however, that since the cost of even the raw materials to the manufacturer includes a certain amount of labor cost,⁶ the wage and salary item in

⁶ For example, the salaries and wages paid in the mining and quarrying industries in 1929 amounted to \$137,639,000 and \$1,091,990,000, respectively; the amount expended in cash for farm labor (exclusive of housework) was \$955,420,000. (This figure does not cover compensation to farm owners or operators.)

manufacturing industries falls short of measuring the actual payment to direct and indirect labor for a given manufactured product.⁷

The Bureau of the Census puts forth no claim that its manufactures statistics provide the basis for precise cost analysis. The values and costs, except detailed values for many items of product and costs for specified materials, are too broadly classified to give anything more than general information on manufacturing incomes and expenditures.

TABLE 18.—PER CENT DISTRIBUTION OF NET VALUE OF MANUFACTURED PRODUCTS AMONG COMPONENT ITEMS, BY INDUSTRY GROUPS: 1929

INDUSTRY GROUP	Net value of products	Salaries	Wages	Cost of raw materials and imported semi-manufactures	Cost of un-manufactured fuels	Other expenses, interest, and profit
All groups, total.....	100.0	8.8	24.4	30.4	2.7	33.7
Food and kindred products.....	100.0	3.3	9.3	63.6	1.4	22.4
Textiles and their products.....	100.0	6.7	28.2	30.9	1.8	32.4
Forest products.....	100.0	9.3	40.3	12.7	1.3	36.4
Paper and allied products.....	100.0	7.9	24.1	26.7	6.3	35.0
Printing, publishing, and allied industries.....	100.0	19.4	24.6	6.1	0.9	49.0
Chemicals and their products.....	100.0	7.5	13.2	30.5	3.1	45.8
Products of petroleum and coal.....	100.0	2.6	7.0	57.6	8.9	23.9
Rubber products.....	100.0	7.2	27.0	27.4	2.5	35.9
Leather and its manufactures.....	100.0	7.5	31.8	30.4	1.2	29.2
Stone, clay, and glass products.....	100.0	7.7	31.1	15.7	10.0	35.5
Iron and steel and their products, not including machinery.....	100.0	7.4	32.9	18.1	4.0	37.7
Nonferrous metals and their products.....	100.0	7.2	22.2	41.2	2.2	27.2
Machinery, not including transportation equipment.....	100.0	12.6	36.5	1.2	1.8	48.0
Transportation equipment, air, land, and water.....	100.0	7.8	39.2	0.2	1.7	51.2
Railroad repair shops.....	100.0	10.9	85.2	-----	3.6	0.3
Miscellaneous industries.....	100.0	8.9	18.9	21.3	0.7	50.2

¹ Basic figure includes amount of receipts for contract work in order that the sum of the percentages for the several items will equal 100.

² Total includes salaries of central-administrative-office employees. See footnotes to Table 10.

The figures in Table 18 indicate that in 1929 the budget for factory salaries and wages, exclusive of incomes of proprietors and firm members, was 33.2 per cent, or one-third of the value of finished manufactured goods. In the 16 groups the corresponding percentage ranged from 9.6 for "Products of petroleum and coal" to 96.1 for "Railroad repair shops." In the first of these two groups the cost of

⁷ In computing the payment for the labor which enters into the value of a given product, both the "direct" labor item, represented in general by wages, and the "indirect" item, as measured by salaries, should be considered. There is no doubt that the work performed in return for wages contributes directly to the creation of the product. The services rendered in return for salaries are more diverse in nature. Proprietors and firm members may obtain their incomes as returns on their capital investment, in which case they are not reported as receiving salaries, even though some of their work may be similar in character to that performed by wage earners. To exclude salaries from the aggregate for labor in its broad sense means that payments to mill clerks, accountants, stenographers, foremen, and research workers, shall not be added into the personnel cost of manufacturing the product.

It is quite probable that in recent years more of the manufacturing functions formerly performed by "productive" workers are given over to salaried employees. For example: The work of the planning department of the large factory, representing a concentration of those duties once performed largely by superintendents, foremen, and factory workers, is likely to be done entirely by salaried workers. Furthermore, much of the technical research originally conducted, at least in part with the help of shop workers, is now done by specialized salaried staffs.

the raw materials was a larger percentage of the value of output than in any other group except that comprising the food industries. In railroad repair shops, in which no raw materials are used and for which the value of products reported for the industries represents, in general, the cost of semimanufactured materials plus the amounts of salaries and wages paid to shop executives and employees, the manufacturing operations are not strictly comparable with those of the other 15 groups of industries.

The estimated net value of manufactures for 1929 was equal to 67.1 per cent of the gross value, as compared with 66.3 per cent for 1904 and 64.7 per cent for 1899 (Table 19). These percentages are not strictly comparable with one another since the composition of the values of the products for the three years differed in some minor respects, and it is impossible to eliminate these differences with the data available. Comparisons of the percentages by groups of industries for the three census years are further impaired by the differences in the composition of the groups in 1899 and 1904 and in 1929. For the two earlier years the industries were classified into 14 groups, for 1929 into 16 groups.

TABLE 19.—GROSS VALUE AND NET VALUE OF MANUFACTURED PRODUCTS BY INDUSTRY GROUPS: 1904 AND 1899

[The classification in effect at the censuses for 1904 and 1899 embraced only 14 groups of industries]

	GROSS VALUE		NET VALUE		PER CENT NET VALUE IS OF GROSS VALUE	
	1904	1899 ¹	1904	1899 ¹	1904	1899 ¹
All groups, total ¹	\$14, 802, 147, 087	\$11, 820, 784, 665	\$9, 821, 205, 387	\$7, 649, 490, 317	66. 3	64. 7
Food and kindred products.....	2, 845, 234, 900	2, 277, 702, 010	2, 176, 489, 626	1, 753, 171, 220	76. 5	77. 0
Iron and steel and their products.....	2, 176, 739, 726	1, 793, 490, 908	1, 239, 490, 273	983, 821, 918	56. 9	54. 9
Textiles.....	2, 147, 441, 418	1, 637, 484, 484	1, 397, 009, 940	1, 081, 961, 248	65. 1	66. 1
Lumber and its remanufactures.....	1, 223, 730, 336	1, 030, 906, 579	805, 315, 333	547, 350, 520	65. 8	53. 1
Chemicals and allied products.....	1, 031, 965, 263	552, 891, 877	714, 489, 549	372, 592, 807	69. 2	67. 4
Miscellaneous industries.....	941, 604, 873	1, 004, 092, 294	602, 990, 604	638, 191, 538	64. 0	63. 6
Metals and metal products, other than iron and steel.....	922, 262, 456	748, 795, 464	442, 912, 699	371, 154, 446	48. 0	49. 6
Paper and printing.....	857, 112, 256	606, 317, 768	590, 872, 350	419, 798, 101	69. 6	69. 2
Leather and its finished products.....	705, 747, 470	583, 731, 046	401, 011, 414	329, 614, 996	56. 8	56. 5
Vehicles for land transportation.....	643, 924, 442	508, 649, 129	324, 109, 901	250, 683, 696	50. 3	49. 3
Liquors and beverages.....	501, 266, 605	425, 504, 167	431, 735, 208	349, 157, 618	86. 1	82. 1
Clay, glass, and stone products.....	391, 230, 422	293, 554, 235	334, 971, 057	245, 447, 118	85. 6	83. 6
Tobacco.....	331, 117, 681	283, 076, 546	307, 100, 175	264, 052, 573	92. 7	93. 3
Shipbuilding.....	82, 769, 239	74, 578, 158	46, 707, 258	42, 492, 518	56. 4	57. 0

¹ Values assigned to "hand trades" at the census for 1899 are deducted, but it was impossible to deduct either the values for establishments with products valued at less than \$5,000 or those for custom flour and feed mills (gristmills) and custom sawmills, the combined output of which amounted to \$413,858,000.

The percentages for 1904 for all groups in combination, when adjusted so that they are comparable with those for 1929 should throw some light upon whether manufacture is becoming less direct; that is, upon whether there is a tendency for the processes required for the manufacture of a given product to be distributed among a larger number of specialized establishments and for the cycle of production to be thereby lengthened. The tendency can best be seen by observing changes in the distribution of the gross value of products among the several items which compose the total, as shown in Table 20.

TABLE 20.—PER CENT DISTRIBUTION OF THE GROSS VALUE OF MANUFACTURED PRODUCTS AMONG COMPONENT ITEMS: 1929 AND 1904

ITEM	1929	1904	ITEM	1929	1904
Gross value of products..	100.0	100.0	Cost of semimanufactures, total.....	34.1	133.5
Salaries.....	6.0	3.9	a. Domestic.....	31.5	(?)
Wages.....	16.5	17.6	b. Imported.....	2.6	(?)
Cost of raw materials.....	18.0	121.4	Cost of fuel and purchased energy.....	2.6	2.2
			Other expenses, interest, and profits.....	22.8	21.4

¹ Freight charges, reported separately, were added to the costs of raw and of semimanufactured materials to secure comparableness with data for 1929; cost of mill supplies was deducted from that of semimanufactures for the same reason.

² No data.

The cost of raw materials, as a percentage of gross value of products, was considerably less in 1929 than in 1904; the cost of semimanufactures, on the other hand, increased slightly, the combined share of the two types of materials being 54.9 per cent of the gross value of products in 1904 and 52.1 per cent in 1929. The corresponding percentage amounted to 57.4 for the postwar year 1919, a year of comparative extravagance in the utilization of materials; by 1927 it had fallen to 53. These percentages, together with corresponding figures for the other census years from 1899 to 1929, are given in the following table:

TABLE 21.—PER CENT WHICH COST OF MATERIALS FORMS OF GROSS VALUE OF PRODUCTS: 1899 TO 1929

CENSUS YEAR	PER CENT OF GROSS VALUE FORMED BY—		CENSUS YEAR	PER CENT OF GROSS VALUE FORMED BY—	
	Cost of materials, fuel, and purchased electric energy	Cost of materials and containers only		Cost of materials, fuel, and purchased electric energy	Cost of materials and containers only
1929.....	54.7	52.1	1919.....	60.0	57.4
1927.....	56.0	53.0	1914.....	59.5	56.7
1925.....	57.3	(¹)	1909.....	59.0	56.2
1923.....	57.3	(¹)	1904.....	57.7	² 55.5
1921.....	58.0	(¹)	1899.....	57.6	55.8

¹ No data.

² Unadjusted. See Table 20, footnote 1.

The material cost constituted an increasing proportion of the value of products from 1899 to 1919, after which year the figures took a downward direction.

At least three explanations of the trends are possible: (a) The first has to do with the disparity in the prices of raw materials and of manufactured goods; (b) another concerns the increasing economy in the utilization of industrial materials; (c) while a third has to do with the relative increase in the proportion of semimanufactures consumed, that is, with the increasing indirectness of manufacture.

The comparison of price changes may be made from the following indexes:

TABLE 22.—INDEX NUMBERS¹ OF WHOLESALE PRICES OF RAW MATERIALS AND OF MANUFACTURED GOODS: 1899 TO 1929

YEAR	Raw materials	Manufactured goods	YEAR	Raw materials	Manufactured goods
1929	181.1	187.4	1913	128.7	123.7
1928	185.3	189.4	1912	136.4	121.5
1927	180.3	188.1	1911	127.7	118.7
1926	184.9	194.9	1910	127.0	123.8
1925	196.8	200.9	1909	123.9	118.7
1924	180.8	197.0	1908	116.7	117.1
1923	182.1	201.7	1907	126.8	125.1
1922	171.2	191.5	1906	119.6	119.2
1921	160.9	201.3	1905	115.8	112.7
1920	260.2	296.3	1904	113.5	109.6
1919	252.4	255.0	1903	115.2	110.4
1918	243.1	245.5	1902	114.9	109.6
1917	224.5	209.6	1901	106.2	106.5
1916	164.6	160.1	1900	106.4	108.9
1915	134.1	126.2	1899	100.0	100.0
1914	127.0	121.0			

¹ Computed by National Bureau of Economic Research from data collected by the United States Bureau of Labor Statistics, and published in *Economic Tendencies in the United States*, by F. C. Mills. Adjusted for the purposes of this table on an 1899 base.

As has been said, the cost of materials formed a gradually increasing proportion of the gross value of products from 1899 to the period of the World War, a trend consistent with price movements for the same period. During those years the wholesale prices of raw materials rose almost 125 per cent, while those for manufactured goods increased about 110 per cent. Although two-fifths—scarcely more than one-third in 1929—of the manufacturers' expenditures for materials generally go for the purchase of raw materials as distinguished from semimanufactures, whose price levels are governed both by those of finished goods and of crude materials—nevertheless, the disparity between the prices of raw materials and of fabricated goods modified the ratio between the total cost of materials and the value of the products made from them.

In the postwar period the proportion which the material cost formed of the value of output decreased from 60 per cent in 1919 to 55 in 1929, a change of much greater magnitude than can be accounted for by price movements as measured by the indexes. Raw materials and manufactured goods were at levels in 1919 more than 150 per cent above their respective 1899 positions. The former rose moderately and the latter strikingly in 1920. Then came the drastic drop in the two sets of prices in 1921, and thereafter both sets fluctuated, but the net movement of the raw-material index was upward, while that of the index for manufactured goods was downward. By 1929 raw-material prices had fallen 28 per cent below the 1919 levels but were still 13 per cent higher than in 1921, while those for manufactured goods were 27 per cent lower than in 1919 and 7 per cent lower than in 1921. Although there was considerable disparity between the movements of the two series of prices during the 10-year period, price differences alone can not account for the pronounced change in the ratio of cost of materials to value of products.

It is significant that from 1904 to 1929, the only two census years for which separate and comparable costs of semimanufactures are available, the proportion which those costs formed of the gross value of output underwent only a slight change. This relationship seems to indicate, as would be expected, a close correlation between the price levels of what the manufacturer buys as partially manufactured materials and of what he sells as products. This could hardly be other-

wise, since approximately one-third of the products (as measured in monetary terms) sold by manufacturing establishments are purchased by other plants for further processing or assembly.

The Census Bureau collects no data by which economy and efficiency in the utilization of materials can be measured directly, but there is considerable evidence elsewhere of noteworthy improvement in the selection, handling, and use of materials during recent years.⁸ Pronounced extravagance in the utilization of materials in the factory preceding the postwar decade was not at all uncommon. Since rigid systems for controlling the requisitions of materials from factory store-rooms were not generally in effect, the spaces beneath the workbenches of the foremen and workers were likely to be repositories for much unused and spoiled material. Losses from theft were in some cases considerable. Without the technique of precise specification and of expert purchasing, unsatisfactory materials were often obtained. The reclamation of scrap materials did not then receive the attention given it in recent years.

In the decade after the war marked improvement was made in the use of materials. The prices of manufactured goods were declining, and the necessity for cost reduction was felt by most of the manufacturers. Materials, among the most docile and manageable factors in production, lent themselves well to closer control. Methods were introduced which were intended to prevent waste, such as specialized purchasing, rigid inspection and careful handling, release of materials to workers only upon formal requisitions, maintenance of quality scores for workers and departments dependent in part upon amounts of materials spoiled, and the development of the reclamation of scrap. The greater efficiency in the utilization of materials and the growth of the practice of manufacturing by-products in salable form tended to increase the amount of fabrication applied to materials—in other words, to increase the value created in the manufacturing plant more than in proportion to the added cost of materials.

It is impossible to measure accurately the effect of these changes on material costs, although it seems likely that here might be found at least a part of the explanation for the gradually decreasing proportion which material costs form of value of output.

Finally, it is probable that manufacturing has become more indirect, thereby increasing the cost of semimanufactured materials as a share of the value of products. The fact that the proportion for semimanufactures increased in 1929 over 1904, while that for raw materials decreased, gives credence to this explanation. It would seem that the developments in recent years in manufacture have increased the number of stages and therefore in all probability the number of separate plants through which materials pass before they emerge in the form of finished products. (It is doubtful that the many combinations of industrial establishments have greatly affected the situation, for generally an individual return is made to the Census for each plant, whether it be an independent concern or a subsidiary of a multiplant organization.)

⁸ A graphic description of material organizations and administrative procedures in various types of metal-manufacturing plants is found in *Material Control and Storekeeping in Machine Shops and Foundries*, by Willis Wissler, published by the Bureau of Business Research, The Ohio State University.