

# **MECHANIZATION IN THE BRICK INDUSTRY**

 WORKS PROGRESS ADMINISTRATION  
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## WPA NATIONAL RESEARCH PROJECT

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WORKS PROGRESS ADMINISTRATION

F. C. HARRINGTON  
Administrator

CORRINGTON GILL  
Assistant Administrator

NATIONAL RESEARCH PROJECT

ON

Reemployment Opportunities and Recent Changes  
in Industrial Techniques

DAVID WEINTRAUB  
Director

Studies in Equipment Changes and Industrial Techniques  
George Perazich, Engineer in Charge

**MECHANIZATION IN THE BRICK INDUSTRY**

by

Alfred J. Van Tassel  
and  
David W. Bluestone

**WORKS PROGRESS ADMINISTRATION, NATIONAL RESEARCH PROJECT**

Report No. M-2

*Philadelphia, Pennsylvania*

*June 1939*

**THE WPA NATIONAL RESEARCH PROJECT  
ON REEMPLOYMENT OPPORTUNITIES AND RECENT CHANGES  
IN INDUSTRIAL TECHNIQUES**

Under the authority granted by the President in the Executive Order which created the Works Progress Administration, Administrator *Harry L. Hopkins* authorized the establishment of a research program for the purpose of collecting and analyzing data bearing on problems of employment, unemployment, and relief. Accordingly, the National Research Program was established in October 1935 under the supervision of *Corrington Gill*, Assistant Administrator of the WPA, who appointed the directors of the individual studies or projects.

The Project on Reemployment Opportunities and Recent Changes in Industrial Techniques was organized in December 1935 to inquire, with the cooperation of industry, labor, and governmental and private agencies, into the extent of recent changes in industrial techniques and to evaluate the effects of these changes on the volume of employment and unemployment. *David Weinstraub* and *Irving Kaplan*, members of the research staff of the Division of Research, Statistics, and Finance, were appointed, respectively, Director and Associate Director of the Project. The task set for them was to assemble and organize the existing data which bear on the problem and to augment these data by field surveys and analyses.

To this end, many governmental agencies which are the collectors and repositories of pertinent information were invited to cooperate. The cooperating agencies of the United States Government include the Department of Agriculture, the Bureau of Mines of the Department of the Interior, the Bureau of Labor Statistics of the Department of Labor, the Railroad Retirement Board, the Social Security Board, the Bureau of Internal Revenue of the Department of the Treasury, the Department of Commerce, the Federal Trade Commission, and the Tariff Commission.

The following private agencies joined with the National Research Project in conducting special studies: the Industrial Research Department of the University of Pennsylvania, the National Bureau of Economic Research, Inc., the Employment Stabilization Research Institute of the University of Minnesota, and the Agricultural Economics Departments in the Agricultural Experiment Stations of California, Illinois, Iowa, and New York.

# WORKS PROGRESS ADMINISTRATION

WALKER-JOHNSON BUILDING  
1734 NEW YORK AVENUE NW.  
WASHINGTON, D. C.

F. C. HARRINGTON  
ADMINISTRATOR

June 6, 1939

Colonel F. C. Harrington  
Works Progress Administrator

Sir:

The report *Mechanization in the Brick Industry*, transmitted herewith, describes the changes in production techniques that the industry has experienced in the past 50 years. The changes of the last 20 years are analyzed in some detail.

Although the improvements in machines and in manufacturing techniques were limited largely to refinements in design and to the addition of relatively inexpensive auxiliary equipment, the cumulative effect of these minor changes on the amount of labor required per unit of product was considerable. In addition, the industry has benefited from the general technological progress since 1920 which resulted in the use of more wear-resistant metals and ball and roller bearings in brick-making machinery, in widespread electrification, and in the mechanization of clay-pit operations.

From the standpoint of the industry's capital outlays, it is notable that during the early and middle 1920's equipment purchases were made in the expectation of stable or increased demand and were concentrated on major production units. After the peak of production was passed in 1925, and particularly after 1929, the emphasis gradually shifted from increasing output to reducing production costs or to improving quality. In recent years the objective has been to accomplish these results without major capital investments, and the industry's equipment purchases have therefore centered mainly on devices that required small capital outlays relative to the economies which they made possible.

Much of the economy in labor utilization could not, however, be realized during the past 10 years because of the extremely low level of capacity at

which the industry has been operating; in fact, the output per man-hour was actually lower in 1935 than in 1929. An upturn in the demand for brick is therefore bound to result in an appreciable increase of labor productivity and to reduce the amount of labor required to produce 1,000 common brick to much less than the 9 hours needed in 1925, the year of the last production peak.

During the last two decades brick manufacturing has also experienced a considerable concentration of production in a progressively declining number of plants. The technological base for this concentration was provided by the availability of equipment which can be used most economically in the larger establishments and under conditions of fairly continuous operation. The present low level of operations relative to the capacity of the brick-manufacturing plants is furnishing an important stimulus to further consolidation. In the past such concentration of production has often been the result of mergers of a number of plants in a given region, the shutting down of the least efficient plants, and the operation of only the more efficient establishments. Should the same procedure be followed in the future, the general level of productivity of labor is bound to be raised with little or no expenditures on machinery and equipment to help offset the reductions in labor requirements in the manufacture of brick.

Respectfully yours,

A handwritten signature in cursive script that reads "Corrington Gill". The signature is written in dark ink and is positioned above the typed name.

Corrington Gill  
Assistant Administrator

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## PREFACE

Not only do technological changes exert an effect on employment conditions and on the investment of capital, but they are themselves affected by the sphere of economic relationships within which they occur. An analysis of the industrial applications of the principles of science and engineering must therefore also embrace the economics of their application and the economic conditions that affect their introduction. With this as an approach, the National Research Project has conducted a series of studies on types and rates of technological change.

Some of these studies centered on individual types of technological advance that affect many industries.<sup>1</sup> One deals with the growth of industrial research in the United States since the World War.<sup>2</sup> In others, an individual industry was selected as the unit of investigation, and the subject for study was the relationship of the economic requirements of the industry to the development and introduction of a variety of machines and production techniques. The present report is an example of this last type of study. Dealing with the brick-manufacturing industry, it is also a companion piece to the Project's broader study of production, productivity, and employment in the brick and tile industry<sup>3</sup> and presents a detailed picture of the mechanical improvements that were associated with the changes in productivity recorded in that volume.

The report was prepared by Alfred J. Van Tassel and David W. Bluestone. The field data used in this report were collected in cooperation with the National Bureau of Economic Research as part of the cooperative study on productivity and employment in the brick and tile industry. The series of "Studies in Equipment Changes and Industrial Techniques" are under the supervision of George Perazich. J. Van Horn Whipple organized the field work and supervised the editing of the materials collected. The completed manuscript was edited and prepared for publication under the supervision of Edmund J. Stone.

<sup>1</sup>See, for example, the report by George Perazich and Others, *Industrial Instruments and Changing Technology* (NPA National Research Project, Report No. M-1, Oct. 1938).

<sup>2</sup>Report now in preparation by George Perazich.

<sup>3</sup>Miriam E. West, *Productivity and Employment in Selected Industries: Brick and Tile* (NPA National Research Project in cooperation with National Bureau of Economic Research, Report No. N-2, Feb. 1939).

We appreciate the cooperation of the machinery manufacturers who provided our field workers with records on which most of the data presented in this report are based. James P. Martin, Vice President of the Lancaster Iron Works, Inc.; W. E. Cramer, President of the Harrop Ceramic Service Company; and M. E. Holmes, Dean of the New York State College of Ceramics at Alfred University reviewed the manuscript and made suggestions for its improvement. The National Research Project is of course alone responsible for the content of the report and the conclusions reached.

DAVID WEINTRAUB

PHILADELPHIA

June 5, 1939

## APPENDIX

### DESCRIPTION OF SURVEY DATA<sup>1</sup>

#### NRP MACHINERY-MANUFACTURERS SURVEY

Data were obtained in a field survey, covering 11 equipment-manufacturing companies, conducted by the National Research Project in cooperation with the National Bureau of Economic Research. From these companies was obtained the value of sales, for 1920 to 1936, of equipment used in the manufacture of brick and tile. Of these companies, eight produced clay-working (clay-preparing and machine-house) equipment and three produced excavating equipment.

#### Clay-Working Equipment Companies

For 5 of the 11 companies surveyed the data obtained refer to the value of sales of new clay-working machinery and repairs.<sup>2</sup> These five companies are among the seven largest producers of clay-working equipment.

For some of the companies sales were not available for a few years of the period 1920-36. For such years sales of the missing companies were estimated on the basis of the proportions that the sales of these companies comprised of the sales of the others in years for which the sales of all were available. One of these companies required such estimates for the period 1920-27. In one case estimates for the last 2 months of 1936 were made on the basis of the average for the first 10 months.

For 3 of the 11 companies surveyed the data obtained refer to the value of sales of selected types of new machinery only. These three companies together sold only about two hundred thousand dollars worth of such equipment over the entire period.

Data for one of the three companies were available only through the first 10 months of 1936; sales for the remaining months were estimated from the 10-month average.

<sup>1</sup>Prepared by Julius M. Ballick in collaboration with the authors.

<sup>2</sup>Repairs include sales of repair parts and charges for rebuilding.

Table A-1.- VALUE OF TOTAL PRODUCTION AND OF SALES SAMPLE OF CLAY-WORKING EQUIPMENT, 1919-36

Year	Value of total production <sup>a</sup>		Value of sales by eight companies <sup>b</sup>		Percent that eight-company sales are of total value
	Thousands of dollars	Index (1925=100)	Thousands of dollars	Index (1925=100)	
1919	3,187	60.2	n. a.	-	-
1920	n. a.	-	1,389 <sup>c</sup>	71.5	-
1921	3,772	71.2	1,197 <sup>c</sup>	61.6	31.7
1922	n. a.	-	1,771 <sup>c</sup>	91.2	-
1923	5,508	104.0	2,208 <sup>c</sup>	113.7	40.1
1924	n. a.	-	1,776 <sup>c</sup>	91.5	-
1925	5,298	100.0	1,942 <sup>c</sup>	100.0	36.6
1926	n. a.	-	2,040 <sup>c</sup>	105.0	-
1927	4,308	81.3	1,462 <sup>c</sup>	75.3	33.9
1928	n. a.	-	1,569	80.8	-
1929	4,402	83.1	1,651	85.0	37.5
1930	n. a.	-	903	46.5	-
1931	1,671	31.5	561	28.9	33.6
1932	n. a.	-	193	9.9	-
1933	591	11.2	229	11.8	38.7
1934	n. a.	-	324	16.7	-
1935	1,071	20.2	420	21.6	39.2
1936	n. a.	-	627 <sup>c</sup>	32.3	-

<sup>a</sup> Represents all clay-working machinery. Data are from *Census of Manufactures: 1925* (U. S. Dept. Com., Bur. Census), p. 1031; *1929*, II, p. 1099; *1933*, p. 526; and *1935*, p. 1090.

<sup>b</sup> Data are from NRP machinery-manufacturers survey and cover sales of clay-working (clay-preparing and machine-house) equipment and repairs to the brick and tile industry by eight companies manufacturing equipment.

<sup>c</sup> Partly estimated.

n. a. Data not available.

Table A-1 presents a comparison of the value of sales of clay-working machinery as obtained from the foregoing eight companies<sup>b</sup> and the value of production of all clay-working machinery as reported to the *Census of Manufactures*. Examination of table A-1 reveals that the volume of sales obtained in the survey fluctuates closely with the value of total production. The percentage which the former series comprises of the latter varies between 32 and 40. The average for the entire

<sup>b</sup> The sales of clay-excavating equipment by three companies producing power shovels and locomotive cranes have not been included, since the census figures do not include excavating equipment.

period is 36.<sup>4</sup> It should be noted that the census values include machinery used exclusively in the production of clay products other than brick and tile. Such machinery is not included in the sales series.

The *Census of Manufactures* specifies two industries that manufacture products made of clay - the "Clay products (other than pottery) and nonclay refractories" industry and the "Pottery, including porcelain ware" industry. The former, which includes the production of brick and tile, has roughly 90 percent of the total rated horsepower of the two industries.<sup>5</sup> This proportion is not utilized exclusively in the production of clay brick and tile. Of the value of products of the "Clay products (other than pottery) and nonclay refractories" industry, between 5 and 20 percent represent the value of nonclay refractories.<sup>6</sup> Such products, however, are manufactured by processes other than those used to produce brick and tile,<sup>7</sup> and the equipment used in their manufacture is probably not included in the series for value of clay-working machinery. The sample sales series therefore accounts for a somewhat larger proportion of total production of brick and tile equipment than is indicated in table A-1.

The eight-company sales series was broken down by kinds of equipment sold by varying numbers of companies. The break-downs are discussed below. Because data for several companies were not available for the entire period under consideration, partial estimates were required for these break-downs.

*Crushing and Grinding Equipment.* - Table A-3 presents the value of sales of crushing and grinding equipment. Such sales are presented in three categories - wet and dry pans; smooth-roll crushers; and granulators, disintegrators, and pulverizers - and are based on the records of seven companies.

<sup>4</sup>Except for 1935, the survey series represents an increasing proportion of the census series in years for which the latter is higher than in the preceding census year; the survey series represents a decreasing proportion of the census series in years for which the latter is lower than in the preceding census year. An apparent reason for this relationship is that the survey series represents sales, whereas the census figures are for production. In years of rising sales, inventories may be depleted; in years of low sales volume, inventories may be built up.

<sup>5</sup>The percentages are 93.5 in 1910, 91.5 in 1923, 91.2 in 1925, 90.6 in 1927, and 89.8 in 1929, the last year for which data are available (based on *Census of Manufactures*).

<sup>6</sup>The percentages over the period 1923-35 range from 6.7 in 1924 to 19.1 in 1935. The movement of these percentages is almost steadily upward (based on *Census of Manufactures*).

<sup>7</sup>*Clay Products Cyclopedia and Equipment Catalog* (3d ed.; Chicago: Industrial Publications, Inc., 1928), *passim*.

## MECHANIZATION IN THE BRICK INDUSTRY

**Table A-2.- RELATIVE VALUE OF SALES OF CLAY-WORKING EQUIPMENT TO THE BRICK AND TILE INDUSTRY BY VARYING NUMBERS OF COMPANIES, 1920-36**

Year	Index of sales (1925=100) by -				Percent of eight-company sales comprised by sales of -		
	Eight companies <sup>a</sup>	Seven companies <sup>b</sup>	Five companies <sup>c</sup>	Three companies <sup>d</sup>	Seven companies	Five companies	Three companies
1920 <sup>e</sup>	71.5	82.1	71.2	76.7	66.1	96.5	32.0
1921 <sup>e</sup>	61.6	54.6	61.9	66.3	67.7	99.5	52.1
1922 <sup>e</sup>	91.2	92.4	91.4	81.5	77.0	99.3	43.3
1923 <sup>e</sup>	113.7	114.6	113.8	101.9	76.7	96.7	43.4
1924 <sup>e</sup>	91.5	97.6	91.7	91.2	72.9	99.3	46.3
1925 <sup>e</sup>	100.0	100.0	100.0	100.0	76.1	99.0	46.5
1926 <sup>e</sup>	105.0	109.9	105.2	104.7	79.6	99.3	48.3
1927 <sup>e</sup>	76.3	76.6	75.7	81.0	77.6	99.5	52.1
1928	60.3	61.2	60.6	61.5	76.4	99.1	48.9
1929	85.0	91.4	85.6	89.9	81.8	99.7	51.2
1930	46.5	46.5	46.6	46.9	74.4	99.2	51.0
1931	28.9	28.3	29.2	36.8	74.4	100.0	61.7
1932	9.9	8.9	9.9	10.9	66.2	99.0	33.0
1933	11.8	11.8	11.8	14.5	76.1	99.4	50.8
1934	16.7	17.9	16.5	24.0	81.6	97.7	69.8
1935	21.6	23.3	21.8	31.1	82.0	96.5	69.8
1936 <sup>e</sup>	32.3	36.6	32.0	50.5	66.3	96.2	75.7

<sup>a</sup>Computed from table A-1.

<sup>b</sup>Companies whose sales were used in constructing table A-2.

<sup>c</sup>Companies whose sales were used in constructing table A-4.

<sup>d</sup>Companies whose sales were used in constructing table A-3.

<sup>e</sup>Partly estimated.

**Table A-3.- VALUE OF CRUSHING AND GRINDING EQUIPMENT SOLD TO THE BRICK AND TILE INDUSTRY BY SEVEN COMPANIES, 1920-36<sup>a</sup>**

(Thousands of dollars)

Year	Total	Wet and dry pans	Smooth-roll crushers	Granulators, disintegrators, and pulverizers	Percent that pans are of total (3-year moving average <sup>b</sup> )
1920	82	67 <sup>c</sup>	2 <sup>c</sup>	13 <sup>c</sup>	-
1921	101	67 <sup>c</sup>	2	2 <sup>c</sup>	67.9
1922	107	91 <sup>c</sup>	5	11 <sup>c</sup>	86.2
1923	223	162 <sup>d</sup>	10	21 <sup>c</sup>	82.0
1924	165	123	15	27	81.6
1925	122	101	7	14	77.3
1926	223	170	7	46	76.6
1927	103	81	10	12	75.6
1928	196	98	4	38	76.5
1929	109	87	5	17	73.7
1930	41	26	6	9	77.6
1931	35	31	3	8	74.0
1932	1	0	0	1	75.0
1933	6	2	*	6	16.7
1934	3	0	0	3	48.9
1935	10	7	*	3	39.3
1936	15	4	1	10	-

<sup>a</sup>Data are from the MRP machinery-manufacturers survey and cover sales to the brick and tile industry by seven companies manufacturing crushing and grinding equipment. Of the seven, two make wet and dry pans, four make smooth-roll crushers, and five make granulators, disintegrators, and pulverizers.

<sup>b</sup>Weighted.

<sup>c</sup>Partly estimated.

<sup>d</sup>Less than \$600.



**Table A-4.- VALUE OF SALES BY FIVE COMPANIES OF SELECTED TYPES OF EQUIPMENT USED PRINCIPALLY IN STIFF-MUD BRICK PLANTS, 1920-36<sup>a</sup>**

(Thousands of dollars)

Year	Total	Deslring equipment	Augers and combined pugmill and auger machines				3-year percent that combined machines are of total	Pug-mills <sup>b</sup>	Cutters	Feeders <sup>b</sup>
			Total	Augers	Combined machines					
1920	309	-	159	57 <sup>c</sup>	102 <sup>d</sup>		38 <sup>e</sup>	102 <sup>e</sup>	10 <sup>e</sup>	
1921	235	-	138	38 <sup>c</sup>	100 <sup>c</sup>	70.6	13 <sup>e</sup>	75 <sup>e</sup>	9 <sup>e</sup>	
1922	269	-	134	32 <sup>c</sup>	102 <sup>c</sup>		26 <sup>e</sup>	82 <sup>e</sup>	11 <sup>e</sup>	
1923	335	-	184	64 <sup>c</sup>	120 <sup>d</sup>		43 <sup>e</sup>	97 <sup>e</sup>	11 <sup>e</sup>	
1924	326	-	166	65	121	66.4	43	63	14	
1925	339	-	181	66	125		46	99	13	
1926	377	-	234	48	166		45	61	17	
1927	287	-	171	30	141	79.1	26	77	11	
1928	230	-	146	37	109		21	60	9	
1929	269	-	148	20	129		36	74	16	
1930	172	-	95	9	86	66.7	26	47	4	
1931	106	-	56	10	46		16	26	7 <sup>d</sup>	
1932	32	18	4	4 <sup>e</sup>	0 <sup>e</sup>		0 <sup>e</sup>	8 <sup>e</sup>	1 <sup>e</sup>	
1933	52	48	1	1 <sup>e</sup>	0 <sup>e</sup>	-	2 <sup>e</sup>	1 <sup>e</sup>	1 <sup>e</sup>	
1934	45	41	0	0 <sup>e</sup>	0 <sup>e</sup>		3 <sup>e</sup>	1 <sup>e</sup>	1 <sup>e</sup>	
1935	152	141	0	0 <sup>e</sup>	0 <sup>e</sup>	-	8 <sup>e</sup>	7 <sup>e</sup>	1 <sup>e</sup>	
1936	186	154	14	3 <sup>e</sup>	11 <sup>e</sup>		4 <sup>e</sup>	12 <sup>e</sup>	1 <sup>e</sup>	

<sup>a</sup>Data are from MRP machinery-manufacturers survey and cover sales to the brick and tile industry by five companies manufacturing brick equipment. Of the five, two make deslring equipment, four make augers, four make combined pugmill and auger machines, five make pugmills, four make cutters, and four make feeders.

<sup>b</sup>Includes sales to soft-mud plants.

<sup>c</sup>Partly estimated.

<sup>d</sup>Less than \$500.

**Table A-5.- INDEXES OF VALUE OF SALES OF STIFF-MUD AND SOFT-MUD EQUIPMENT BY FIVE COMPANIES, 1921-36<sup>a</sup>**

(1925=100)

Year	Total	Stiff-mud equipment	Percent that value of sales of stiff-mud equipment is of total (3-year moving average <sup>b</sup> )	Year	Total	Stiff-mud equipment	Percent that value of sales of stiff-mud equipment is of total (3-year moving average <sup>b</sup> )
1921	71.1	72.0	-	1929	67.0	74.4	78.4
1922	68.0	81.4	69.4	1930	40.9	49.6	37.3
1923	112.7	100.7	70.0	1931	22.0	22.3	23.1
1924	69.2	68.1	71.6	1932	10.7	13.6	68.6
1925	100.0	100.0	75.9	1933	17.8	23.1	66.2
1926	100.4	104.9	77.0	1934	14.6	16.4	66.1
1927	75.0	81.8	75.7	1935	44.7	59.9	66.6
1928	72.4	67.0	77.0	1936	53.4	71.3	-

<sup>a</sup>Data are from MRP machinery-manufacturers survey and cover sales to the brick and tile industry by five companies manufacturing brick equipment. Of the five, one manufactures soft-mud and all manufacture stiff-mud equipment. The figures used are based upon a selected series of machines.

<sup>b</sup>Weighted.

These seven companies accounted for from 66 to 86 percent of the eight-company sales series (table A-2).

*Stiff-Mud and Soft-Mud Equipment.*- The sales of selected types of machinery used principally in stiff-mud plants are presented in table A-4. These sales are presented in the following categories: Deairing equipment, augers, pugmills, combined augers and pugmills, cutters, and feeders. The figures presented are based on the sales records of five companies, which accounted for over 98 percent of the eight-company sales series (table A-2).

Of the five companies, one also produced soft-mud equipment. Since this company produces the AutoBrik machine, the fundamental piece of equipment used in further mechanizing soft-mud plants, the sales of this company are believed to represent adequately the purchase of soft-mud equipment. Table A-5 presents the trend in the relative importance of stiff-mud and soft-mud equipment. The value of equipment sales used in constructing table A-5 is based upon a selected series of

**Table A-6.- VALUE OF SALES OF NEW MACHINERY AND REPAIRS SOLD TO THE BRICK AND TILE INDUSTRY BY THREE COMPANIES, 1922-36<sup>a</sup>**

(Thousands of dollars)

Year	Total	New machinery	Repair parts	Percent that new machinery is of total
1922	767	253	514	33.0
1923	959	404	555	42.1
1924	859	426	433	49.6
1925	941	465	456	51.5
1926	985	543	442	55.1
1927	607	426	381	52.8
1928	766	394	372	51.4
1929	846	458	388	54.1
1930	460	213	247	46.3
1931	346	195	151	56.4
1932	102	49	53	48.0
1933	136	85	51	62.5
1934	227	146	81	64.3
1935	292	182	110	62.3
1936	475	266	189	60.2

<sup>a</sup>Repairs include sales of repair parts and charges for rebuilding. Data are from NRP machinery-manufacturers survey and cover sales to the brick and tile industry by three companies manufacturing brick equipment.

machines, equal to about one-fourth of the eight-company total shown in table A-1.

*New Machinery and Repairs*<sup>8</sup>.— A comparison of the sales of new machinery and repairs is given in table A-6. Data are based upon sales of three companies, which represent from 43 percent in 1922 to 76 percent in 1936 of the eight-company sales series (table A-2).<sup>9</sup>

#### Excavating-Equipment Companies

In addition to the eight companies producing clay-preparing and machine-house equipment, three companies were covered which produced excavating equipment. Each of the companies manufactured power shovels, and one manufactured both power shovels and locomotive cranes. The data obtained are for sales to the brick and tile industry; they refer only to complete new units and, probably, some rebuilt units.

The brick and tile industry consumed only a small fraction of the power shovels and locomotive cranes produced by the three companies. Total sales of these products by the three companies, however, comprise a large portion of the value of total output of the two types of equipment (table A-7).

Repairs and resales make up a considerable portion of the sales of two of these companies; for the third, available data cover only new units.<sup>10</sup> The *Census of Manufactures* normally includes in its detailed production tables only new units and parts, listing receipts for repair work separately. It is therefore likely that the percentages shown in table A-7 are inflated.

The total-sales series was partly estimated. For one company the 1936 data were obtained for only 9 months; figures for the last 3 months were estimated on the basis of the monthly average for the first 9 months. For another company the figures for 1920 and 1936 were estimated on the basis of the ratios in 1921 and 1935 respectively of the sales of this company to the sales of the other two.

In the instance of sales by these companies to the brick and tile industry, however, only one estimate was needed. Such

<sup>8</sup>Repairs include sales of repair parts and charges for rebuilding.

<sup>9</sup>The percentages fluctuated between 43 and 62, without evincing any trend, during the period 1920-32. In 1933 the percentage rose from 53 to 60, rose again to 70 in 1934, and then to 76 in 1936.

<sup>10</sup>See table A-7, fn. b.

sales were available, for one company, for only the first 10 months of 1936; data for the last 2 months were estimated on the basis of the average for the first 10.

Table A-7.- VALUE OF TOTAL PRODUCTION AND OF SALES BY THREE COMPANIES OF POWER SHOVELS AND LOCOMOTIVE CRANES, 1919-36

Year	Value of total production <sup>a</sup> (thousands of dollars)	Value of sales by three companies			
		Total <sup>b</sup>		To brick and tile industry <sup>c</sup>	
		Thousands of dollars	Percent of value of total production	Thousands of dollars	Index (1925=100)
1919	15,368 <sup>d</sup>	n. a.	-	n. a.	-
1920	n. a.	14,478 <sup>e</sup>	-	650	122.2
1921	15,887 <sup>d</sup>	5,422	34.2	148	27.4
1922	n. a.	9,074	-	409	76.9
1923	29,226 <sup>d</sup>	14,112	48.3	577	108.5
1924	n. a.	11,648	-	568	106.8
1925	32,835 <sup>f</sup>	12,547	38.2	532	100.0
1926	n. a.	13,005	-	413	77.6
1927	38,494 <sup>f</sup>	12,742	33.1	329	61.8
1928	n. a.	14,878	-	232	43.6
1929	49,301	16,952	34.4	308	57.9
1930	n. a.	9,941	-	83	15.6
1931	20,442	8,183	40.0	82	15.4
1932	n. a.	3,507	-	0	0
1933	5,095	3,108	61.0	19	3.8
1934	n. a.	4,568	-	13	2.4
1935	13,295	6,282	47.3	32	6.0
1936	n. a.	8,218 <sup>g</sup>	-	47 <sup>d</sup>	8.8

<sup>a</sup>Based on *Census of Manufactures: 1925* (U. S. Dept. Com., Bur. Census), p. 1031; 1929, II, 1099; and 1935, p. 1078.

<sup>b</sup>Data are from NRP machinery-manufacturers survey and cover two companies manufacturing power shovels and one company manufacturing both power shovels and locomotive cranes. Data for the latter company are for new units only (no repairs or rebuilt equipment). Data for the former companies include repairs and resales. In the case of one, about 70 percent of the sales represented sales of new units, about 20 percent represented resales, and about 10 percent represented parts. In the case of the other, about one-third represented repairs.

<sup>c</sup>Includes complete units only. Some rebuilt units may be included. The company manufacturing both power shovels and locomotive cranes sold only the latter to the brick and tile industry.

<sup>d</sup>Data for locomotive cranes were not reported for 1919, 1921, and 1923. Values were estimated by multiplying the value of power shovels in these years by the 1925 ratio of the value of locomotive cranes (see fn. f) to the value of power shovels.

<sup>e</sup>Partly estimated.

<sup>f</sup>Crawler and locomotive cranes were reported in combination in 1925 and 1927. The value of locomotive cranes only was estimated on the basis of the 1929 proportions.

n. a. Data not available.

## NRP-NBER 1936 BRICK-PLANT SURVEY

Data were obtained in a field survey conducted by the National Research Project in cooperation with the National Bureau of Economic Research. The results of this survey are summarized in a report by Miriam E. West, entitled *Productivity and Employment in Selected Industries: Brick and Tile* (WPA National Research Project in cooperation with National Bureau of Economic Research, Report No. N-2, Feb. 1939).

One hundred and eight plants were surveyed, their major product being either common brick, face brick, paving brick, hollow building tile, or drain tile. Average annual production per plant for plants for which the information is available was 35 million common-brick equivalents in 1925, 24 million in 1927, 19 million in 1929, and 7 million in 1935.<sup>11</sup>

## BRICK AND CLAY RECORD 1927 BRICK-PLANT SURVEY

This study, published in the *Brick and Clay Record* (Vol. 70, No. 13 [June 21, 1927], 1002-25) as an article entitled "Clay Pit and Mine Methods", is based upon 120 plants reporting on loading methods, 102 using power shovels, 82 reporting on shovel size, and 73 reporting on type of power utilized by shovels. The plants covered in the study made common brick and building tile; their size, as represented by annual production per plant, was 22 million brick (average for 36 plants which reported production).<sup>12</sup>

## BLS 1922 BRICK-PLANT SURVEY

This survey covered 71 plants manufacturing common building brick. Of these plants, 45 used the stiff-mud process and 26 the soft-mud process. The average annual production per plant was 38 million brick.<sup>12</sup> The results of the survey are presented by William F. Kirk in *Productivity Costs in Common-Brick Industry* (U. S. Dept. Labor, Bur. Labor Statistics Bull. No. 356, 1924).

<sup>11</sup>Plants studied in this survey tend to be larger than the plant of average size when the entire industry is considered. Average annual production in the industry (based on *Census of Manufactures*) was 10 million common-brick equivalents per establishment in 1925-29 and 5 million in 1935, according to Miss West's report (p. 98). See chap. II, ftm. 1.

<sup>12</sup>For average production of all plants see ftm. 11.

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The bibliography was derived from a survey of the periodical literature for the period 1920-36; this covered selected articles listed in the *Engineering Index* and in the *Industrial Arts Index* and also a comprehensive review of the *Brick and Clay Record*, the leading trade journal of the industry.

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