Chapter 3

Employment in Mining

WE ARE NOW READY to proceed to the second phase in our investigation—the study of labor input. Once this has been completed, we shall be in a position to relate output to employment, and so to construct indexes of productivity for individual industries and for mining as a whole.

The extraction of minerals from the surface of the earth occupies but a small fraction of the nation's labor force. Of the entire working population, only about one person in fifty is engaged in mining, in quarrying or in operating oil wells. It should be remembered in this connection that the smelting of ores, the refining of oil and the dressing of stone are classed not as mining, but as manufacturing, operations. Consequently the employment statistics given in the present chapter and elsewhere in this volume are confined as closely as possible to the actual separation of minerals from the earth, to the simpler processing operations which are normally carried on at the mine or quarry (such as the milling of ore and the crushing of stone), and to development work undertaken in connection with the actual operation of the mine.

THE SHARE OF THE LABOR FORCE ATTACHED TO MINING

The most comprehensive data we possess concerning the distribution of the labor force, among industries and occupations, are derived from the decennial Census of Population. The entire occupied population consists of all persons who report themselves as having a gainful occupation, whether or not they are actually working at the date of enumeration.

The distribution of the labor force among mining, manufacturing, agriculture, and other industries is given for Census years

TABLE 5

THE LABOR FORCE AND ITS INDUSTRIAL DISTRIBUTION, 1870-1940[a]
Gainfully Occupied Persons, 10 Years of Age and Over[b]

Year	Total[c] (thousands)	Percentage Distribution[d]			
		Mining	Manufacturing[e]	Agriculture[e]	Other Industries[f]
1870	12,925	1.5	16.8	53.0	28.6
1880	17,392	1.9	19.3	49.4	29.4
1890	23,318	2.1	20.3	42.6	35.0
1900	29,073	2.7	22.1	37.5	37.7
1910	37,371	2.9	23.1	31.0	42.9
1920	42,434	3.0	26.8	27.0	43.3
1930	48,830	2.5	24.2	21.4	51.9
1940	52,148	2.2	25.2	17.6	55.1

[a] All data are derived, directly or indirectly, from the Census of Population. The labor force includes persons unemployed as well as those in employment.

[b] Prior to 1940, occupational data were tabulated for all persons 10 years of age and over. In 1940, for the first time, the Bureau of the Census considered it no longer worth while to collect occupational data for persons below the age of 14. The vast majority of child workers today are to be found in agriculture. For 1940 the numbers of such workers in both agricultural and nonagricultural occupations were estimated by the Bureau of the Census and are included (see U. S. Bureau of the Census release, "Trends in the Proportion of the Nation's Labor Force Engaged in Agriculture: 1820 to 1940," March 28, 1942).

[c] Bureau of the Census release, March 28, 1942 (see preceding footnote). In 1940 the distribution between agricultural and nonagricultural occupations of persons employed on emergency work had to be estimated by the Census Bureau; also numbers of occupied persons aged 10 to 13 (see footnote b). Besides these adjustments to the data for 1940, revisions were made in some other years also (see U. S. Bureau of the Census release, "Industrial Distribution of the Nation's Labor Force: 1870 to 1930," October 23, 1938; also Harold Barger and Hans H. Landsberg, *American Agriculture, 1899–1939: A Study of Output, Employment and Productivity*, National Bureau of Economic Research, 1942, Chapter 6).

[d] The distribution between agricultural and nonagricultural workers was first obtained from the Bureau of the Census release, March 28, 1942 (see footnote b). Nonagricultural workers were then distributed among mining, manufacturing and other industries as follows. For 1870 to 1930 the distribution was carried out on the basis of figures compiled by Daniel Carson, "Labor Supply and Employment" (National Research Project, unpublished). For 1940 the distribution was based upon the Bureau of the Census release, "Industry Classification of Persons 14 Years Old and Over in the Labor Force, for the United States and for Regions: March 1940," November 11, 1942.

[e] Includes electric light and power and manufactured gas in addition to all activities ordinarily classed as manufacturing.

[f] Includes forestry, fishing, construction, transportation, communication, trade, finance, public service, professional service, domestic and personal service.

since 1870 in Table 5.[1] Here it is shown that mining approximately doubled its share of the total number occupied in all

[1] We are interested in the industrial, rather than the occupational, distribution of the occupied population; accordingly for years in which only the latter classification was available (1870 to 1900 and 1920), clerical and other industrially nondescript occupations have been distributed among the various industrial categories. The distribution in question was made by Daniel Carson ("Labor Supply and Employment," National Research Project, unpublished).

branches of the economy between 1870 and 1920. The proportion of the nation's labor force attached to mining has always been small as compared with manufacturing, but the trends in both fields have been similar: as in the case of manufacturing, the contribution of mining to the occupied population as a whole appears to have reached a peak during the first quarter of the present century, and to have begun to decline in recent years.

NUMBERS OCCUPIED VERSUS EMPLOYMENT

The distribution of occupied persons, furnished by the decennial Census of Population, provides a very comprehensive view of the number of workers attached to an industry. This enumeration includes, in addition to workers actually engaged in production at the time of the Census, those who are unemployed, perhaps even some who are retired. If, however, we were to use such figures to measure labor input, we should be debiting the industry with numerous individuals whose responsibility for current output is remote, or even nonexistent. This scarcely seems an appropriate procedure. Yet every person who reports himself as occupied in a given industry—whether currently employed or not—must be regarded, in some degree at least, as immobilized by that industry. He is immobilized to the extent that his present employment, his memories of past employment, his prospects of future employment, his geographical location, or his peculiar skills prevent him from becoming a candidate for a job in some other industry. Thus his attachment to the industry in which he claims to be occupied must be viewed, at least from the social aspect, as part of the costs of operation of that industry. Nevertheless, it remains true that for purposes of measuring labor input and productivity we are interested in employment rather than in numbers occupied. The Census of 1940 was the first population count to report employment as well as occupational status. These employment figures, which are strictly comparable with the occupational data, appear in the center of Table 6. Unfortunately, they cannot easily be used for precise comparisons with employment in any other year; at this writing they have not been released with detailed breakdowns. Consequently we shall make no extensive use of them in the present report. The most detailed employment data we have been able to assemble relate to the year

1939, and are derived not from the Census of Population but from the Census of Mineral Industries. These figures, given fully in Table 7, are shown for comparison in summary form at the right hand side of Table 6.

The two sets of employment data shown in Table 6 differ because each is the product of a separate inquiry. The figures from

TABLE 6

PERSONS OCCUPIED AND EMPLOYED IN MINING, 14 YEARS OF AGE AND OVER, 1939–40

Industry	*Population Census*				*Census of Mineral Industries*	
	Occupied[a] March 1940		Employed[b] March 1940		Employed Average 1939[c]	
	Thousand	Percent	Thousand	Percent	Thousand	Percent
All Industries[d]	48,163	..	44,477	..	..	..
Mining	1,044	100.0	913	100.0	887	100.0
Metal mining	132	12.6	117	12.8	102	11.5
Coal mining	611	58.5	527	57.7	491	55.3
Oil and gas	203	19.4	184	20.1	203	22.9
Other	98	9.4	85	9.3	91	10.3

[a] Numbers employed (column to right), plus workers seeking employment; U. S. Bureau of the Census release, "Industry Classification of Persons 14 Years Old and Over in the Labor Force, for the United States and for Regions: March 1940," November 11, 1942. The figures are derived from the Census of Population.

[b] Source same as for numbers occupied (column to left): see preceding footnote.

[c] These figures comprise wage earners (average of 12 monthly counts), salaried workers, and individual proprietors and firm members. See Table 7.

[d] Does not include 2,530 thousand persons employed on public emergency work, or 689 thousand persons who failed to specify the industry in which they were occupied.

the Census of Population result from a single count in March 1940, whereas the Census of Mineral Industries presents an average of employment for the year 1939. Apparently also there are differences in degree of coverage, though these are difficult to assess; not all persons canvassed by the population enumerators disclosed the industry in which they were occupied; similarly, the Census of Mineral Industries cannot be regarded as a complete record.[2] Finally, employment in the mining industries as a whole

[2] For example, the absence of any reference to bootleg operations, at least in the preliminary releases, suggests that this sector of the anthracite industry was not covered by the Census of Mineral Industries; but presumably bootleg operators would report themselves in the Population count as employed in coal mining.

was higher in March 1940 than it was on the average during 1939.[3] Despite these and other divergences, it is broadly true that the data in Table 6 confirm each other and afford a consistent picture. Judged by input of labor, coal mining is still overwhelmingly the most important form of extraction; between one half and two thirds of all miners are coal miners. Oil and gas wells employ about one fifth of the nation's miners, metal mines another tenth, and the remaining industries together less than one tenth.

CHANGES IN THE DISTRIBUTION OF EMPLOYMENT AMONG MINING INDUSTRIES

A complete view of employment in the nation's mines is possible only for the years in which a Census of the industry was taken. The best conspectus of the changing composition of employment in mining over our period is to be obtained by comparing 1939 with 1902. Accordingly, data for 1939 are shown at the right hand side of Table 7. The column "total engaged" affords a breakdown of material already given in Table 6. Unfortunately, however, we have not been able to present in comparable form employment data from the Census of Mines and Quarries taken in 1902. Figures for wage earners in that Census are presented (for the most part) in the form of 300-day averages: that is to say, where an enterprise worked fewer than 300 days in 1902, the number of workers reported for that year was written down proportionately during the process of editing the schedules.[4] At this late date these results cannot be unscrambled; nor can we determine what the 1902 figures would have looked like had the Census refrained from applying this averaging procedure. We cannot compute other kinds of average from the 1902 Census, but it is fairly easy in a rough way to convert 1939 employment figures to a 300-day basis. In fact the "300-day workers" shown for 1939 in Table 7 are simply the mandays reported (by the Bureau of Mines or by the Census of Mineral Industries; see note b to Table 7) divided by 300. These figures for 1939 are as comparable

[3] Bureau of Labor Statistics indexes report that mining employment was 7 percent higher; the rise suggested by Table 6 is only 2 percent.

[4] U. S. Bureau of the Census, *Special Reports*, "Mines and Quarries, 1902," p. 1123.

TABLE 7

EMPLOYMENT IN MINING, 1902 AND 1939[a]

Industry	300-Day Workers[b] 1902		300-Day Workers[b] 1939		Wage Earners, Census Average[c] 1939		Total Engaged, Census[d] 1939		Active Period Average, Bureau of Mines[e] 1939
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number
Metal mining, total	120,583	20.3	91,232	14.7	90,671	11.6	101,858	11.5	..
Iron ore	40,027	6.7	16,204	2.6	20,456	2.6	22,680	2.6	21,859
Copper	27,920	4.7	22,553	3.6	23,840	3.0	26,744	3.0	23,153
Other metal mining, except placers	49,486	8.3	49,104	7.9	43,147	5.5	48,469	5.5	59,954
Gold and silver, lode	..	..	..	..	21,822	2.8	24,486	2.8	..
Lead and zinc	..	..	..	..	15,613	2.0	17,166	1.9	..
Manganese	..	..	..	..	494	.1	530	.1	..
Mercury	..	..	..	..	652	.1	951	.1	..
Bauxite	..	..	..	..	732	.1	831	.1	..
Molybdenum	..	..	..	..	940	.1	1,103	.1	..
Tungsten	..	..	..	..	714	.1	936	.1	..
Vanadium and uranium	..	..	..	..	391	[r]	493	.1	..
Other[f]	..	..	..	..	1,789	.2	1,973	.2	..
Placer mining	3,150	.5	3,371	.5	3,228	.4	3,965	.4	..
Fuels, total	410,917	69.2	479,266	77.1	612,200	78.2	693,629	78.2	704,872
Pennsylvania anthracite	94,937[q]	16.0	56,793	9.1	82,890	10.6	88,646	10.0	93,138
Bituminous coal[g]	283,710	47.8	263,133	42.3	373,225	47.7	401,886	45.3	444,953
Oil and gas wells[h]	32,270	5.4	159,340	25.6	156,085	19.9	203,097	22.9	166,781
Other nonmetal mining, total	62,599	10.5	51,297	8.2	58,570	7.5	65,665	7.4	..
Stone quarrying[i]	49,837	8.4	33,473	5.4	36,339	4.6	40,230	4.5	48,329
Phosphate rock	5,991	1.0	2,749	.4	3,372	.4	3,753	.4	..
Gypsum	823	.1	1,040	.2	1,327	.2	1,424	.2	..

For footnotes see pp. 66-68.

TABLE 7—(concluded)

Industry	300-Day Workers[b] 1902 Number	1902 Percent of Total	1939 Number	1939 Percent of Total	Wage Earners, Census Average[c] 1939 Number	1939 Percent of Total	Total Engaged, Census[d] 1939 Number	1939 Percent of Total	Active Period Average, Bureau of Mines[e] 1939 Number
Other nonmetal mining (cont.)									
Abrasive materials[j]	729	.1	720	.1	804	.1	931	.1	..
Asbestos	23	r	134	r	151	r	160	r	..
Asphalt	156	r	541	.1	730	.1	853	.1	..
Barite	336	.1	606	.1	792	.1	870	.1	..
Borates	153	r	446	.1	533	.1	638	.1	..
Clay[k]	2,547	.4	5,846	.9	7,742	1.0	8,578	1.0	..
Feldspar	252	r	412	.1	512	.1	605	.1	..
Mica	98	r	150	r	190	r	221	r	..
Monazite	88	r	0	0	0	0	0	0	..
Sand[l]	335	.1	1,869	.3	2,375	.3	2,833	.3	..
Sulfur[m]	..	..	1,351	.2	1,503	.2	2,010	.2	..
Talc and soapstone	779	.1	862	.1	970	.1	1,137	.1	..
All other nonmetals[n]	452	.1	1,098	.2	1,230	.2	1,422	.2	..
Total, comparable industries[o]	594,099	100.0	621,795	100.0	761,441	97.2	861,152	97.1	..
Industries not canvassed in 1902:									
Common clay and shale	..	..	..	..	2,906	.4	3,044	.3	..
Potash	..	..	..	..	1,516	.2	1,800	.2	..
Rock salt	..	..	..	..	1,380	.2	1,561	.2	..
Sand and gravel	..	..	..	..	14,584	1.9	17,740	2.0	..
General contract services[p]	..	..	..	..	1,365	.2	1,656	.2	..
TOTAL, ALL INDUSTRIES	..	..	..	..	783,192	100.0	886,953	100.0	..

For footnotes see pp. 66-68.

Footnotes to Table 7.

[a] In addition to providing data on the distribution of employment among different branches of mining activity, this table is designed to contrast: (1) employment in 1902 and in 1939, in terms of 300-day workers (which alone allow such a comparison); (2) employment in 1939 in terms of 300-day workers and of active period average workers, for those industries for which such a comparison can be made; (3) employment in 1939 in terms of wage earners and of total engaged (wage earners, salaried employees, and individual proprietors and firm members). Data cover employment at mines, quarries or wells, and at mills or crushing plants. Employment in manufacturing operations, such as smelting metallic ores, dressing or cutting dimension stone, calcining gypsum or refining petroleum, is so far as possible excluded.

[b] Figures in these columns represent the number of workers who would have been required if each of them had worked 300 days or shifts during the year. The Census of 1902 adopted this concept in presenting its figures, and its results cannot now be adapted to allow of comparisons with later years on any other basis. In essence the number of 300-day workers in 1902 is obtained by multiplying the number of workers reported by the mine by the number of days the mine was active, and dividing the result by 300. For all mines reporting fewer than 300 days' operation this adjustment was performed in 1902 by the Bureau of the Census itself in the course of editing the schedules. (See U. S. Bureau of the Census, *Special Reports,* "Mines and Quarries, 1902," pp. 1122-23. The implication, in the second footnote on p. 90 of the same volume, that the method used was "practically the same" as that followed in the Report on Manufactures for the Twelfth Census, i.e., an average of 12 monthly counts, appears to be misleading. That the two methods lead to divergent results is admitted indirectly in the following quotation from the *Fifteenth Census,* "Mines and Quarries, 1929," p. 5: "The Census Bureau's figures for wage earners . . . are averages based on the number employed on the 15th of each month, and while representing the number, according to the pay rolls, to whom wages were paid on that date, they doubtless represent a larger number than would be required to perform the work in any industry if all were continuously employed during the year." This may now be confirmed by comparing, for 1939, mandays divided by 300 with average wage earners: the latter, an average of 12 monthly counts, nearly always exceeds the former, which approximates the number of 300-day workers.) In those few industries where more than 300 days were worked, a corresponding adjustment was roughly made by ourselves. In Pennsylvania anthracite and bituminous coal, where for 1902 mandays are available directly, these were divided by 300. For 1939 mandays reported by the Bureau of Mines, or manshifts reported by the Census, were uniformly divided by 300.

For iron ore, copper, gold and silver (lode), lead and zinc, mercury, bauxite, pyrites, manganese and stone, 1902 data come from the Census of that year. For Pennsylvania anthracite 1901 data, and for bituminous coal 1902 data, are from the U. S. Geological Survey. For all the above industries, data for 1939 are derived from the accident statistics collected by the Bureau of Mines. In these industries, technical, supervisory and other employees who actually work in and about the mines (but not office employees) are included in both years. For all other industries for which data are given the figures cover wage earners only, and (except for employment in gypsum mining and at oil and gas wells in 1902) rely in both years directly upon Census data. For gypsum, data for 1902 are derived from Robinson Newcomb and Knute Peterson, "Production, Employment and Output per Man in Gypsum Mining" (U. S. Bureau of Mines, Information Circular 7134, 1940), Table 1. For oil and gas wells, data for 1902 are from O. E. Kiessling and others, *Petroleum and Natural-Gas Production* (National Research Project, Philadelphia, 1939), p. 327. Many of the above data can readily be derived from Appendix Table A-3. Figures for "other metal mining, except placers" run slightly higher than corresponding data reported for mandays in Appendix Table A-3 because of the inclusion of tungsten, uranium and vanadium, chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile in 1902; and tungsten, uranium and vanadium, titanium, magnesite, molybdenum, antimony ore and chromite in 1939. The coverage of these industries by "Metal-Mine Accidents" is in doubt; in Appendix Table A-3 they are not included for 1902, and we have assumed that they are not included there for 1939.

For oil and gas wells in 1939 employment is not available in mandays. However, for natural gasoline plants and for oil- and gas-well contract services, it was possible to estimate mandays by multiplying active period average employment by average number of days active. Mandays so obtained were then divided by 300. For petro-

leum and natural gas wells proper the number of 300-day wage earners was assumed to equal the Census average. Since wells generally operate throughout the year without interruption, this treatment probably introduces little distortion. The figures are derived in Appendix Table A-19.

[c] Data are uniformly from preliminary releases of the Census of Mineral Industries, 1939. The method of averaging employment over the year is the same as that followed in Censuses of Manufactures since 1899 (*Twelfth Census*), i.e., an average of twelve monthly figures for each enterprise, including inactive months (if any). Where enterprises operated for twelve months, but for fewer than 300 days in the aggregate, Census average wage earners tend to exceed the number shown for 300-day workers (see note b above). On the other hand, where the latter included numerous supervisory employees, 300-day workers tend to exceed in number Census average wage earners.

[d] Data are uniformly from preliminary releases of the Census of Mineral Industries, 1939. Figures include salaried employees, and individual proprietors and firm members, in addition to average wage earners.

[e] Except for oil and gas wells, the figures in this column are obtained from Bureau of Mines accident statistics, and represent the average number of employees during the active period of operation of each enterprise. Technical, supervisory and other employees who actually work in and about the mine (but not office employees) are included. The figure for oil and gas wells relates to wage earners only, and is taken from preliminary releases of the Census of Mineral Industries, 1939. Since in most industries for which data are shown in this column the mines worked fewer than 300 days on the average in 1939, active period average employment runs higher than the number of 300-day workers. The Census method of averaging (see note c) counts the number on the payroll as of the fifteenth of each month, and then averages these monthly figures over the entire year. Where idle days are uniformly distributed throughout the year, the active period average of the Bureau of Mines will tend to equal the Census average. But where shutdowns cover an entire month, the active period average will exceed the Census average: nevertheless it probably still falls short of the number of individuals who were employed by the industry, at one time or another during the year, for however brief a period. The figure for "other metal mining, except placers" exceeds the corresponding figure in Appendix Table A-3 for the reason given in note b above.

[f] Magnesite and brucite, chromite, antimony, titanium and pyrites. In 1902 also includes employment at sulfur mines (not separable from pyrites), and nickel and cobalt; and in 1939 at fluorspar mines in Illinois and Kentucky (not always separable from lead and zinc mining, and included for comparability with other columns).

[g] Includes peat and lignite; also anthracite outside Pennsylvania.

[h] Covers employment at natural gasoline plants as well as at oil and gas wells; includes employment by contractors furnishing field services to producers, as well as by regular producers. Figures for 300-day workers, and for active period average workers, in this industry are for wage earners only, and do not include technical, supervisory and other salaried employees. For 1902 the source of the data is given in note b above. For 1939 all data are from the Census of Mineral Industries: their derivation, together with that of similar figures in Table A-3 for comparison, will be found in Appendix Table A-19.

[i] The industries covered are limestone (including that used for lime and cement), marble, sandstone (except when used for abrasive purposes), granite and slate. Employment at nondimension quarries and crushers, and at dimension quarries, is included; but not employment at plants engaged in dressing or cutting dimension stone.

[j] Includes grindstones, millstones, oilstones and other abrasive stones; corundum and emery; pumice; garnet; crystalline quartz; infusorial earth, tripoli and diatomite; flint.

[k] Includes fire clay, kaolin, ball clay, bentonite and fuller's earth; but not common clay, such as that used for brick making, which was covered for the first time by the 1939 Census.

[l] Includes glass sand and foundry sand; but not common sand or gravel.

[m] Employment data for sulfur in 1902 cannot be separated from those for pyrites. Apparently production consisted mainly of the latter, and the figure for both industries is therefore included in "other metal mining" above.

[n] Includes fluorspar (in 1939, only such mines outside Illinois and Kentucky: see note f above); lithium minerals; graphite; marl (greensand); vermiculite; kyanite,

Footnotes to Table 7 continued on next page.

with the corresponding figures for 1902 as it is possible to make them.[5]

Between 1902 and 1939 total employment in mining hardly changed, but there were sharp alterations in the relative importance of different minerals. A decline occurred in the percentage of workers engaged in metal mining, and particularly in iron mining: we shall see that technological advance has been especially rapid in the extraction of iron ore. The fraction of the working force engaged in mining fuel increased—but only because the large expansion of employment in oil and gas wells more than offset the decline in coal mining. Nonmetals other than fuels lost some ground as sources of employment, especially because of the decline of stone quarrying in this respect. Several minor industries, particularly clay and sand, employ, relatively, much more labor than formerly. On the other hand monazite (a thorium compound used for gas mantles) is no longer mined.

Changes in the number of 300-day workers between 1902 and 1939 are shown in index form in Table 8. While total employment in mining apparently rose some 5 percent,[6] the number of

[5] As explained, the figure for 300-day workers is essentially an estimate of the number of mandays worked divided by 300. Even in 1939 mandays were not always obtained by summing payroll records: they were sometimes derived by multiplying number of men by number of days that the mine was active (see, for example, *Minerals Yearbook, 1940,* pp. 799-800, for comment on methods of reporting employment at bituminous coal mines). This second method is almost certain to overstate the number of mandays worked, for not all the men will work every day the mine is active. However, the mandays implicit in the data for 1902 were uniformly derived by the second method, and must contain an even larger element of exaggeration. It seems probable, therefore, that the comparisons between 1902 and 1939 shown for 300-day workers in Tables 7 and 8 understate the rise, or overstate the decline, in employment between the two years.

Another way of making the same point would be to say that the number of men reported is not a true "active period" average. To yield an accurate manday figure when multiplied by number of days active, such an average would have to be derived by each mine from daily counts of its employees, but in fact in the majority of cases this is not the way in which the average in question is computed.

[6] This may be an understatement; see preceding footnote.

Footnotes to Table 7, concluded.

andalusite and dumortierite; and some miscellaneous varieties of stone.

[o] These totals exclude items shown below, because of lack of data for 1902; and precious stones (covered in 1902) for which data for 1939 are not available.

[p] Does not include contract services to oil and gas wells; see note h above. Other services were covered in 1939 for the first time by the Census: about one third were performed by companies engaged principally in loading and hauling activities; about one third by companies specializing in the stripping of overburden from mineral deposits; and the remainder by firms engaged in sinking mine shafts, driving tunnels, and performing miscellaneous maintenance and development work. Most of this employment can, if desired, be distributed among the industries serviced.

[q] Figure is for 1901; employment in 1902 was affected by the strike.

[r] Less than 0.05.

metal miners declined 24 percent, and of miners of nonmetals other than fuels, 18 percent. Numbers engaged in the production of fuels expanded 17 percent, but only because of the fivefold increase in employment at oil and gas wells.

TABLE 8

CHANGES IN MINING EMPLOYMENT, 1902–39[a]

Industry	*1902*	*1939*
Metal mining, total	100	76
Iron ore	100	40
Copper	100	81
Other metal mining[c]	100	100
Fuels, total	100[b]	117
Pennsylvania anthracite	100[b]	60
Bituminous coal	100	93
Oil and gas wells	100	494
Other nonmetal mining, total[d]	100	82
Stone	100	67
All other nonmetals[d]	100	140
Total mining, including oil and gas	100[b]	105
Total mining, excluding oil and gas	100[b]	82

[a] Data based upon the comparison for 300-day workers shown in Table 7.
[b] Because employment in Pennsylvania anthracite in 1902 was greatly affected by strike conditions, for this industry data for 1901 were substituted.
[c] Includes placer mining.
[d] Does not include common clay, potash, rock salt, sand and gravel, and general contract services; these industries were not canvassed in 1902.

SALARIED WORKERS, WAGE EARNERS AND INDIVIDUAL PROPRIETORS

The Census of 1902 reported a total employment in mining of 620 thousand persons, of whom 582 thousand [7] were wage earners and 38 thousand salaried workers. This suggests a ratio of one salaried worker to every fifteen wage earners. In 1939 the corresponding ratio was one salaried employee to every ten wage earners. The relevant data are set forth in Table 9. It will be seen that salaried workers are relatively most important in the petroleum industry, and least important in coal mining, but that in each branch of extraction their share in labor input has expanded since the turn of the century. A similar picture is shown by manufacturing, which employed one salaried worker for every

[7] Since these are apparently 300-day workers, the number of jobs, or of active period average workers, would considerably exceed this figure. It differs from the total reported for 1902 in Table 7 for the reasons given in note a to Table 9.

TABLE 9

WAGE EARNERS AND SALARIED EMPLOYEES, 1902 AND 1939[a]

	Total	*Metal Mining*[b]	*Pennsylvania Anthracite*	*Bituminous Coal*	*Oil and Gas Wells*	*Other*[c]
1902						
Wage earners, average for year	581,728	111,816	69,691	280,638	22,230	97,353
Salaried employees	38,128	8,300	3,014	14,413	4,956	7,445
Ratio, wage earners to salaried employees	15.3	13.5	23.1	19.5	4.5	13.1
1939						
Total engaged	886,953	101,858	88,646	401,886	203,097	91,466
Wage earners, average for year	783,192	90,671	82,890	373,225	156,085	80,321
Salaried employees	81,849	9,815	5,469	19,828	37,704	9,033
Individual proprietors and firm members	21,912	1,372	287	8,833	9,308	2,112
Performing manual labor	12,250	992	159	7,030	3,247	822
Ratio, wage earners to salaried employees	9.6	9.2	15.2	18.8	4.1	8.9

[a] Data derived from U. S. Bureau of the Census, *Special Reports,* "Mines and Quarries, 1902," and from preliminary releases of the Census of Mineral Industries, 1939. Figures for wage earners in 1902 and 1939 as shown in this table are not really comparable. In 1902 the Census adjusted the average number of wage earners to a 300-day basis wherever an enterprise operated fewer than 300 days during the year. While it made no such adjustment in the case of enterprises operating more than 300 days, the figures shown for wage earners in 1902 approximate a 300-day average. In 1939, on the other hand, the number shown for wage earners represents the average of 12 monthly counts. If the 1939 figures had been obtained in the same manner as the figures for 1902, they would stand substantially below the level shown.

For 1902 figures for wage earners shown here differ from figures for the number of 300-day workers in Table 7 for the following reasons. (1) The latter include nonclerical salaried workers; and for wage earners have been adjusted by us to a 300-day basis in the case of enterprises working more than 300 days during the year (see note b to Table 7). (2) In obtaining the data in Table 7 we adjusted the Census totals upward to correct for undercoverage of employment in gold mines and at oil and gas wells, and downward to exclude employees engaged in processing dimension stone and gypsum (see notes to Appendix Table A-3). (3) In Table 7 figures for anthracite mining relate to 1901 instead of 1902, whereas here all data refer to 1902. (4) In Table 7 precious stones are omitted for 1902 because data for this industry are not available for 1939. No such adjustments were made in this table, and the figures shown here are unadjusted Census totals, both for 1902 and (in preliminary form) for 1939. Data on individual proprietors and firm members are not available for 1902.

[b] In 1902, gold, silver, copper, lead and zinc; iron ore, manganese, mercury, sulfur and pyrite, mineral pigments, bauxite, tungsten, uranium and vanadium, chrome ore, magnesite, molybdenum, nickel and cobalt, rutile (titanium). In 1939, gold, silver, copper, lead and zinc, iron ore, manganese, mercury, pyrites, bauxite, tungsten, uranium and vanadium, magnesite and brucite, molybdenum, titanium, fluorspar in Illinois and Kentucky, miscellaneous metallic minerals (antimony ore and chromite).

[c] In 1939 includes common clay, potash, rock salt, sand and gravel, and general contract services; these industries were not canvassed in 1902.

13 wage earners in 1899, and one for every 8 wage earners in 1939.[8]

It seems certain that this growth in the importance of salaried employees is to be attributed, not to a change in methods of remuneration, but to a genuine variation in the significance of different functions. On the whole, persons who receive salaries once or twice a month are white collar workers; if not office employees, their functions are predominantly of a technical or supervisory character. Persons who receive wages by the day or week for the most part perform manual work. The basic distinction here is between managerial functions (in the broadest sense) and the physical operations of production. Partly because of more rapid progress in mechanizing the work of the wage earner than that of the salary earner, partly because of the increasing complication, both economic and technical, of the modern productive process, the type of work performed by the salaried employee has risen in quantitative importance compared with that done by the wage earner.[9]

In 1939 the proportion of individual proprietors and firm members in the working force was somewhat greater in mining than in manufacturing: 2.5 percent in the former, 1.4 percent in the latter.[10] As in manufacturing, so also in the mining industries this percentage has declined with the years. The Census of 1902 did not collect data of the kind indicated, but in 1909 individual proprietors and firm members comprised 3 percent of all persons engaged in mining.

[8] Solomon Fabricant, *Employment in Manufacturing, 1899–1939* (National Bureau of Economic Research, 1942), Appendix B.

[9] That the change reflects a shift in the relative importance of different functions, and is not due merely to alterations in methods of remuneration, may be seen from an examination of the Census schedules. *Salaried employees* are defined as follows: "Principal officers of corporations; managers, superintendents, and other responsible administrative employees; technical employees, mining engineers, and chemists; clerks, stenographers, bookkeepers, and other clerical employees on salary." *Wage earners* are thus described: "Wage earners, including employees paid by the ton, car, yard, or other unit and miners and others compensated by share of product . . . DO NOT include persons who were not employed on manual or mechanical work." (See *Fifteenth Census,* "Mines and Quarries, 1929," p. 411.) The distinction is thus primarily one of function: see also Fabricant, *Employment in Manufacturing, 1899–1939,* pp. 179-80.

[10] Fabricant, *Employment in Manufacturing, 1899–1939,* Appendix B. However, the figure for manufacturing, at least, represents an understatement, owing to the exclusion by the Census of Manufactures since 1921 of establishments with products valued at less than $5,000.

HOURS OF WORK

In constructing indexes of productivity we shall find it convenient to take output per manday as our basic measure. As already indicated, in many respects the manhour is preferable to the manday as a unit of employment. It is therefore important to discover, at least roughly, how the length of the working day has altered. We shall thus obtain some indication of the bias introduced into our figures through the use of mandays rather than manhours.

In Table 10 will be found data on the length of the work day in the more important mining industries. In 1939 the prevailing length of the shift was about eight hours, except in coal mining where it had been reduced to seven. The working day has been shorter in coal mining than in other industries at least since the close of the first World War. The length of the working week depends not only on the length of the day, but also upon the number of days worked per week. However, in most mining industries the basis on which wage earners are remunerated is the day or shift rather than the week; for this reason data on the number of hours worked per week are difficult to assemble and not very meaningful. Our discussion will therefore be confined for the most part to the length of the work day.

TABLE 10
HOURS PER SHIFT[a]

Industry	*1902*	*1909*[b]	*1919*	*1929*	*1939*
Metal mining, total	9.4	..	8.6	8.3	7.9
Iron ore	9.9	9.9	9.1	8.9	8.0
Copper	8.9	8.2	8.4	8.2	8.0
Other metal mining	9.2	..	8.3	8.0	7.9
Coal, total	8.9	8.8	8.0	8.1	7.0
Pennsylvania anthracite	9.5	9.0	8.0	8.0	7.0
Bituminous	8.8	8.7	8.1	8.1	7.0
Stone	9.7	..	9.5	9.3	7.9
Phosphate rock	10.3	10.5	10.1	10.2	8.1
Gypsum	10.0	..	9.7	8.9	7.9
AVERAGE, ABOVE INDUSTRIES	9.1	..	8.3	8.2	7.3

[a] Except for stone in 1902, and the figures shown for 1909, the data in this table may all be derived from Appendix Table A-3: for sources see notes to that table. For stone in 1902, and for all industries shown in 1909, figures are derived from Census data.

The absence from this table of data for oil and gas wells is explained in the text.

[b] Data on hours of work released by the Census of 1909 were less extensive than in the case of other Censuses. This fact explains the lack of data for some industries in 1909.

The reduction in the number of hours worked per shift undoubtedly antedates the period which is studied here. Even as late as 1880 a work day in excess of ten hours was not uncommon in American industry.[11] In 1902 the average length of the work day in mining was apparently about 9 hours, and since 1902 it has been further reduced by perhaps a fifth. This shortening of the work day has been far from a steady process. Although the partial data for 1909 reveal some decline in hours during the first decade of the century, a much larger reduction evidently occurred during the second decade, which of course includes the first World War. Again, little change seems to have occurred during the 1920's, except apparently in gypsum mining, but a further sharp fall took place between 1929 and 1939.

Why the second and fourth decades of the century should have been so much more productive of increased leisure for employed workers than the first and third decades is by no means completely clear. Certainly the forces operating during the first World War were very different in character from those present during the Great Depression. But the result in both periods was increased unionization—during the war because of the shortage of labor, and the enhanced bargaining power of the working force; during the depression because of governmental policies followed after 1933. To be sure it may be doubted, especially with regard to the 1930's, how far labor union action was responsible, in any exclusive sense, for the reduction in hours that occurred. Partly under the influence of a movement to "share the work," there were numerous initiatives of a governmental or quasi-governmental character which tended to shorten the work day, notably the National Industrial Recovery Act (1933) and the Wage and Hour Act (1938). Clearly the reasons leading to success or failure of the movement for a shorter work day are complex: they cannot be analyzed in detail here. But it seems no accident that the periods of sharpest contraction in the length of the shift—the second and fourth decades of the century—were also periods of rapid social change and serious economic dislocation.

Up to this point nothing has been said about the length of the work day at petroleum and natural gas wells, an industry

[11] See, for example, David A. Wells, *Recent Economic Changes* (Appleton, 1889), p. 415; A. S. Bolles, *Industrial History of the United States* (Henry Bill Publishing Co., Norwich, Conn., 1878), pp. 889-90.

which accounts for about one fifth of all mining employment. Unfortunately it is not possible to present data for this industry in the same form as for other industries. Nevertheless it is certain that large reductions have occurred in the length of the work day here as they have elsewhere. According to the Census of 1902 a 12-hour shift was worked at the overwhelming majority of wells. The production of crude oil and gas is peculiar in that, if a well is flowing, it flows—and may need some degree of attention—24 hours a day. In 1902 this need appears to have been met in general by two 12-hour shifts, much longer working hours than were common in any other kind of mineral production at that time.[12] Of course the burden imposed on the labor force depends partly also upon the number of such shifts worked: it might be no more onerous to work, for example, three 12-hour shifts a week than six 8-hour shifts. However, the long hours worked at oil and gas wells in 1902 do not seem to have been offset in any marked degree by a smaller number of shifts worked per week or month. Data based upon the 1902 Census suggest a figure of over 3,600 for the number of hours worked per year.[13] This means that in 1902 the full time worker must have worked something like 300 of these 12-hour shifts.

Certainly hours worked by full time workers at oil and gas wells declined in marked degree after 1902, as they did in other mining industries. The following figures relate to operations of oil and gas wells by regular producers only.[14]

[12] Of 133,810 oil and gas wells reporting, 127,270 operated 2 shifts a day, and 127,931 operated 12-hour shifts ("Mines and Quarries, 1902," p. 110). The evidence seems conclusive.

[13] O. E. Kiessling and others, *Petroleum and Natural-Gas Production* (National Research Project, Philadelphia, 1939), p. 327. The figure quoted is obtained by dividing 122,824 thousand manhours (derived from wage payments) by 33,400 wage earners. The latter are apparently full time wage earners; but if some of them did not work full time, the number of full time hours per year would be even higher than that suggested in the text.

[14] *Ibid.* Regular producers employ about three quarters of the labor force. The data were obtained by dividing manhours worked, measured by wage payments, by average numbers employed. It is possible that average employment does not take adequate account of inactive periods, in which case the figures quoted understate hours worked by full time employees. For example the Bureau of Mines reports average weekly hours in 1937 as 40.5 for oil wells and 49.6 for gas wells ("Recent Trends in Employment and Productivity in the Oil and Gas Fields," Mineral Market Reports No. 728, April 24, 1939). If these are weighted roughly by workers employed in 1935 (from the same source), the average hours per week for oil and gas wells is 41.2 in 1937. If we assume a full time wage earner works 50 weeks a year, a figure of 2,060 hours per year is indicated. Perhaps because their employment is intermittent, wage earners employed by contractors apparently work fewer hours per year than do those hired by regular producers (see note to Appendix Table A-3).

Year	*Hours per Year*
1902	3,558
1909	3,034
1919	2,471
1929	2,310
1937	1,977

For 1939 an apparently comparable figure of about 1,800 is obtainable for the number of hours worked in that year by full time wage earners.[15]

Evidently hours worked per year in oil and gas production have been reduced rather steadily, and now stand at about half their level at the beginning of the century. It is not certain, however, that hours worked per day have fallen more sharply in petroleum and natural gas than in other mineral enterprises, for we have no recent data on the length of the shift at oil and gas wells. In other mining industries the working day has been shortened by about one fifth. It would seem likely, particularly in view of the very long hours which we know were worked at oil and gas wells at the turn of the century, that the decline has been proportionately greater here than elsewhere.

In all branches of mining for which we have data very substantial additions were made during the forty year period to the leisure of those in full time employment. In the next chapter we shall find that over the same period significant increases occurred in output per manday in most of these industries. It is obvious that corresponding increases in output per manhour must have been even larger.

[15] By dividing 190,674 thousand manhours by 105,505 wage earners (average for the year, including inactive periods). Data are from the 1939 Census and cover producing and nonproducing oil and gas operations, but not labor employed by contractors. This, too, may be an understatement because of inclusion of some wage earners who did not work a full year.