MINES AND QUARRIES.

CHAPTER I.

PLAN AND SCOPE OF INQUIRY.

I.

PROVISIONS OF LAW.

The First Census of the United States, taken in 1790 by the United States marshals and their assistants, contained no statistics relative to manufacturing or mining industries, being confined to an enumeration of the inhabitants or population of the country. The Second Census, taken in 1800, was practically the same in scope. The first attempt to collect any industrial statistics was made in connection with the Third Census, under the provisions of a special amendatory act, passed May 1, 1810, which required the "marshals' secretaries and their assistants * * * to take * * * an account of * * * manufacturing establishments and manufactures." From the digest of these statistics, prepared by Tench Coxe under the direction of the Secretary of the Treasury, it appears that the schedule secured information concerning the cutting and dressing of marble, slate, and other stones, the quarrying of slate, the mining of saltpeter, and the production of red and yellow ocher, but that no reference was made to minerals from which metallic substances are derived save in the classification "lead and manufactures of lead." There was included under this classification the substance known as black lead (graphite). Although the law providing for the census of 1820 contained a provision similar to that of the law of 1810 concerning industrial statistics, there is no evidence that statistics of mines and quarries were taken. The section concerning industrial statistics was omitted from the law providing for the census of 1830.

No further attempt appears to have been made to collect statistics for mines and quarries until the census of 1840, which was taken in conformity with the act of March 3, 1839. This was the first census law to contain a specific provision for the collection of statistics of mines. Section 13 of the law provided that "the aforesaid marshals and their assistants * * * also shall collect and return in statistical tables under proper heads, according to such forms as shall be furnished, all such information relating to mines, agriculture, commerce, manufactures, and schools as will exhibit a full view of the pursuits, industry, education, and resources of the country * * *."

The Seventh, Eighth, and Ninth censuses were taken under the act of May 23, 1850, which authorized not only the enumeration of all inhabitants, but also the collection of "all the other statistical information * * * specified in the instructions which shall be given by the Secretary of the Interior and in the tables annexed." Under this provision statistics of mines continued to be taken, but only in a scattering way and in connection with other statistics until the census of 1870, when they were given separately and with comparative fullness.

Section 18 of the act of March 3, 1879, providing for the census of 1880, contains the following provision: "And said Superintendent may employ experts and special agents to investigate in their economic relations the manufacturing, railroad, fishing, mining, and other industries of the country * * *." The form of the inquiries concerning mining and other productive industries was left to the discretion of the Superintendent of the Census and the Secretary of the Interior.

The only direct reference to a mining census that is made in the act of March 1, 1889, which provided for the Eleventh Census is contained in section 17. This section provided that the only volumes to be published in connection with that census were those relating to population and social statistics, manufactures, mining, agriculture, mortality and vital statistics, valuation and public indebtedness, recorded indebtedness, and statistics relating to railroad corporations and incorporated express, telegraph, and insurance companies. But among the reports which the Superintendent was "required to obtain," if directed to do so by the Secretary of the Interior, were those "from all corporations or establishments reporting products other than agricultural products."

The act of March 3, 1899, providing for the Twelfth Census, was the first census law to describe the scope of the mining census and to make a definite line of demarcation between the statistics of mines and those of manufactures. Section 8 provides "that after the completion and return of the enumeration and of the work upon the schedules relating to the products of agriculture and to manufacturing * * * the Director of the Census is hereby authorized to collect statistics relating to * * * mines, mining, and minerals, and the production and value thereof, including gold in divisions of placer and vein, and silver mines, and the number of men employed, the average daily wage, average working time, and aggregate earnings in the various branches and aforesaid divisions of the mining industry * * *." Before the reports on population, agriculture, and manufactures were completed the act of March 6, 1902, providing for the establishment of a permanent Census Office, became a law, and it was therefore in conformity with this law rather than that of March 3, 1899, that the census of mines and quarries of 1902 was taken. No material change was made, however, in the provisions of section 8, cited above.

At all censuses prior to the Twelfth the statistics of mines and quarries, whenever taken, were collected in connection with the statistics of population, agriculture, and manufactures, and were published as a part of the regular census reports. This practice is correct from both a theoretical and a practical point of view. The separation for the census of 1900 was made apparently because the work incident to the mining census might have tended to delay the completion of the reports on the other more important subjects. It is a distinct advantage, however, to have the reports on agriculture, manufactures, and mining cover the same, or practically the same, period, as it is thus made possible to present statistics of all branches of productive industry for the same year. Under the present law and practice the year covered by the mining census does not expire until more than two and one-half years after the close of that covered by the other industrial statistics—one being the calendar year, and the other the year ending June 1—therefore the reports for the mining census can not be published until about four years after the census year covered by the statistics of manufactures and agriculture. The period covered by the present mining census is the year ending December 31, 1902, and the conditions prevailing during that year in some branches of mining differed materially from those that prevailed during the census year ending June 1, 1900. This difference is especially noticeable in the anthracite coal industry, where the mining operations were practically suspended for six months, although they were in full operation during the entire year covered by the census of 1900. Still, in order to show totals for the mechanical, manufacturing, and mining industries, the statistics for these two dissimilar years must be combined, though the totals are a combination of statistics that represent a prosperous condition for manufactures and a depressed condition in one important branch of mining. The combination, therefore, is not indicative of the results of a year's work under either condition. The office was cognizant of these objections to a mining census covering the year 1902 and the advisability of such a census was carefully canvassed. After much consideration Mr. S. N. D. North, who then held the position of chief statistician for manufactures, sent the following letter of recommendation to the Director of the Census:

October 11, 1902.

Hon. William R. Merriam,
Director of the Census.

Dear Sir: In accordance with your verbal instructions I have consulted with a number of people, including Colonel Wright, Commissioner of Labor, and Mr. Walcott, Director of the Geological Survey, in regard to the advisability of making a census of the mining industry as of the year 1902, in view of the fact that the coal strike in the anthracite regions has produced conditions so abnormal in that branch of the mining industry that a census taken as of the year in which the strike occurred would result in data misleading and unsatisfactory.

It is the judgment of all the gentlemen with whom I have consulted that the fact of the anthracite coal strike does not constitute a good and sufficient reason for postponing the census mining inquiry, and in this judgment I concur. It is the opinion of Mr. Walcott that the statistics of anthracite coal mining can be taken as of the year 1901 so far as quantities and values are concerned. It is suggested by Commissioner Wright that statistics of the anthracite coal mining industry, taken as of the year 1901, so far as quantities and values are concerned, and as of the year 1902, so far as relates to other items, will prove of great value in the immediate future in connection with the discussion of the controversy which has arisen between the coal operators and the coal miners of the anthracite region, and that Congress and the people of the United States ought to have the benefit of such statistics in view of important economic questions arising from the strike in question. Colonel Wright also suggests that certain questions having a direct bearing upon the existing situation in the anthracite coal region may with propriety be added to the special schedule adopted for that branch of the mining industry.

I therefore recommend that the division of manufactures shall continue and perfect its plans for taking a mining census as of the present calendar year, with a view to the commencement of field-work early in the year 1903.

Such a course was undoubtedly contemplated by Congress in the passage of the act providing for a permanent Census Office, approved March 6, 1902. It is true that the portion of section 7 of the act in question which undertakes to fix the date for the mining census is difficult of intelligent interpretation in the form in which it was enacted, but an examination of the debate in the House of Representatives at the time when the words "until July first, nineteen hundred and four," were inserted in the bill in the form of an amendment offered by Mr. Williams, of Mississippi, reveals the fact that the purpose of these words was to restrict the Census Office to a single report upon the mining industry and to exclude annual reports, and that it was intended that this should be taken and published prior to the date named. In order to comply literally with the intent of Congress, as revealed in the debates of the House in connection with this amendment, it will be necessary to take the mining census as of the calendar year 1902.

With reference to the plans for the mining census, I respectfully recommend that the inquiry be divided into three parts, as follows: Part 1, Precious metals; Part 2, Stone quarrying of all descriptions; Part 3, All other minerals, metallic and nonmetallic.

I also recommend that the details of the work for each part shall be under the immediate direction and within the complete control of the chief statistician for manufactures and his assistants.

I recommend the appointment of Mr. I. A. Hourwich, of Washington, D. C., as consulting expert special agent for the precious metals, at a compensation of $6 per diem when actually employed. Mr. Hourwich was formerly connected with the Treasury Bureau of the Mint and is highly recommended by Director George E. Roberts. I make this recommendation with the understanding that Mr. Hourwich is to have access to all the records and data of the Mint in connection with this work, and that the Census Office is to have the benefit of the cooperation of that bureau of the Government as the result of Mr. Hourwich's appointment.

For the second branch of the inquiry I recommend the appointment of Mr. George P. Merrill as consulting expert special agent. Mr. Merrill is one of the head curators of the National Museum, and this recommendation is made with the understanding that he will serve the Census Office without compensation, and that the office is to have the benefit of all the records and data of the National Museum so far as they relate to the stone quarrying industries of the United States.

For the third branch of the mining inquiry I recommend that a consulting expert special agent be appointed who shall be mutually agreed upon by the Director of the Census and the Director of the United States Geological Survey, and with the understanding that the Census Office is to have the use and benefit of the records and data of the statistical division of the Geological Survey in the prosecution of its work, in accordance with section 28 of the act of March 3, 1899, under such conditions as shall prove satisfactory to the Director of the Geological Survey and shall be mutually agreed upon.

I am of the opinion that it will be for the benefit of the Government if the mining statistics annually collected and published by the Geological Survey are collected for the year 1902 by the Survey and the Census Office, working in conjunction and cooperation with each other, thus avoiding a duplication of governmental statistical work, the whole expense of the inquiry for that year to be borne by the Census Office; and the Geological Survey to have the benefit and use of the statistics, so far as it may require them, contemporaneously with their use and publication by the Census Office.

The details of this plan, if it can be carried out, must necessarily be the result of consultation with the Director of the Geological Survey, and must include such arrangements regarding the clerks of the Survey employed in its statistical division and their payment during the period of the inquiry as may be mutually agreed upon.

All of which is respectfully submitted.

S. N. D. North,
Chief Statistician for Manufactures.

The recommendations contained in this letter were approved, and preparations were immediately made for the mining census. These consisted of making ready the schedules and instructions, perfecting the details for cooperative work with the Geological Survey, getting together lists of mines and quarries, districting the entire country, and appointing special agents. Each of these stages of the work is explained at length under its appropriate title.

II.

DEVELOPMENT OF MINING STATISTICS.

Scope of the inquiry.—The census of 1840 was the first, except for the fragmentary information collated in 1810, to include statistics of mining and quarrying. Statistics were shown of capital, employees, and product—in combination, however, with the manufactures of the metal or mineral in each case—for coal, anthracite and bituminous; gold; granite, marble, and other stone; iron ore; and lead.

In 1850 and 1860 statistics for mines and quarries were included with those for manufactures. The first separate census of mines and quarries was in 1870; then followed the censuses of 1880 and 1890. Table 1 shows the character of the inquiries concerning mines and quarries from 1850 to 1902, as far as they are disclosed by the published results.

The subjects presented from 1850 to 1902 are shown in Table 2, which makes very plain the development in this respect during the little more than a half century which has elapsed.

TABLE 1.—CHARACTER OF INQUIRIES CONCERNING MINES AND QUARRIES: 1850 TO 1902.

	1850	1860	1870	1880	1890	1902
Number of establishments	×	×	×			
Number of mines				×	×	×
Number of operators						×
Capital	×	×	×			
Capital, by classes				×	×	
Capitalization, etc., of incorporated companies						×
Wage-earners, by sex	×	×				
Wage-earners, classified as men and boys, above and below ground			×	×		
Wage-earners, by occupation				×		
Wage-earners (men and boys, above and below ground), by occupation					×	×
Average number of wage-earners (men and boys) employed during each month						×
Wage-earners (men and boys), by occupation and daily rates of pay						×
Wages, total			×	×		
Wages, by sex, of wage-earners	×	×				
Wages of men and boys, above and below ground, by occupation					×	×
Cost of supplies and materials	×	×	×	×	×	×
Product, value	×	×	×	×	×	×
Product, quantity			×	×	×	×
Power and machinery			×	×	×	×
Salaried officials				×		
Salaried officials and salaries, by sex					×	
Salaried officials and salaries, by occupation						×
Contract work, amount paid					×	×
Contract work, number of employees						×
Miscellaneous expenses, total					×	
Miscellaneous expenses, in detail						×
Character of ownership						×
Time in operation (or idle)						×

TABLE 2.—SUBJECTS INCLUDED IN CENSUS REPORTS CONCERNING MINES AND QUARRIES: 1850 TO 1902.

Inquiry introduced.	Group.		1850	1860	1870	1880	1890	1902
1850	Metallic	Gold mining	×	×			(1)	
		Gold rockers	×					
		Silver mining		×			(1)	
		Gold and silver assaying and refining ("reduced and refined" in 1870) [2]		×	×			
		Gold quartz			×			
		Gold and silver quartz			×			
		Silver quartz			×			
		Quartz milled			×			
		Gold, hydraulic mined			×			
		Gold, placer mined			×			
		Gold, hydraulic, placer, etc.				×		
		Gold and silver, deep mines				×		
		Gold and silver					×	
		Iron ore	×	×	×	×	×	
		Brown hematite					(1)	(1)
		Red hematite					(1)	(1)
		Magnetite					(1)	(1)
		Carbonate					(1)	(1)
		Lead	×		×	(1)	(1)	(1)
		Lead mining and smelting		×				
		Zinc		×	×	(1)	(1)	(1)
		Lead and zinc ore				×	×	×
	Fuels	Coal	×					
		Coal, anthracite		×	×	×	×	×
		Coal, bituminous		×	×	×	×	×
	Structural materials	Slate	×	×	×	×	×	×
		Stone and marble quarries ("marble and stone work" in 1860)	×	×				
		Stone			×			
		Marble			×		×	
		Sandstones and quartzites ("sandstone" prior to 1902)				×	×	×
		Siliceous crystalline rocks				×	(3)	
		Marble and limestone				×		
		Magnesian limestone				×		
		Limestones and dolomites ("limestone" in 1890)					×	
		Bluestone					×	(4)
		Granite					×	(5)
	Abrasives	Buhrstones	×					
		Millstones [2]	×	×	×	×	×	
		Buhrstones and millstones						
		Grindstones and pulpstones ("grindstones" prior to 1902) [2]	×	×	×	×	(6)	
	Chemicals	Gypsum (plaster) ("plaster, ground," in 1870) [2]	×	×	×		×	
	Pigments	Ocher	×	×	×	×		
		Paints					×	
		Mineral pigments, crude						
	Miscellaneous	Cement ("hydraulic cement" in 1880) [2]	×	×	×	×		
		Chrome ore	×	×		×	×	
		Mica ("isinglass" in 1860)	×	×	×	×	×	×

[1] Production only.
[2] For comparative purposes considered as mining and quarrying.
[3] See "granite."
[4] Included in "sandstones and quartzites."
[5] Included in "siliceous crystalline rocks."
[6] Given under "stone."

TABLE 2.—SUBJECTS INCLUDED IN CENSUS REPORTS CONCERNING MINES AND QUARRIES: 1850 TO 1902—Continued.

Inquiry introduced.	Group.		1850	1860	1870	1880	1890	1902
	Metallic	Copper ore		×	×	×	×	×
		Copper, milled and smelted [1]			×			
		Manganese ore		×		×	×	×
		Nickel and cobalt		×			×	×
		Nickel ore		×	×	×		
		Nickel, smelted [1]			×			
		Cobalt				×		
		Nickel and cobalt matte				×		
		Quicksilver		×			×	×
		Quicksilver, smelted [1]			×			
		Cinnabar			×			(2)
	Fuels	Petroleum ("oil, coal," in 1860)		×	×	×	×	×
	Structural materials	Clay		×				×
		Paper clay		×				
		Fire clay		×	×			(3)
		Kaolin				×		(3)
		Ball clay						(3)
		Stoneware clay						(3)
		Pipe clay						(3)
		Terra cotta clay						(3)
		Water lime ("hydraulic lime" in 1880)		×		×		
1860	Abrasives	Corundum		×			×	
		Emery		×				
		Emery, reduced and ground [1]			×			
		Corundum (emery)				×		
		Corundum and emery						×
		Oilstones		×		×		
		Whetstones		×		×		
		Scythestones		×		×		
		Scythe rifles		×				
		Hones and whetstones [1]			×			
		Shoemaker's sandstone				×		
		Oilstones, whetstones, and scythestones ("whetstones" in 1890)					×	×
	Chemicals	Sulphur		×		×	×	
		Pyrite ("pyrites" in 1890)				×	×	
		Sulphur and pyrite						×
	Pigments	Barytes		×	×	×	×	×
	Miscellaneous	Asphaltum and bituminous rock ("asphaltum" prior to 1902)		×	×	×	×	×
		Graphite ("plumbago, black and silver lead" in 1860)		×		×	×	×
		Magnesite ("magnesia" in 1860)		×				×
		Silica sand ("glass sand" in 1860 and 1880; "silex" in 1870)		×	×	×		×
		Soapstone		×		×		
		Talc				×		
		Talc and soapstone ("soapstone" in 1890)					×	×
1870	Fuels	Peat (cut)			×			
	Abrasives	Garnet				×		×
		Infusorial earth				×	×	
		Infusorial earth, tripoli, and pumice						×
1880	Chemicals	Borax [1]				×		×
		Phosphate rock ("phosphates" in 1890) [1]				×	×	×
	Miscellaneous	Asbestos				×	×	×
		Mineral soap				×		
		Quartz and feldspar				×		
		Flint						×
		Feldspar						×
	Metallic	Aluminum					×	
		Antimony					×	
		Platinum					×	
		Tin					×	
1890	Fuels	Natural gas					×	
	Chemicals	Fluorspar					×	×
	Miscellaneous	Lithographic stone					×	
		Marl					×	×
		Ozocerite					×	
		Precious stones					×	×
	Abrasives	Crystalline quartz						×
1902	Miscellaneous	Bauxite						×
		Fuller's earth						×
		Lithium ore						×
		Molybdenum						×
		Monazite						×
		Rutile						×
		Tungsten						×
		Uranium and vanadium						×

[1] For comparative purposes considered as mining and quarrying. [2] Included with "quicksilver;" production reported separately. [3] Production only.

The census of 1850 was the first at which a complete enumeration of industrial establishments was attempted. It was also the first at which answers were required to definite questions concerning capital, labor, materials, and products, but at this and the census of 1860 the statistics for mines and quarries were subsidiary to those for manufactures, the enumeration being made by the same agencies and the statistics included in the same tables. At the census of 1870 the statistics of mining were presented separately. The defects incident to the collection of statistics for manufactures were intensified in those for mining. It was impossible for the United States marshals and their assistants to make a complete enumeration of mines and quarries, many of which were in remote localities and the schedules used were not in proper form to secure satisfactory information from the mines and quarries that were reported.

The following comparative table is introduced to show the character of the statistics reported for mines and quarries at prior censuses and to illustrate the absence of comparative data on any phase of the industry other than possibly the quantity and value of products. The figures for 1889 in this table do not agree with those in Table 4 for the reason that certain industries not considered mining have been eliminated in order to make the totals comparable; nor do they agree with those in Table 1 of Chapter II because they include only the minerals contained in the body of the report of the Eleventh Census.

TABLE 3.—MINING STATISTICS REPORTED AT CENSUSES: 1850 TO 1902.

	1902	1889	1880	1870	1860	1850
Number of mines or quarries	151,516	59,204	[1] 22,404	[2] 8,775	[2] 9,323	[2] 3,261
Number of operators	46,858					
Capital	(3)	$1,287,709,840	$1,448,808,032	$245,757,606	$65,853,730	$16,750,766
Salaried officials, clerks, etc.:						
Number	38,128	6,120	(4)	(4)	(4)	(4)
Salaries	$39,020,552	$4,724,392	(4)	(4)	(4)	(4)
Wage-earners:						
Average number	581,728	[5] 523,710	295,991	163,185	[6] 100,754	[7] 34,209
Total wages	$369,959,960	[5] $212,676,848	[8] $94,771,944	$79,430,551	$39,830,010	$12,266,236
Above ground—						
Men 16 years and over	215,286	210,964	116,792	74,684	(4)	(4)
Boys under 16 years	6,219	20,869	15,633	7,256	(4)	(4)
Below ground—						
Men 16 years and over	354,585	281,841	153,838	77,232	(4)	(4)
Boys under 16 years	5,638	10,036	9,728	4,013	(4)	(4)
Contract work	$20,677,938	$6,719,531	(3)	(3)	(3)	(3)
Miscellaneous expenses	$71,771,713	$30,236,132	(3)	(3)	(3)	(3)
Cost of supplies and materials	$123,814,967	$74,288,181	$31,447,488	$41,839,820	$25,154,924	$5,049,841
Value of products	$796,826,417	$410,760,770	$251,967,055	$191,002,543	$89,544,435	$29,826,699

[1] Mines, quarries, wells, and establishments.
[2] Establishments.
[3] Not reported.
[4] Not reported separately.
[5] Includes foremen and their wages.
[6] Includes 173 "female hands."
[7] Includes 130 "female hands."
[8] No wages were given for wage-earners in stone quarries.

The number of minerals for which statistics were shown at the census of 1860 would indicate that about all branches of mining followed at that time were included. It is impossible, at this late day, to determine the degree of completeness obtained in the statistics of minerals and mining operations collected at the censuses of 1850 and 1860. It is certain, however, that there was a great deficiency in the 1860 statistics of iron ore. The following statement appears in the Report on Manufactures for 1860, page clxxvii: "Many of the large iron works of the country either own or farm the mineral lands and mine their own ore, which is not included in the foregoing product. The quantity thus raised in 1860 amounted to about 2,309,975 tons, which, added to the product of regular mining establishments, makes the total quantity raised in 1860, 3,218,275 tons. At an average cost price of $2.40 per ton the total value would be $7,723,860." This indicates that more than two-thirds of the iron ore mining operations were omitted from the enumeration, but it is probable that they were included with the statistics of blast furnaces.

Census of 1870.—In 1870 the statistics for the mining industries were presented separately from those for manufactures. Totals were shown for the United States and for each state and territory, also for each mineral in each state by counties. The statistics were accompanied by a short explanatory text, which declared that they were entirely inadequate and fell far short of the total production. At 1870 and prior censuses the statistics, whether for mines, manufactures, or fisheries, were all collected upon a schedule having the same form. The scope of the inquiry was thus necessarily limited. The census of 1870 was supposed to cover all mines and quarries as it did manufactures, but mines and quarries where the annual production did not exceed $500 were not taken. The separation between the mining and manufacturing industries, first attempted at this census, appears to have been made with the intention of including under manufactures all work on the ore after its delivery at the mouth of the mine.

In presenting the statistics Hon. Francis A. Walker, Superintendent of the Census, stated that "the statistics following are of very unequal value, for the reason that the machinery of enumeration provided by the census law of 1850 was created without consideration of certain of the great mining industries of the country, * * * and can not be applied to them with any degree of success. It may fairly be taken for granted that an attempt to enumerate cotton spinning, coal mining, and cod fishing on one and the same schedule will always result in returns unsatisfactory in respect to one if not two of the three industries so widely diverse in character and conditions."[1]

With regard to the statistics for the precious metals Superintendent Walker says: "The statistics of the gold and silver product, as obtained by the census, are here published in conformity with what is understood to be the requirement of law; but it would be wholly unjustifiable were the figures to be put forth without a distinct and emphatic disclaimer of their validity and authority."[2]

Census of 1880.—The incomplete and defective character of the statistics at the census of 1870 and prior censuses led to the adoption of entirely different methods at the census of 1880. The scope of the inquiry was greatly extended, special schedules were introduced, and the conduct of the canvass and the compilation of the statistics were assigned to experts selected from the force of the United States Geological Survey. The inquiry not only covered the occurrence of minerals, employees and wages, and details as to the quantity and value of the different products, but extended to an analysis of the different leading minerals and the collection of numerous specimens. The report included

[1] Ninth Census of the United States, Industry and Wealth, page 748.
[2] Ibid., page 750.

statistics for manufacturing processes, such as lead, zinc, and copper smelting and refining, the refining of precious metals, and of petroleum. A directory of mines and metallurgical establishments was also included in the report. The purpose of the inquiry, as stated in the Instructions to Special Agents, was "to elucidate as far as practicable, the character, extent, and total influence of the mining industry. No industry has ever been examined throughout an extensive region so fundamentally and minutely as it is intended that the mineral industry of the West shall have been when this inquiry is successfully accomplished. The results will be a great addition to the data of political economy and will form a systematic accumulation of technical facts, such as does not at present exist."[1]

The subjects covered by the schedules for the precious metals are as follows:

- Metallic mines.
- Hydraulic mines.
- Hydraulic ditches.
- Ore-dressing works.
- Amalgamating mills.
- Stamp batteries.
- Pan amalgamation.
- Roasting furnaces in amalgamating works.
- Alternate amalgamation and concentration of battery sands.
- Alternate concentration and amalgamation of battery sands.
- Arrastras.
- Smelting works in general:
  - Preliminary operations.
  - Smelting in shaft furnaces.
  - Smelting in reverberatory furnaces.
  - Desilverization by zinc.
  - Pattinsonizing.
  - Improving of lead.
  - Cupellation.

In addition to the above, special schedules were provided for copper, iron, and lead and zinc mines, and quicksilver production; coal mines, farmers' coal diggings, petroleum wells, slate and stone quarries, charcoal burning, and minor minerals.

All mines were included, irrespective of the value of their products, and the irregular workings were enumerated. The census, so far as it related to precious metals, was limited to mines which showed at least 200 feet of shafts and galleries or which produced 50 tons or more of remunerative ore. The enumeration was not intended to be complete, but was apparently planned with a view to obtaining as large a number of representative facts as possible from which to draw general deductions.

[1] Tenth Census of the United States, Precious Metals, Vol. XIII, page 493.

As a census report the work was a failure, but as a scientific and technical report it has considerable value. The reasons for the failure of the 1880 census of the precious metals are concisely stated as follows: "After the work had been some time under way, it was found that both the time and the money which could be allotted to this branch were inadequate to carry it through with the perfection aimed at; that it was impossible to find the number of men required who were in every respect fitted for it by education and experience; and that among owners and superintendents of mines and reduction works, while with a very few unimportant exceptions the greatest willingness was shown to grant us all the information they possessed, it was often found that they were themselves unable to answer the questions we asked, either through want of system in keeping records, or because they had never thought of the importance or bearing of certain facts."[2] If the general canvass of all mines had been confined to the collection of a few main facts and the special technical features to representative mines, the work would have met with a larger measure of success.

The failure of the census of 1880 was apparently accepted as demonstrating the impracticability of including a large number of inquiries on technical and scientific subjects in a schedule to be used for a general canvass of all mines and quarries. The establishment in 1879 of the Geological Survey, and the collection by that office of technical and scientific information concerning the mineral resources of the country, obviated the necessity for the collection of such information by the Bureau of the Census. Therefore the scope of the census of 1890 was considerably curtailed, but followed in a general way the plan outlined in 1880.

Census of 1890.—The statistics for the mining census of 1890 are contained in a volume entitled "Mineral Industries." This report presents detailed statistics for each mineral, but no summary is given of the totals for all, though the following figures purporting to show the totals for the mining industry are obtained from the introduction to the report:

Employees	636,419
Wages paid	$265,290,643
Other expenditures	$115,874,135
Value of products	$587,230,662

The data given in the body of the report for each mineral are summarized in Table 4.

[2] Tenth Census of the United States, Precious Metals, Vol. XIII, page xi.

TABLE 4.—SUMMARY OF MINERAL INDUSTRIES: 1889.

MINERAL.	Number of mines, quarries and wells.	Capital.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.								Miscellaneous expenses.	Supplies and materials.	Value of product.
					Aggregate.		Above ground.			Below ground.					
			Number.	Salaries.	Number.	Wages.	Total.	Men.	Boys.	Total.	Men.	Boys.			
Total	59,494	$1,310,585,318	6,541	$5,520,600	536,043	$222,041,887	244,127	223,229	20,898	291,916	281,880	10,036	$39,521,596	$86,075,925	$438,111,548
Aluminum															97,335
Antimony					28	[1] 12,218	7	7		21	21		[2] 7,145	3,859	28,000
Asbestos [3]		42,600	1		11	2,700	8	8		3	3			525	1,800
Asphaltum		2,651,500	2	3,000	131	63,503	119	119		12	12		[2] 17,950	13,884	171,537
Barytes		351,150			215	[1] 54,524	45	40	5	170	170		2,083	8,200	106,313
Chromic iron ore	6	8,000			30	6,000	[4] 30	30						[5] 4,000	30,000
Coal	[6] 12,552	342,757,929	2,936	2,193,870	296,623	106,937,058	67,137	49,301	17,836	229,486	219,690	9,796	[7] 18,576,762	18,828,590	160,226,323
Copper	[8] 11	74,984,737	147	266,108	13,508	9,885,623	7,350	7,214	136	6,158	6,075	83	[2] 2,348,588	10,093,587	[9] 19,686,562
Corundum	[10] 4	73,400			129	44,660	55	55		74	74		[2] 3,062	9,383	105,565
Fibrous talc															211,170
Fluorspar		192,000			101	14,213	73	71	2	28	28		3,008	5,025	45,835
Gold and silver [11]	3,729	486,323,338	873	1,347,373	56,434	40,412,022	22,025	21,943	82	34,409	34,366	43	[2] 7,874,002	13,817,739	99,283,752
Graphite		259,475			101	38,329	25	25		76	76		[2] 8,678	7,734	72,662
Gypsum	[12] 24	2,473,175			761	[1] 249,200	586	579	7	175	175		[2] 55,293	128,854	764,118
Infusorial earth		110,750			52	8,388	52	52					[2] 7,530	760	23,372
Iron ore	592	109,766,199	520	529,043	37,707	13,880,108	17,999	17,290	709	19,708	19,597	111	[1] 5,373,519	4,998,988	33,351,978
Lead and zinc [13]	[14] 21	5,518,489	358	672,029	12,052	6,874,381	11,186	10,979	207	866	863	3	[2] 2,066,729	6,215,925	[15] 15,335,364
Lithographic stone	1				3	154	3	3					228	200	243
Manganese		2,188,950			432	123,958	[4] 432	432							[16] 240,559
Marl	[17] 3														63,906
Metallic paint		462,164	8	5,540	191	69,820	191	188	3				[2] 22,929	65,498	286,294
Mica [3]	4	691,550			185	42,174	185	185					8,753	7,408	52,430
Millstones		54,945			99	17,853	99	97	2				[2] 2,118	1,413	35,135
Mineral waters	[18] 258	5,994,683				433,583							210,304	524,864	1,748,438
Natural gas	[19] 2,247	[20] 59,682,154	411	290,403	6,273	1,445,986	6,273	6,267	6					13,184,497	21,097,029
Nickel and cobalt		279,000	6	9,600	181	84,200	113	103	10	68	68		[2] 3,151	29,236	[21] 40,000
Ocher		386,453			196	[1] 59,695	196	193	3				7,541	19,011	177,472
Ozocerite															2,500
Petroleum	[19] 35,163	[20] 114,157,370	173	163,156	22,366	8,383,744	22,366	22,210	156					9,505,935	26,963,340
Phosphate rock	[22] 25	6,131,718			5,011	[1] 1,209,151	5,011	4,920	91				[2] 459,201	317,159	2,937,776
Platinum and iridium															2,000
Precious stones					299	148,355	299	187	112				[5] 55,762		188,807
Pyrites		1,358,882		5,512	237	62,379	108	86	22	129	129		[2] 53,365	42,000	202,119
Quicksilver	11	1,221,114	20	34,966	937	580,042	416	412	4	521	521		[2] 46,771	219,622	1,190,500
Soapstone		924,900			280	[1] 115,621	280	268	12				[2] 12,363	35,454	231,708
Stone	4,163	90,212,433	1,086		81,288	[1] 30,555,877	81,288	79,807	1,481				2,293,706	7,923,220	53,655,630
Sulphur	2	320,750			12	2,410	12	9	3					1,700	7,800
Tin	[23] 678	898,000			79	202,047	67	67		12	12			[5] 60,817	(24)
Whetstones		57,510			91	21,911	91	82	9				[2] 1,055	838	32,980

[1] Includes salaries.
[2] Includes amount paid contractors.
[3] Statistics, except those of production, refer also to mines at which development work was done.
[4] Not separated into above and below ground.
[5] "Other expenditures."
[6] Including 9,969 "local mines," the product only of which is shown.
[7] Includes contract work.
[8] Stamp mills; number of mines or establishments otherwise not given. Statistics include those for stamp mills, concentrating plants, and copper refining.
[9] Value of product is that of copper refined.
[10] Firms; from textual statement, page 711: "The entire industry is controlled by three or four firms."
[11] Includes reduction works.
[12] Producers; from textual statement, page 700: "There were 24 producers who used steam power at their works."
[13] Includes smelting and refining.
[14] Smelting works.
[15] Value of product of zinc and lead mines, and, in some cases, value of ore treated by smelters and refiners; other statistics include smelting and refining.
[16] Not including value of manganiferous zinc ore, which was $54,560 at the mines.
[17] Organized companies.
[18] Springs.
[19] Producing wells.
[20] Includes value of pipe lines.
[21] Includes value of matte at mines, but not the value of other smelted nickel ores.
[22] Number of establishments given for South Carolina only.
[23] Number of openings.
[24] No production during the census year.

The totals for the United States, as shown by Table 4, are considerably less than the total referred to in the introduction to the report of the Eleventh Census. There is apparently no explanation of this difference, but it is believed that the figures given in Table 4 represent actual conditions as nearly as they can be ascertained from the data furnished at the Eleventh Census. Table 4 includes statistics for the following, which are not considered as forming a part of the mining census of 1902, i. e., aluminum, copper smelting, lead smelting and refining, and spelter and oxide of zinc, and mineral waters. Lack of uniformity is apparent in the statistics for the different minerals shown in Table 4. To illustrate: For aluminum and fibrous talc, marl, and ozocerite, product only is reported; for antimony, the number of establishments, capital, salaried employees, or salaries are not reported. The number of establishments and miscellaneous expenses are not reported for asbestos, while the production is given for California only, though the expenditures evidently include the nonproducing mines in Wyoming.

In addition to the mining statistics, the census of 1890 included statistics for the smelting and refining of gold, silver, copper, and lead and zinc. The statistics

apparently included all reduction works, though the general line of demarcation between manufacturing and mining agrees very closely with that followed in the canvass of the Twelfth Census. In the Report of Mineral Industries at the Eleventh Census it was stated that "the subjects taken for the investigation included all minerals which would have a definite market value, wherever they occur, provided the deposit contained the mineral in sufficiently pure form. This ruled out such minerals as ice, water (except mineral waters), sand for street paving, and other materials the condition of which is not changed, but which are simply made valuable by the work of placing in a special position, as earth for embankments."

"In the treatment of the various subjects the limit of the mining features was considered as reached when the product became a regular article of commerce."[1]

The following minerals were apparently produced in commercial quantities in 1889, though the report contains no data concerning them, i. e., borax, bauxite, cement, flint, feldspar, potters' clay, and rutile.

Census of 1902.—The scope of the census of mines in 1902, as stated in the act approved March 6, 1902, providing for a permanent Census Office, was intended to embrace the collection of statistics relating to "mines, mining, quarries, and minerals, and the production and value thereof, including gold in divisions of placer and vein, and silver mines, and the number of men employed, the average daily wage, average working time, and aggregate earnings in the various branches and aforesaid divisions of the mining and quarrying industries."

The purpose was to include in the enumeration the processes involved in the extraction from the earth of mineral products of all kinds. To accomplish this successfully the special agents engaged in the field-work were instructed to secure reports for all mines and quarries, and for reduction works connected with mines or engaged in reducing the ores containing the precious metals. It is believed that this census is as broad and as comprehensive in its scope as any of its predecessors; certainly it may be claimed that the canvass has been more complete than any statistical inquiry heretofore made concerning the mines and quarries of the United States.

No restrictions or limitations were established as to the size or importance of mines and quarries to be enumerated, except that the special agents were instructed to eliminate from the inquiry small placer gold mines at which less than two wage-earners were employed. The schedules received bear evidence that in many instances this instruction was not followed, and the reports included a number of small mines operated without hired labor.

Mineral springs were omitted from the canvass for the reason that in most cases the production is entirely spontaneous and does not require the employment of capital or labor except to place the product upon the market in the form of bottled mineral waters.

The production of salt was also omitted for the reason that a thorough canvass of the inquiry had been made in 1900 for the census of manufactures. The statistics are presented, with a report on the subject, in Part III of the Report on Manufactures.

What appears to be a serious defect in the published results of some of the earlier censuses is the absence of summaries showing the statistics other than those for quantity and value of product. Complete summaries by states and by industries for the United States, and for each industry by states and each state by industries were published at the census of 1870. At the census of 1880 a similar summarization was made for bituminous coal and lignite, anthracite coal, iron ore, copper ore, lead and zinc ore, and the minor minerals, but the absence of uniformity in the collection of statistics was referred to in the report of that census as follows: "It will therefore be seen that the duties of this office in regard to the statistics of mining were very different in different parts of the country, and further that the statistics were collected on blanks of different forms. The lack of uniformity in this respect added greatly to the difficulty of tabulation."[2]

The statistics for 1902 are presented in this report in summarized form and in detail. The tables show the statistics for the United States by states and by industries. Each industry is also presented by states and each state by industries. In connection with the reports on the different minerals, tables pertinent to the subject are presented.

A careful study of the statistics for the different censuses leads to the conclusion that there are no reliable comparative data for all mines and quarries other than the quantity and value of products.

The development of mining statistics may be considered as dating from the Tenth Census. The principal features of this development have been: (1) The separation of the statistics for mines and quarries from those for manufactures; (2) the adoption of special schedules designed to accentuate the peculiar features of the different minerals; (3) the employment of expert special agents to collect and present the data; (4) the collection of statistics in collaboration with the United States Geological Survey.

Mining and manufacturing.—Separate schedules were first provided for the mining industries at the census of 1880. Prior to that date the statistics had been collected in connection with the census of manufactures, the same schedule being applied indiscriminately to large manufacturing establishments, small shops, mines, quarries, and fisheries.

In some cases the mining industry is restricted to the digging of ore and the quarrying of rock—that is, to

[1] Eleventh Census of the United States, Mineral Industries, page ix.

[2] Eleventh Census of the United States, Mining Industries (excluding Precious Metals), Vol. XV, page xxii.

the minerals as delivered f. o. b. at the mine or quarry. In others a certain amount of labor is expended in the preparation of the product for the market. All labor expended on material after it is taken from the earth may be regarded as employed in manufacturing, and a strict demarcation between the two industries would so assign all such processes, but it is impossible in many instances to make this separation. To assist in the separation where possible and to aid in a more definite statistical presentation, all mines can be arranged in two groups: (1) Those where the product is marketed in the form in which it is extracted from the earth; (2) those where the initiatory manufacturing process is necessarily done at the mine or in immediate connection therewith.

No attempt was made to segregate the statistics for the two branches of industry, mining and manufacturing, respectively, prior to the census of 1870. At that census the distinction between mining and manufacturing was sharply defined, and the statistics for mining were presented in a separate series of tables. The reasons for the distinction were given as follows:

(1) Because these industries are in theory and in their practical relations essentially distinct. * * * The occupation of the miner is not so much unlike that of the artisan, yet writers on political economy have been quite generally disposed to hold that if the occupations of mining and fishing are to be assigned to any one of the three grand divisions of industry which have been indicated, it should be to agriculture, as dealing in the spontaneous products of the earth and the sea, and also as furnishing material in the earliest forms for subsequent processes of industry.

(2) For convenience of reference and citation. The statistics of mining * * * occupy so little space comparatively as not to be easily found upon occasion in voluminous tables of manufactures.

(3) Because the statistics of mining * * * with the present modes of collection are distressingly inadequate to the known facts of the case, and their addition to the tables of manufacturing industry amounts to a positive disparagement of the latter. The statistics of manufactures have their own faults, as is elsewhere frankly acknowledged, under the present census system of the United States, but they are incomparably more complete and accurate than any statistics of mining * * * to be obtained by existing machinery. To merge them with matter so defective is, in a degree, to subject them to the same discredit. A separation, therefore, is on all accounts desirable.[1]

The separation at the census of 1870 was effected in some cases by means of correspondence with the mine operators, so far as they were disposed to afford the information, and in other cases by estimates prepared according to approved formulas at the Bureau of the Census. The theoretical division between mining and manufactures thus applied is not wholly practical. Companies, firms, and individuals that operate both a mine and a reduction works, or that break, wash, screen, or roast the ore, almost invariably consider preparation for the market a part of the mining operations, and so report, insisting that the statistics can not be separated, since the employees were frequently engaged interchangeably on both branches of the work and no separate accounts were kept either of the wages or of other expenses.

At the census of 1880 the statistics related not only to mining, but included such technical data as to the various processes by which the metals are reduced from the ores as would serve to show the actual condition of the industry,[2] and therefore embraced manufacturing processes, such as the smelting of ores and the refining of petroleum. A more practical separation was attempted in 1890, but the statistics for that census also covered a number of manufacturing processes that are incident to the production of metal. At the census of 1902 the manipulation of the ore after it leaves the mine, if so interwoven with the business of mining as to be inseparable, has been considered a part of the mining industry. All other processes have been eliminated.

The combination of mining and manufacturing by the use of the same capital, the same wage-earners, etc., has been accentuated by the consolidation of industrial enterprises, carried to a high state of perfection during the past decade. If the statistics for mining and manufacturing were to be taken together it would be easy to find a common term for this union and comparatively simple to show the aggregate figures, but such work would not supply the demand for separate statistics for these important industries. Where the milling, separating, washing, burning, calcining, or other processes of reduction or manufacturing were carried out at the mine or quarry, the census of mines and quarries includes, as a rule, the employees, wages, miscellaneous expenses, and supplies and materials involved in the work of the entire establishment. At the census of 1902 the instructions to special agents on this subject were as follows:

There are several branches of mining in which the mineral products do not reach the market in the crude condition, but are subjected to certain processes at the mine or quarry before being regarded as marketable commodities. These may be processes of milling, separating, washing, burning, calcining, or other forms of manufacture. In some industries these processes are performed entirely at the mine or quarry, and in such cases the special agents are instructed that the census schedule should include the statistics of employees and wages, miscellaneous expenses, and supplies and materials involved in the entire work of mining the crude material and preparing the same for market. For example, the following branches of mining and quarrying are of this character: Emery and corundum mines, where finished emery wheels are frequently manufactured; mica mines, sheet and crushed mica being the finished product; graphite mines, where the crude graphite is refined; grindstone and millstone quarries, where grindstones and millstones are the finished products; mines or quarries of kaolin, flint, ocher, barytes, manganese, chalk, talc, mica, umber, sienna, and other iron-oxide colors, where the crude mineral is ground or otherwise prepared; marble, granite, and other stone quarries, where the stone is cut and dressed and monuments and tombstones are manufactured; slate quarries, where roofing slate, slate blackboards, school slates, and sanitary plumbing slate slabs are manufactured. In all such cases as the foregoing and others where any form of manufacturing is necessary at the mine or quarry before the product is placed on the market, the Census schedule should cover the entire work of the establishment.

[1] Ninth Census of the United States, Industry and Wealth, page 383.

[2] Tenth Census of the United States, Precious Metals, Vol. XIII, page x.

The practice followed and the line of demarcation adopted for the different minerals were as follows:

ABRASIVE MATERIALS:

Buhrstones and millstones: The quarries producing buhrstones and millstones almost invariably report the value of dressed stones, a segregation of actual quarrying operations from the finishing process being generally impracticable. The stones manufactured range in diameter from 14 to 84 inches, and are generally sold in pairs. A considerable by-product of paving blocks is included in the value of product reported by this industry.

Corundum and emery: These minerals are usually concentrated, cleaned, and pulverized at the mines, and the statistics are mainly those of the finished product.

Crystalline quartz: The value of the crude product is generally reported for this abrasive, although the crushing, drying, and screening operations incident to its preparation for use in the manufacture of sandpaper, garnet paper and cloth, etc., are in some instances carried on in connection with the quarrying. A segregation of quarrying and finishing operations is not always practicable, and of the total production reported, 20.9 per cent has been manufactured or finished to a certain extent after being taken from the quarry.

Garnet: Preliminary manipulation of the crude garnet ore is almost invariably carried on at the mines, and the cost of these finishing operations, consisting for the most part of the crushing of crystals to available sizes, washing, drying, and concentrating, is not separable from the expense of mining. The product reported for this abrasive may therefore be regarded as partly finished, and the value may be regarded as including somewhat more than that of the crude mineral.

Grindstones and pulpstones: A portion of the product of this abrasive is reported in the rough, that is, trimmed down for lathe finishing. The larger and more important establishments, however, complete the stone ready for mounting, in which instances the value reported is that of the finished product. Of the total production of grindstones, 71.9 per cent is a by-product of sandstone quarries. The capital and operating expenses for this part of the total production are therefore included in the statistics of the quarries in which the product was secured.

Infusorial earth, tripoli, and pumice: One-third of the product for this industry is reported by the Bureau of the Census as crude; this quantity represents about one-fourth of the total value. The remainder is finished at the mines by various processes. The process of working infusorial earth consists in burning and pressing into fire brick or drying, pulverizing, and bagging. The finishing of tripoli generally consists in burning, grinding, and washing, or, as is the case in the largest establishments of this kind, the product is manufactured by means of lathes, saws, and emery wheels into filter tubes, and disks, and shapes for water filters. The value reported for pumice is for the crude material. Its use, principally in the manufacture of certain kinds of soap, was by the company also controlling the mining operations; but the expense of this manufacture and the finished value of the product are not contained in this report.

Oilstones, whetstones, and scythestones: Of the total oilstone production in the United States 20.9 per cent is finished at the quarries, this amount representing 51.2 per cent of the total valuation. The finishing process, which consists in sawing or cutting the stone into strips averaging about 2 by 1½ by 8 inches and polishing these to a smooth surface, is necessary before the product is marketable. The crude value reported represents almost entirely the product of one company, owning quarries in various localities and shipping to one central plant for the finishing process. The United States Geological Survey reports the product of this company as it is finally manufactured, while the Bureau of the Census reports the production and value of the stone at the quarries.

Asbestos: Of the quantity shown for this mineral 59.9 per cent represents crude ore. The remainder was crushed, separated, and otherwise prepared at the mine for the market.

Asphaltum and bituminous rock: A large part of the asphaltum—elaterite, uintaite, etc.—was refined. Some of the bituminous rock was pulverized at the mine or quarry.

Barytes: The only preparation given this mineral at the mines was that of washing to free it, when necessary, from the associated earth or clay.

Bauxite: This mineral is usually sorted at the mine and subjected to solar or artificial heat to dry it prior to its shipment to market.

Borax: The product is that of refined borax, the crushing, grinding, mixing, crystallization, and other processes of refining being accomplished under the management of the mine owners.

Cement: In the case of cement the manufacture overshadows the mining of the raw material. Over 97 per cent of the Portland and natural-rock hydraulic cement production is made by establishments that mine, quarry, or excavate the raw material, and operate the mines or quarries and mills in conjunction. Only establishments excavating the whole or part of their raw material are included in the statistics. Although the reports do not permit of a complete segregation of the labor and expense for the mining and manufacturing processes, yet it would appear that in the case of the manufacture of natural rock cement the mining expense is not to exceed one-third of the cost of the marketable product, and in the case of Portland cement the portion on the side of mining or quarrying is very much less.

In the case of the cement companies using the marl deposits contiguous to the Great Lakes, which material is simply excavated with steam dredges, the cost of mining or excavation is an almost insignificant part of the cost of cement manufacture. Nearly 14 per cent of the Portland cement production was made from marl thus dredged or excavated.

Clay: Of the quantity of products shown, 17.3 per cent was prepared at the mine or quarry. This preparation consists principally of washing and grinding.

Coal, anthracite and bituminous: Anthracite coal is broken and screened and sometimes washed at the mine; bituminous is shipped as the run of the mine.

Copper ore: The reduction of the Lake Superior copper ores is done mechanically in stamp mills located at the mine, and the product, known as "copper mineral," is shipped to a smelter, operated either by the same or by some other company. As the stamp mill is in all cases regarded as part of the mine equipment, a thorough separation of the labor and expenses of the mine from those of the mill is impracticable; both have therefore been included in the mining census. The identity of the smelter, on the contrary, as distinct from the mine is maintained, as a rule, even in those cases in which it is owned and operated by the mining company. It has been possible, therefore, to eliminate smelters from the census of mines proper. The statistics for copper ores, other than those of the Lake Superior region, are generally for the crude ore; still in some cases the ore is dressed at the mines before smelting.

Flint and feldspar: The flint produced is properly quartz and not true flint, which is the nodular variety of silica occurring in calcareous strata, particularly in chalk. Approximately 52 per cent of the so-called "flint," or quartz, and feldspar production is marketed in its crude state and the balance as ground material. With the exception of the one process of grinding, the material is not subjected to manufacturing processes.

Fluorspar: Less than one-tenth of the quantity and about one-fifth of the value reported represents the product prepared at the mine for the market, the preparation consisting of washing, drying, and grinding.

Fuller's earth: The mining of fuller's earth is mere excavation and does not require skilled labor. The material is dried, ground, and in some cases sized, but is not otherwise subjected to manufacturing processes.

Gold and silver: The reduction or reworking of argentiferous and auriferous ores is carried on by establishments which, for the purpose of the mining census, are divided into four classes: (1) Reduction works, commonly known as "mills" (stamp and amalgamation, chlorination, cyaniding, and concentrating mills), which are located at the mine and operated by the mining company, the labor being employed interchangeably in the mining and the milling; (2) reduction works (mills) which are operated independently and in which the ore is either treated for a fixed compensation or purchased outright and the contents sold to smelters; (3) smelting establishments, which are usually operated independently, even when the mine and smelter are owned by the same company; (4) ore-dressing works (concentrators) which are operated by and in connection with the smelting establishments. The first two classes have been included in the mining census. The third class has been excluded, having appeared in the census of manufactures, 1900. The fourth class is so intimately allied with the smelting and refining of ores that it was impossible to make a separation, and therefore they have been classed also as manufactures.

Graphite: Almost the entire production reported is that of the mineral prepared for the market. The ore is crushed, stamped, separated, dried, and screened.

Gypsum: Nearly all of the gypsum quarried is calcined and manufactured into wall or cement plaster, and the manufacturing expense is the largest part of the cost of production of the marketable products. About 10 per cent of the gypsum quarried is reported as used in the crude state, and 7.4 per cent is ground for land plaster. The remaining 82.6 per cent is calcined into plaster of Paris, and most of the plaster of Paris is made into wall or cement plaster by the admixture of a retarder—fiber, hair, or other material.

Iron ore: Some of the ore is crushed, separated, calcined, and dried at the mines.

Lead and zinc ores: The dressing of these ores, preparatory to their final treatment by smelting, is usually done at the mine, either by hand jigs or in concentrating mills operated in connection with the mine; therefore no separation of labor and other expenses as between the mine and the mill is possible. There are a few custom mills which are not connected with any particular mine, but which either treat rough ores for a fixed compensation or purchase them outright and sell the dressed contents. Since the custom mills form but a small proportion of the total, all mills, whether connected with mining companies or independent, have been included in the mining census. Smelters, on the contrary, in those cases where they are owned by mining companies, as well as in all others, are operated as independent establishments, and they have not, therefore, been included in the mining census.

Lithium ore: This represents the crude ore, no manufacturing process being undertaken at the mine.

Magnesite: Of the quantity reported, 72.5 per cent was calcined at the mine, the remainder being the crude ore.

Manganese ore: The preparation usually given to the ore at the mine is crushing, washing, and screening.

Marl: The statistics presented in the report on marl pertain to the green sand marls of New Jersey and Virginia, which are used for fertilizing. One-third of the product is dried and ground, but with this exception the product is not subjected to any manufactur-

ing process. The mining of marl is simply a process of excavation.

Mica: The statistics include such manufacturing processes as are involved in the removal of adhering fragments of flint and feldspar and such parts of the mica itself as contain foreign ingredients. The sheet mica is prepared by splitting the blocks into sheets, which are cut to a size.

Mineral pigments, crude: Most of the processes necessary for the marketing of crude pigments are undertaken at the mine. The ore is disintegrated by exposure to the atmosphere, roughly crushed, dried, pulverized, and screened or separated. The ground ore is sometimes levigated and the settled products dried.

Monazite: Monazite is obtained in placer mining; nearly all of it for which statistics are given was prepared at the mine for the market by washing and sometimes by concentration. A little of the mineral was concentrated electro-magnetically.

Natural gas: The statistics are for the product as piped from the wells, and the value is that received for it at the point of consumption.

Petroleum: The statistics shown are wholly for the crude product.

Phosphate rock: Rock phosphate is usually washed to free it from sand and other impurities and kiln-dried to free it from moisture. When mined in too large bowlders to be easily handled, it is crushed. This is all done at or near the mine. River pebble is washed and screened immediately after being pumped up from the river bottom, and is dried with hot air and screened again before being marketed.

Precious stones: The value is reported for the product in the rough state as mined or found.

Quicksilver: Almost the whole of the output is that of the quicksilver extracted from its chief ore, cinnabar; only a small part of the ore was reported unconcentrated.

STEEL HARDENING METALS:

Chrome ore: The statistics are for the ore as mined, none of it having been prepared at the mine.

Molybdenum: The molybdenite was reported as crude, no process of manufacture being given.

Nickel and cobalt: The statistics are for the nickel and cobalt ore, washed and then smelted into matte at the mine.

Rutile: The report is for the crude mineral, in no way selected or concentrated.

Tungsten: Some of the ore is concentrated to from 60 to 65 per cent tungsten oxide, but much of it is the crude as mined.

Uranium and vanadium: The values are for the crude ores from which these metals are derived, except that a few tons of the uranium ore was reported as concentrated.

STONE:

Limestones and dolomites: Of the total product 18.3 per cent in value was for building purposes, 17.3 per cent for blast furnace flux, and the value of lime burned 30.7 per cent, most of the remainder being crushed for concrete, railroad ballast, roadmaking, macadam, etc., or prepared for curbing and flagging.

Marble: Of the total product, 45.1 per cent was sold rough. The remainder was sold dressed, for building purposes, for interior decoration, and for monumental, ornamental, and other purposes.

Sandstones and quartzites: Of these, 29.4 per cent in value was sold rough; 27.2 per cent was disposed of dressed for building purposes; and the remainder was crushed for concrete, ballast, riprap, etc., or prepared for curbing and flagging.

Silica sand: This, as shown here, is the product of quarries, not of sand banks, and was generally obtained from rock pulverized at the mine.

Siliceous crystalline rocks: Of the whole product, 24.3 per cent in value was sold in the rough state; 26.6 per cent was dressed for building purposes; 12.5 per cent was prepared for monumental work; and the remainder was crushed for roadmaking, riprap, etc., or prepared for curbing, paving, flagging, etc.

Slate: The slate is split and cut into roofing slate or made into slates and slate pencils, sanitary slabs, etc., at the mines, as it is necessary to work the material when moist. The proportion of the value of product prepared for roofing was 86.9 per cent.

Sulphur and pyrite: The statistics for the sulphur are for the refined; for the pyrite they are, generally speaking, for the substance as picked, rolled, jigged, and assorted at the mine. Some pyrite was a by-product of coal mines, being picked from the refuse.

Talc and soapstone: The talc is almost all ground for the market, and the soapstone is manufactured into washtubs, slabs, sanitary ware, etc., nearly all the product mined being manufactured by the original producers. The foliated variety of talc is usually ground into talcum powder and the fibrous variety into material for paper filling. All these processes are accomplished at or near the mine.

The limitation of the census inquiry to the operations at the mine or quarry has resulted in the exclusion of a considerable portion of the values generally assigned to the mineral products of the country. These differences are fully explained in the special reports for each mineral. A comparison of the quantity of the ores as reported to the Bureau of the Census for the year 1902, with the quantity of the metal obtained from the same class of ore during the same period, but possibly mined, at least in part, during the preceding year, illustrates the disparity in the quantities. It is possible to make

this comparison for a few minerals, and the totals are given in the following statement:

MINERAL.	Metal obtained, or manufactured product.	Product (quantity).
Iron ore, long tons		35,567,410
	Pig iron, long tons	17,821,307
Mineral pigments, crude, short tons.		35,479
	Mineral paints, short tons	[1] 60,491
Gold and silver ore, short tons		[2] 10,002,271
	Refined metal:	
	Gold, fine ounces	3,149,128
	Silver, fine ounces	42,746,064
	Copper, pounds	14,028,863
	Lead, short tons	205,519
	Zinc, short tons	35,789
Copper ore, short tons		11,780,064
	Refined metal:	
	Gold, fine ounces	92,911
	Silver, fine ounces	11,452,280
	Copper, pounds	625,004,529
	Lead, short tons	276
Lead and zinc ores, short tons		623,662
	Refined lead, short tons	[1] 79,445
	Spelter, short tons	[1] 156,927

[1] Reported by United States Geological Survey, zinc white and Venetian red omitted.
[2] Exclusive of placer bullion; this is shown in refined metal. Also exclusive of Alaska.

Special schedules.—At the census of 1840 the statistics for mines and quarries were collected on a schedule entitled "Schedule of mines, agriculture, commerce, manufactures, etc." The schedule used at the censuses of 1850, 1860, and 1870 was designated "Products of industry," and comprehended manufactures, mines, and fisheries. As already stated, the special schedules were introduced and carried to excess at the census of 1880, which was taken under the supervision of Gen. Francis A. Walker, who had already emphasized the necessity of such a schedule in presenting the statistics for the census of 1870. There were 44 special schedules, a separate schedule being provided not merely for each of the different minerals, except those tabulated as "minor minerals," but for the different conditions under which the same mineral was mined, and different sections of the country were assigned to different expert agents, and they in turn were permitted to use different forms of schedules for the same mineral as mined in their respective districts.

The use of special schedules was continued at the census of 1890, but the number of separate schedules was reduced to 23—1 general and 22 special. The special schedules were used to develop features peculiar to iron ore, gold and silver mines and reduction works, transportation of gold and silver ore and bullion, copper mines, lead mines, zinc mines, quicksilver mines and reduction works, manganese ore, precious stones, coal mines, distribution of coal for consumption, crude petroleum, natural gas, stone quarries, mineral waters, copper smelters and refiners, lead smelters and refiners, lead refiners, and zinc reduction works.

The object of the special schedule is to develop in detail the technique of an industry and to obtain from each establishment a schedule carefully filled out, the completion of which requires knowledge and time. The primary object of a census is to obtain complete and rapid enumeration, to show the magnitude of an industry, the number of people it employs, the amount paid in wages, and the quantity and value of its products. It is obvious, therefore, that these objects are in a measure antagonistic, and that the success of a census depends very largely upon the degree to which they can be harmonized. The schedules should not be so elaborate and technical that they can not be prepared by an agent of average intelligence, since they would so delay the canvass as to make a complete enumeration impossible.

The value of the statistics for a number of the minerals at the census of 1880 was seriously impaired by the adoption of a too elaborate and technical schedule.[1] The technical features of a special schedule are so interwoven with the general features to be developed by a census that it is, in many cases, impracticable to combine the two so as to obtain uniform statistics for all industries or all branches of the same industry. The use of special schedules is essential to the development of the census statistics for mines and quarries, but there are certain data—such as the number of different classes of employees, total wages, amount of miscellaneous expenses, cost of supplies and materials, and the quantity and value of the product—that should be called for uniformly in all such schedules. If these inquiries are not uniform it becomes impossible to make aggregates for all branches of industry. The omission of these general inquiries, and the lack of uniformity in the answers obtained in cases where they are included, are serious impediments to the use of the mining statistics of the censuses of 1880 and 1890.

The general tendency in statistical inquiries, as conducted by the Bureau of the Census, is to simplify the schedule.

An investigation designed to develop technical features can be conducted with better advantage and the results be more satisfactory if the inquiries are confined to representative establishments. Many of the inquiries concerning technical matters are not applicable to the major portion of the establishments enumerated, and therefore are confusing to the enumerator and to the person who furnishes the information.

The technical portions of the census of mines and quarries relate very largely to matters that are pertinent to the investigations of the United States Geological Survey, the results of which are given in the annual reports on the mineral resources of the United States. The collaboration between that office and the Bureau of the Census in the mining census of 1902 very largely relieved the Bureau of the Census from the task of obtaining technical data.[2] The special schedules of the Survey accompanied the more general Census schedule, both being prepared for every mine and quarry enumerated. There were 7 Census schedules, designated as follows:

Special schedule No. 6. All mines and quarries must be reported on this schedule except those for which special schedules are pro-

[1] Tenth Census, Mining Industries, Vol. XV, page xxiv.
[2] See pages 16 and 17 for memorandum concerning collaboration between the United States Geological Survey and the Bureau of the Census.

vided. Mines and quarries of the following minerals are to be reported on this schedule: Bluestone, granite, limestone, marble, sandstone, slate, trap rock, grindstones, millstones, soapstone and talc, cement rock, clay, barytes, emery and corundum, gypsum, mica, mineral paints, phosphate rock, iron ore, and manganese ore. Special attention is called to the fact that on this schedule also (special schedule No. 6) should be reported the nonargentiferous or soft lead mines located east of the Rocky mountains, the copper mines of the Lake Superior region, and zinc mines. Other minerals mined as such to be reported on this schedule, except where they accompany minerals of more importance, as platinum in gold placers, are the following: Antimony, asbestos, asphaltum, bauxite, borax, chrome ore, cobalt, feldspar, fibrous talc, flint, fluorspar, fuller's earth, garnet, graphite, infusorial earth and tripoli, magnesites, marls, molybdenum, monazite, oilstones, platinum, precious stones, pyrite, crystalline quartz, quicksilver, rutile, sulphur, tungsten, uranium, and vanadium.

Special schedule No. 8, for coal mines, both anthracite and bituminous, and anthracite coal washeries.

Special schedule No. 9, for petroleum and natural-gas wells.

Special schedule No. 10, for gold and silver and argentiferous and auriferous lead and copper mines.

Special schedule No. 11, for reduction works of the precious metals (other than smelters and refineries).

Special schedule No. 6a, a supplemental schedule for administrative and general offices. This schedule is intended for corporations, firms, or individuals operating more than one mine, quarry, or reduction works, with a central office for all of them. Upon this schedule should be reported the employees of such central office, with their salaries or wages, and all other employees whose work is not confined to one particular mine, quarry, or reduction works, such as general superintendents, machinists, surveyors, etc. All general expenses are also to be reported on this schedule and the data relating to capital stock, bonds, dividends, and assessments of incorporated companies. No data reported on this schedule should appear on the separate reports for the individual mines, quarries, or reduction works. Separate schedules are supplied for these individual plants.

Special schedule No. 6b, a supplemental schedule for bluestone, granite, limestone, marble, sandstone, slate, and trap rock quarries, upon which a full description of the quarrying and stone-dressing machines in use should be given. This schedule is to be filled out in addition to and supplementary to special schedule No. 6 for all stone quarries.

The special schedules of the Geological Survey were in the form of small cards and were provided for the following minerals:

Slate.
Marble.
Trap rock.
Granite.
Sandstone.
Bluestone.
Limestone.
Sulphuric acid.
Barytes.
Mineral paints.
Mica.
Salt.
Phosphate rock.
Gypsum.
Emery and corundum.
Millstones.
Grindstones.
Soapstone and talc.
Bituminous coal.
Anthracite coal.
Coke.
Coke, by-product plants.
Brick and tile.
Pottery.
Clay mined.
Mineral waters.
Cement.
Deep mines (precious metals).
Reduction works at mines.
Placer and surface mines (precious metals).
Local or custom mills or smelting works (precious metals).
Natural gas.
Crude petroleum.
Iron ore.
Manganese ore.
Gas, tar, and ammonia.
Precious stones.
Minor minerals (a general schedule for the production of all other minerals not included in the foregoing list).

The combination of the data contained on the Census and Geological Survey schedules makes possible the presentation of complete census statistics for the general features of the industries and also of technical information concerning each mineral. It is believed that this arrangement has resulted in the most complete and harmonious census of mines and quarries ever taken. It has made possible a separation of the purely scientific and technical inquiries from the statistical. At the same time, full information on each phase of the subject has been secured through the medium of the same agents.

Expert special agents.—At the censuses of 1850 to 1870, inclusive, the mining census was made by the United States marshals, and was incident to the enumeration of population and the collection of the statistics of agriculture and manufactures. The principal duty of the assistant marshals was the enumeration of population. The other three inquiries—agriculture, manufactures, and mining—were regarded as of much less importance, and it is probable that their importance was rated in the order named.

The first provision of law authorizing the employment of expert special agents is contained in section 18 of the act of March 3, 1879, providing for the census of 1880. This provision was reenacted in the laws providing for the Eleventh and Twelfth censuses and in the act of March 6, 1902, under which the cens. of that year was taken.

Persons engaged in an industry, or intimately associated with it through financial identification or through long experience in the compilation of statistical information concerning it, are in a position to select the data of greatest value and to pass upon the practicability of the schedule to be used in collecting these data. The principal advantage to statistical work from the employment of such persons is in the drafting of the schedules and analysis of the results. After the form of the schedule is determined and the inquiries thoroughly understood, the collection of the returns requires but slight, if any, technical knowledge. At the census of 1880 an attempt was made to employ experts to make the canvass,[1] but it was impossible to obtain a sufficient number of agents who had either a theoretical or practical knowledge of mining to do the work. At the census of 1890 experts and others were employed, the expert agents, as a rule, having supervision of the canvass for certain sections of the country or for certain minerals, irrespective of the location of the mines. In 1902 the schedules followed the general form used in collecting the statistics of manufacturing and mechanical industries. This was necessary in order that the totals for manufacturing and mining might be combined and the aggregate for all such industries presented. Moreover, as the technical schedules used by the Geological Survey were adopted by the Bureau of the Cen-

[1] Tenth Census, Precious Metals, Vol. XIII, page xi.

sus, there was no necessity for the employment of experts by the Bureau in the preparation of any of the returns. The canvass was made by the regular force of the Bureau, assisted by the office and field force of the Geological Survey.

Collaboration with the United States Geological Survey.—The United States Geological Survey was organized under the act of March 3, 1879, which established the office and, among other duties, provided that it should examine "the geological structure, mineral resources and products of the national domain." An act of Congress of August 7, 1882, provides that an amount not to exceed $10,000 may be annually applied by the Director of the Survey, under the direction of the Secretary of the Interior, to the procuring of statistics in relation to mines and mining other than gold and silver and to making chemical analyses of iron, coal, and oil. The first annual report of the Survey, which was transmitted to the Secretary of the Interior on November 1, 1880, covered the fiscal year ending June 30, 1880. Since then reports have been made annually, covering the calendar year.

In organizing the census of 1880, Gen. Francis A. Walker made arrangements with the Geological Survey to collect the statistics of mines and quarries.[1] Similar arrangements were made at the census of 1890.

The Geological Survey collects annually statistics of the quantity and value of production of the different minerals, in connection with its examination of the geological structure, mineral resources, and products of the national domain, and is necessarily in constant communication with mining companies, thus establishing an intimate relationship. Collaboration between the Survey and the Bureau of the Census in taking the decennial census of mines and quarries is, therefore, ideally correct, but the actual practice at earlier censuses of turning over to the employees of the Survey the entire work of collecting and compiling the census statistics resulted in a statistical presentation which was out of harmony with the presentation made in all other census industrial statistics. In other words, the mining census of 1880 was conducted on lines somewhat similar to those followed by the Survey in its annual reports, designed to show for the most part the quantity and value of the different minerals, their occurrence, an analysis of ores, and the possibility of development of the mineral resources of the country.

[1] In 1879 Prof. Ralph Pumpelly, head of the Division of Mines and Geology, United States Geological Survey, and the force working under him, were detailed to act as special agents of the Census Office to collect and discuss the statistics of the mining industries of the United States, exclusive of the precious metals. A report on the statistics and technology of the precious metals was prepared under the direction of Hon. Clarence King, Director of the Geological Survey, and the report on the production, technology, and uses of petroleum and its products was prepared by Mr. S. F. Peckham; on the manufacture of coke, by Mr. Joseph D. Weeks; and on building stones and the quarry industry, by Dr. George W. Hawes and others.

The report for the census of 1880 is contained in three volumes—one on the precious metals, another on nonmetalliferous minerals, and a third containing special reports on petroleum, coke, and building stones. Many of the reports are exhaustive, containing not only much statistical matter, but historical treatises and analyses as well. Uniform statistical aggregates, however, are wanting. The mining census of 1870 had proved to be so far from complete that in 1880 an effort was made to improve upon it by covering the entire field in an analytical and technical manner. Unfortunately, in doing this the necessity for a complete enumeration was lost sight of, and the inquiry was crushed by its own weight.

The United States Geological Survey had become thoroughly organized by 1890, and the mining census was taken under the direction of Dr. David T. Day, of the Survey, acting as a special agent of the Census Office. The method of presenting the statistics, however, was not in harmony with that adopted in making other census reports, and it is impossible to combine the totals of the different reports so as to show the aggregate for the mining, manufacturing, and mechanical industries of the country.

Although collaboration between different departments of the Government engaged in the same general class of work is likely to result in economy in administration, the act of Congress of March 6, 1902, provides that certain facts which differ radically from those compiled by the Survey are to be collated decennially by the Bureau of the Census. In order to compile these data and insure their harmony with other census reports, it is necessary that the Bureau of the Census have absolute control of both the canvass and the office work. Prior to the census of 1902, however, it was contended by the Survey that statistical conditions existed in the work of that office similar to those at the Bureau of the Census, and that if the statistics for the annual report on "Mineral Resources" were to be taken in collaboration with the census of mines and quarries, the fieldwork and the preliminary examination of the census schedules should be under the supervision of the Survey. It was therefore impossible to make arrangements that would be entirely satisfactory to both offices. The methods followed at the censuses of 1880 and 1890 having proved entirely inadequate, however, the following memorandum was agreed upon as the working basis of the two offices for the census of 1902:

Memorandum of agreement between the Director of the United States Geological Survey and the Director of the United States Census regarding the cooperation of the two offices in taking the mining census of 1902.

For the purpose of avoiding a duplicate canvass of the mining industry as provided for by the laws relating to the Geological Survey and the Census Office, of saving an unnecessary expenditure which would arise from such simultaneous duplication of the can-

vass, and to insure harmony between the statistics of the Geological Survey and of the Census Office, the following agreement has been reached:

I. The Geological Survey to take the general supervision of the fieldwork for the mining census, transmitting the several schedules of the Census Office to the producers in the same envelope with its own schedule and receiving them back in its own penalty envelopes; the Census schedules thus obtained by the Geological Survey to be transmitted to the Census Office as rapidly as received for examination and correction; such of the Census schedules as may require additional fieldwork to perfect them to be returned to the Geological Survey, at the discretion of the Census Office, in order that the desired corrections may be obtained. The clerical expense of handling the schedules and the correspondence connected therewith to be borne by the Geological Survey, but with the understanding that whenever more clerks are required than can be spared from the regular force of the Geological Survey the Census Office will detail such additional clerks from its regular force and will continue to carry them upon its pay rolls. All the work of tabulating and compiling the Census schedules to be done in the Census Office by the Census Office clerks. The Census Office to have the privilege of transcribing from the schedules of the Geological Survey such additional information contained therein as may be omitted from its own schedules for the purpose of greater simplicity.

II. The fieldwork which may be necessary in addition to correspondence in order to secure an early return for the mining census shall be done by the present force of trained experts—some 25 in number—employed by the Geological Survey in its regular fieldwork; and such additional clerks as may be required to complete the fieldwork with all possible rapidity shall be drawn from the regular clerical force of the Census Office.

III. The Geological Survey will contribute toward the expense of this fieldwork from its regular appropriation a sum equal to its annual expenditure for this purpose in previous years, the entire remainder of the cost of the fieldwork to be borne by the Census Office. This will involve, in many instances, a temporary transfer of the field agents of the Geological Survey from the rolls of that office to the rolls of the Census Office, this transfer to be made in every instance at the rates of compensation which they are receiving from the Geological Survey. The allowance for per diem expenses to be the same in every case as the Census allowance for its own field agents. The fieldwork for the mining census in 1890, as shown by the records of the Census Office, cost $142,113.47, being the amount paid to the maximum number of special agents employed, namely, 228.

IV. A representative of the Census Office to be detailed to act as assistant to the statistical division of the Geological Survey during the progress of the fieldwork. This is necessary in order that the Census Office may have a properly trained expert in its own clerical force thoroughly cognizant of all the details of the work, and thus qualified to oversee the tabulation and compilation of the Census statistics.

V. Whenever it may be so desired the Census Office to have the privilege of calling upon the experts of the Geological Survey to prepare the texts of its reports on the several branches of the mining industry.

VI. The schedules of the Census inquiry to be prepared and ready for delivery to the Geological Survey not later than January 1, 1903.

VII. The schedules to be thus handled by the Geological Survey to include all the mining schedules issued by the Census Office, including those for gold, silver, and stone quarrying.

The schedules of the Bureau of the Census and of the Geological Survey were mailed by the latter office to all mines and quarries known to be in existence, the letter of transmittal being signed by the directors of both offices.[1] The schedules were returned to the Survey and there given a cursory examination, the amounts reported in the schedules for the two offices being compared and the schedules separated. The schedules for the Census were then forwarded to the Bureau of the Census. This method, though it simplified the office work, multiplied the difficulties of the canvass. Each mine operator was required to prepare two schedules, a number of the questions on the two being similar. A large number of operators prepared the Survey schedule in conformity with their annual practice, but neglected the Census schedule. In a number of instances the Survey schedule required the quantity and value of the mineral marketed, while the Census schedule called for the quantity produced during the year. In other cases the Survey schedule required a report of the finished manufactured product, while the Census schedule called for the quantity and value of the crude ore.

It was often impossible to obtain a proper adjustment of these differences by correspondence, and in

[1] DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., December 31, 1902.

DEAR SIR: In accordance with an agreement between the Director of the Census and the Director of the United States Geological Survey, as shown in the subjoined letter, this Office will collect the data for the mining census in addition to the usual information collected annually for the report Mineral Resources. I therefore inclose herewith a copy of the census schedule, together with the card of this Office, with the request that you fill them both out and return them at the earliest possible moment. An addressed envelope, requiring no postage, is inclosed for reply.

Please answer every question in both schedules. All information furnished will be held strictly confidential. Only state, county, or district totals will be published. All Census employees are subject to a heavy fine for revealing information obtained for census purposes.

Your especial attention is called to the fact that the inquiry in regard to labor and wages is intended to include all the labor expended upon the product up to the time the material leaves the establishment, including grinding, washing, or other treatment.

Trusting that you will give this matter your prompt and careful attention, and thanking you in advance for your courtesy, I am,

Yours, very truly,

CHAS. D. WALCOTT, *Director.*

CENSUS OFFICE,
Washington, D. C., November 17, 1902.

HON. CHARLES D. WALCOTT, *Director,*
United States Geological Survey, Washington, D. C.

SIR: In accordance with our understanding, you are hereby authorized to collect for the Census Office the schedules relating to the mines and mining industry required by section 7 of the act of Congress to create a permanent Census Office, approved March 6, 1902, at the same time and by the same methods employed in the collection of the annual mining statistics of the United States Geological Survey. This course will be in the interests of economy and efficiency, and will also save the producers the necessity of making out two schedules, at different times, which are in some respects duplicates of each other.

In transmitting the Census schedules to the producers and mine owners you are authorized to assure them that all information received on the Census schedules will be treated as strictly confidential and no publication will be made which will reveal the business or the operations of any individual, firm, or corporation in any branch of the mining or quarrying industry.

Very respectfully,

WILLIAM R. MERRIAM,
Director of the Census.

many cases the special agents found it difficult even by personal investigation to make a satisfactory explanation and to secure harmonious reports for the two offices. Many of these difficulties would have been obviated had the plan been tried of using a single schedule containing all of the inquiries needed for both offices. This, however, was believed to be impracticable, since considerable detail was required by the different reports.

The Census schedules contained inquiries concerning capital, employees, wages, daily rates of pay, materials, miscellaneous expenses, etc., as well as the quantity and value of the product. Under the conditions stated it would appear logical to have had the canvass made under the direct supervision of the Bureau of the Census, and to have included in the Census schedules the few additional inquiries as to finished product or products sold that are required for the annual report of the Survey. Such an arrangement would have required but one schedule for each producer.

III.

DIFFICULTIES AND DEFECTS OF THE ENUMERATION.

The claim is not made for the mining census of 1902 that a complete canvass has been possible, or that the figures presented are the result of an actual enumeration of all mines and quarries in operation during the period covered. The reports for the census of 1870 direct particular attention to the incompleteness of the statistics for 1860 and 1870. The reasons for the incompleteness of the statistics at the census of 1880, so far as they relate to precious metals, are given as follows:

1. From want of previous experience, the agents in charge could not distribute equally the ground to be covered among the experts employed, since the number of mines to be investigated bore no necessary relation to geographical area. As a consequence, toward the end of the time devoted to the investigation some regions received less attention than their relative importance merited.

2. The relative ability of the experts employed was necessarily unknown to the agents in charge until the investigation had proceeded so far that it was too late to make any radical change.

3. It was a practical impossibility to secure uniformity of ability and methods among so large a corps of experts as was necessary for the work. The result was that one would give more attention to one class of facts, another to another class, and, when totals were made up from the schedule returns, it was found that these facts were more complete in one region than another.

The lack of uniformity in the statistics for the different minerals has been referred to above under the title of "Development of mining statistics." It is impossible to determine the extent to which the production of minerals and ores by small operators was omitted from the reports for that census. Special attention appears to have been given to the small operators, and reports were secured from 9,969 small coal mines, classed as "Local mines and farmers' banks," in which coal was produced at irregular intervals. In referring to the incompleteness of the statistics for gold and silver in the report of the same census, it is stated that it was impossible to locate a vast number of independent miners producing gold in small quantities, often in remote and almost inaccessible spots; also that "while the average annual production of these prospectors or miners is small, the aggregate amount is considerable; but no full or accurate statistics of this portion of gold production can be obtained."

The census of 1902 does not contain reports from a number of the irregular producers and small mines. This is especially true of the small placer gold mines, irregular bituminous coal producers, and small lime and sandstone quarries. Schedules were mailed to every mine and quarry of which the name and address could be obtained, and in every case where a satisfactory schedule was not received by mail one was secured by a special agent. The special agents visited every section of the country and made diligent inquiry for mines and quarries not named on their official lists; every known source of information was exhausted in the preparation of these lists. It is believed, therefore, that the statistics are the results of as complete an enumeration as it is practicable to make. It is not contended that reports were secured from all mines and quarries, but that a large proportion of them have been reported is shown by the fact that returns were received for 5,345 operators of mines, quarries, and wells that reported an annual product valued at less than $500. In bituminous coal there were 798 producers of this class, and in limestone 1,296. For gold and silver, 3,252 reports were received for operators engaged in development work only, and 1,196 that reported a product valued at less than $1,000. The enumeration, however, did not extend to mining claims, although reports were received from 5,511 of such claims on which, in order to comply with the law and hold the claim, at least $100 worth of work was done during the year. The agents were instructed to omit from the enumeration the small placer gold mines at which less than two wage-earners were employed, unless such mines were in close proximity to other mines being enumerated. The value of the gold produced by the small placer miners and irregular operators is estimated at $1,633,835. This value is included as a separate item in the production for the United States, but there are no statistics concerning the number of people employed or the cost of materials and supplies.

In previous censuses all mines that did not report a production valued at $500 or more were usually omitted from the reports. This rule, if strictly followed, would exclude a large number of important properties, for some important mines are operated to only a limited extent, the major portion of the work being devoted to development. Therefore, no limit of this character was made at this census. It is admitted, nevertheless, that considerable quantities of mineral mined by farmers, ranchmen, contractors, and others were not accounted

for, because these men were not known as miners or quarrymen, and were overlooked by the agents. This kind of mining is carried on at irregular intervals, no record is kept of the production, and there are no available statistics concerning operations.

During the year 1902 the production of bituminous coal by irregular operators was greatly stimulated by the curtailment of the supply of anthracite coal. A large number of farmers worked their coal banks with farm labor whenever other duties would permit. Every means was exhausted to obtain the names and addresses of these producers, and a small schedule was sent to all whose names could be secured.[1] The report contains the statistics for 4,409 bituminous coal producers, and of this number 825 were reported on the small schedule as irregular operators. When the small schedule showed a production of 500 tons the regular schedule was sent and a full report as to employees, wages, etc., secured.

The nature of the work of the small, irregular operators precludes the possibility of a complete enumeration, nor is it essential for a mining census that returns be secured from all farmers and others who produced a few tons of mineral during the year, a large proportion of which was probably consumed in the local market. The reports for such small mines show, as a rule, only the quantity and value of the production. Most of the labor is done by the owner, and the expense for materials and supplies is so small that it is not reported.

In the mining of lead and zinc ore in Missouri, and in the mining of monazite, mica, and other minerals found in small quantities in different localities, it is the practice of the small producer to devote odd times to mining. In some cases the mining is done by a farmer on his own land; in other cases it is done on leased land or under a royalty agreement. In the majority of cases the ore is sold to one or more of the large establishments in the immediate vicinity, where it is reduced, refined, or prepared in some manner for the market. Under these conditions it is very difficult to obtain reports from the producers.

The census of zinc-lead mining in Missouri and Kansas presented peculiar difficulties, because of the method of the organization of this industry in that district. Only a few of the larger properties are operated by the owners. Nearly all of these properties are divided into tracts and leased to individuals or companies, who again divide them into small plots of an acre or less and sublease them to operators. In some cases this system of subleasing is carried still further. The actual operators are frequently practical miners, who work with pick and shovel. As the earnings of such operators are dependent upon the run of the ore, the mine is abandoned by the sublessee as soon as the returns prove unsatisfactory. A shaft is thus worked intermittently, a few weeks by one operator, then a few weeks by another, often changing hands several times during the year. The operators are constantly moving from one place to another. Those found on the properties by the Census agents in 1903 were only too often new operators, who had not been connected with the mines during the year 1902, for which information was sought, while those who had operated them in 1902 had moved away and could not be located. In such cases the only information available was that which could be furnished by the landowner. This information was naturally confined to the quantity and value of the product of the entire property; if the property was owned by a large company, its books, at best, might show the quantity and value of product of each of the first lessees. No further census data could be obtained.

The figures of production furnished by the owners, while correct in themselves, because taken from their books, presented still other difficulties, when treated in connection with other reports. A typical case could be described as follows: A report was secured from the owner covering the production of his entire property, with the exception, perhaps, of one tract leased to a large corporation, which furnished its own report. A few similar reports were received from first lessees of the owner, some of whom were active operators and some were sublessees. One or two of the sublessees could be located, and these furnished reports substantially accurate, although mostly from memory. Other first lessees could not be found or had transferred their leases to new holders, but some of their sublessees remained on the property and furnished reports to the census agent.

In order to avoid duplications, it was necessary to compare all these reports, and to subtract from the owner's report that which was reported by his first lessees and the sublessees. When it was attempted to balance the figures it appeared that the results could not be made to agree; for example, the sublessees showed a larger quantity of lead and zinc than that reported by the first lessee, while the value was considerably less than that reported by the owner. The explanation lay in the fact that part of the ore was sold in rough state by the sublessees to the owner, who concentrated it at his mill and disposed of it at a higher price. An inquiry addressed to one of the leading companies of the district brought the reply that the records of the company could not be adjusted to meet the figures furnished by the operators. The letter concluded by saying: "If it is your intention to reconcile their figures with those furnished from this office, we think you will have a hopeless and never ending task." Some of these discrepancies could be and were corrected at this office. If the value of zinc ore was reported by one operator at something like $3 per ton, whereas the average value reported by the owner and other operators on his property was about $30 per ton, it was safe to infer that the

[1] See Appendix A.

former represented rough ore and the latter dressed ore; if, on the contrary, the report showed that the lessee operated a concentrating mill in connection with his leased mine, the unusually low price of the ore would indicate a low percentage of zinc in the dressed ore. In the former case a substantial agreement between the conflicting figures could be attained by reducing the quantity of rough ore to terms of dressed ore, taking as a basis the average price per ton of dressed ore; in the latter case the quantity could not be disturbed. It is of course obvious that omissions and duplications could not be avoided. Still the census figures for the value of zinc and lead mined in the state of Missouri, which yields the bulk of the product, substantially agree with the returns secured, independently of the Bureau of the Census, by the state lead and zinc mines inspector.

The conditions prevailing in the region precluded anything like a complete and accurate presentation of all the labor employed in the mines. Aside from the numerous class of small operators who themselves work in the mines and are helped by members of their own family, or perhaps by one or two hired men, many of the operators who work the mines with none but hired labor frequently keep no books whatsoever. They may be able to state with substantial accuracy the number of men employed during the year and, by computation from the average rates paid by them, the amount expended for wages; but the items of "supplies" and "miscellaneous expenses" are in such cases nothing but rough estimates, and the accuracy of the results can not be vouched for. There is a large class of mines in which no miners are hired either by the day or by the ton, all mining labor being done on shares by "lessees," so called, who agree to pay the operator a stipulated royalty on all ore mined. In most cases of this class no records of the number of such lessees were kept by the operators, who could furnish no information beyond the total quantity and value of ore mined and the royalty received. Whenever practicable the number of men working on shares was secured from the landowner. The proceeds from the sale of the ore, less the royalty received by the landowner, represent the gross earnings of the miners, who are required to buy their own mine supplies. The number of such miners with their gross earnings, as far as reported, is shown separately, but is not included among regular wage-earners.

In the monazite industry the production is controlled by a single establishment, the product of a number of operators being purchased by one company, from which a complete report was secured. It was impossible to obtain reports from the small independent miners, but the number of such operators was known by the company and they were included as its employees. It was considered that the ore was mined on a contract basis, and the amount paid for it, or a proper proportion of such amount, was credited as wages.

The conditions under which mica is mined are somewhat similar to those prevailing in the monazite industry. Returns were secured from a number of the small independent producers, but a considerable proportion of the production could not be covered by such reports and was accounted for only in the schedules of the large establishments where it was prepared for the market.

There were only 17 regularly worked mines reported for the production of precious stones. Many of the precious stones were obtained by incidental discoveries or systematic search. The number of people engaged in this irregular work and the value of the stones are largely estimates based on information obtained from merchants and others familiar with local conditions.

In addition to the difficulties and the possibilities of error attending the collection of statistics of minerals for which the mining operations were similar to those enumerated above, there are uncertainties in connection with the collection of the reports and compiling the statistics for minerals mined by large and well organized companies. For instance, the schedule required the value of the product f. o. b. at the mine or quarry. A number of the anthracite coal companies contended that it was impossible to give such a value, or, in fact, any value for their product, since a portion was consumed at the mines in connection with their operation, considerable quantities were sold in the local market, and an unknown quantity was sold at a loss; also, that it was impracticable to deduct, or, in fact, to ascertain, the freight charges. The values are therefore largely estimated, based on the average value per ton of coal at the mine, the results being compared and checked with every available source of information. The production of petroleum is largely in the control of the Standard Oil Company, which contended that it was impossible to obtain separate reports from the individual producers. The company made one report covering the operations of 9,806 producers of oil in 39,301 oil wells in Pennsylvania, also similar combined reports for 2,123 producers and 8,443 wells in New York, 9,997 producers and 42,469 wells in Ohio, 4,435 producers and 12,951 wells in West Virginia. There were in all 7 schedules received from the company, which contained the statistics for 28,925 producers and 112,794 wells. In addition to the reports of the Standard Oil Company, there were 604 schedules received from 597 producers covering the operations of 5,877 wells. The 7 schedules from the Standard Oil Company covered 98 per cent of the producers and 95 per cent of the wells reported for the United States. Similar reports were made by the company for its production of natural gas, 4 schedules being received for 19 producers and 1,701 wells in Pennsylvania, New York, Ohio, and West Virginia, the producers forming 1 per cent and the wells 10.8 per cent of the total for the United States. Under these conditions it was impossible to localize the statistics for petroleum and natural gas by counties or to

check or verify the estimates of the number of employees, wages, expenses, etc. The schedules were carefully prepared and evidently cover the entire production of all the wells. The conditions under which the statistics have been compiled are in some respects similar to those prevailing in the mining of lead, zinc, mica, and monazite, in that the production is sold to one or more large establishments that put it on the market and thus in a measure control the output.

Since the recent discoveries of rich placer deposits have given prominence to the gold fields of Alaska, efforts have been made by the Government to obtain statistics by direct communication with the numerous owners of those mines. Mr. Charles G. Yale, special agent of the Bureau of the Mint, reported the following for the calendar year 1899:

> The population of these camps is more or less nomadic, moving from place to place as strikes in new creeks are announced. The season of mail communication among the camps along the Yukon river and creeks is very short, and when the spring "clean ups" have been made or the summer diggings begin to freeze the men come "outside" for the winter or go to larger camps. For these reasons it is almost impossible to obtain the desired statistical information as to the output of gold by correspondence with the individual miners.[1]

Dr. Cabell Whitehead, formerly assayer of the Mint, reported as follows from Nome, under date of September 5, 1900:

> Many men are prospecting throughout the entire country and we can only tell what they produce when they come in, as they are very secretive in all matters concerning their productions.[2]

The same was the experience of the agent of the Department of Labor, who investigated on the spot the conditions of Alaska gold mining. The difficulties in obtaining statistics of the placer mines in Alaska may be judged from the number of claims recorded, which in the Nome district alone had, up to January 10, 1900, reached 4,500.[3] This number is largely in excess of the total number of producing properties embraced in the present census of gold and silver mines for all states and territories. Important as it may be to ascertain the exact conditions under which an individual miner can nowadays produce gold without any capital, practically with his own hands, it was thought that this could be most successfully done in connection with the general census of population and occupations, whereas it could not be accomplished without an extraordinary expenditure of time and money as a part of the census confined to mines and mining. The quantity and value of the output of the Alaska gold mines are reproduced in this report from the report of the Director of the Mint, whose estimates are based upon the returns from the mints, assay offices, and from private refineries.

Porto Rico was the only insular possession in which the mineral resources were deemed of sufficient importance to attempt an enumeration. While it is known that a variety of minerals exist in the island, very few, if any, mines and quarries were operated as a regular business during the year 1902. The work was done at odd times and only sufficient material extracted to satisfy the local demand. It was difficult to locate the properties that had been worked, and practically impossible to obtain any information concerning the number of people employed or the quantity and value of the product. Under these conditions the statistics for the island are not comparable with those compiled for continental United States, and no reference is made to them in the general tables. The report on the mineral industries of Porto Rico consists principally of a compilation of historical data, a statement of the mining laws, and a list of the mineral deposits, with such information as could be obtained concerning the quantity and value of the products.

The omission of the small producers and the impossibility of obtaining individual reports from certain other producers, the data being included in a combined schedule, are the principal sources of error in the canvass. Another source of error is inherent in the preparation of the reports. A comparatively small proportion of the reports were prepared from data obtained from account books; but those which were prepared from such accounts were, as a rule, for the important operators and represented a large proportion of the production. The data in many of the schedules are estimates based on the recollection of the person answering the inquiries. This is particularly true of the answers to such inquiries as "The average number of wage-earners employed during each month" and "The average number of wage-earners at specified daily rates of pay." Few establishments keep books from which answers to inquiries of this character, covering a period of twelve months, could be readily obtained. If the information was obtained from the account books, it required an examination of a number of books and a large number of entries. The principal anthracite coal companies gave the office permission to examine their account books and compile the totals required for an answer to each inquiry. Two clerks were detailed to New York, N. Y., and Scranton, Pa., for this work. The method of keeping the pay rolls of the anthracite coal companies, from which was obtained the average number of persons employed by them during the year and the amount of wages paid, differs but slightly with the different companies. The original pay rolls are in sheet form, but by most companies are copied into books, these books being retained for office reference and the originals placed in vaults at the general offices of the companies or in storage. The census data were obtained from the office copies. The pay rolls are made out semimonthly. The names of the employees are written twice each month by some of the companies, while others arrange their books so that both the first and last halves of each month are carried on the same

[1] Report of the Director of the Mint upon the Production of the Precious Metals during the calendar year 1899, page 51.
[2] Ibid., 1900, page 56.
[3] Bulletin of the Department of Labor, 1900, "The Yukon and Nome Gold Regions," page 861.

set of sheets. The greater number of the companies keep their wage accounts "by collieries," having for each colliery a separate book in which are shown all the operations of that colliery during the year. Other companies keep these accounts "by months," having for each month a separate book in which are shown the operations of all their collieries for that one month. Usually the classes of employees were listed on the pay rolls in nearly the same order as they are shown in the census schedule, the list being headed by foremen, followed by clerks and the various classes as indicated; usually the employees above ground and those below ground are listed separately and designated as "outside" and "inside," respectively. Few, if any, of the companies distinguish on their pay rolls between boys under 16 years of age and employees over that age, and the records of none of the companies show the number of boys under 16 years of age in their employ. The average number of wage-earners employed during the year by these companies was obtained in all cases by first averaging each semimonthly sheet of the pay roll separately, adding together these sheet averages to obtain the average for the month, and finally dividing the sum of the monthly averages by 12 to show the average number employed during the year. The averaging of the number of wage-earners by sheets was accomplished by different methods. In some cases the number of men employed and the hours of labor were so uniform throughout the month that the number of names shown on the roll was used as the monthly average. As the rolls were usually headed by foremen, clerks, etc., the average numbers in these classes were easily obtained, and the deduction of these averages from the sheet average would show the average number of other employees; but in many cases where conditions were not uniform throughout the month, the sheet average was obtained by multiplying the number of employees on each sheet by the number of days in operation and dividing the product by the number of working days in the month, usually 25, 26, or 27 days. The sum of the sheet averages gave practically, but not exactly, the average for the month. To have obtained an exact average would have necessitated the addition of the total number of hours worked by each man during the month, the division of this aggregate by the number of hours fixed upon as constituting a day's labor, and the division of the quotient thus obtained by the number of working days in the month. From such monthly averages an exact yearly average could be obtained.

As no company keeps a record of the aggregate number of hours of labor performed each month, the length of time which would have been required to obtain the averages by this method would have caused too great a delay in the publication of the report. The two methods first mentioned gave sufficiently accurate averages for the months in which regular forces were employed throughout. It was found necessary, however, to adopt the latter method to obtain the average for those months during the strike when the number of employees was constantly varying.

While there were comparatively few operators for whom the preparation of the Census reports was attended with so many difficulties, still it is evident that the data furnished in reply to the majority of the inquiries were not obtained from the account books. It is probable that the percentage of error due to the fact that the answers are based on memory or rough memoranda, and not on actual records—a condition incident to all census work—is greater in the mining census than in any other branch of the industrial census.

IV.

OFFICE AND FIELD WORK.

The most important feature of the preliminary work of the mining census was the preparation of the schedules and instructions.[1] This work was started in November, 1902, and the last installment of the schedules was received from the Government Printing Office about the last of January, 1903. In the meantime the mailing of the schedules to the mine operators had been in progress and was completed shortly after the 1st of February, 1903. The mailing of the schedules and the general supervision of the fieldwork was under the direction of the Geological Survey. The theory of the work was that the schedules, instructions, and all circulars necessary for the canvass should be prepared at the Bureau of the Census and placed at the disposal of the Geological Survey for transmission to the field force. As the schedules were received, either by mail direct from the operators or from the special agents, they were immediately turned over to the Bureau of the Census for examination, all defective schedules being returned to the Survey for correction. The Survey schedule accompanied the Census schedule, and the quantity and value of the products reported on both were made to agree before they were separated. The Survey schedule was frequently filled and returned through the mail without the Census report, which was neglected until the field agent called. This neglect and the necessity for returning a large proportion of the Census schedules for correction resulted in the separation of the schedules in such a large number of cases that a general comparison of the final tabulations was necessary to insure an agreement between the two offices.

The schedules for bituminous coal, clay, stone, gypsum, cement, and fuller's earth were the only ones mailed directly to the mines from the Washington office of the Survey. All of the other schedules were sent in bulk to the offices of the field assistants of the Survey and mailed from there to the operators. About

[1] For copy of schedules see Appendix A, and for instructions see Appendix B.

three weeks were allowed for the return of the schedules by mail. The entire United States was then divided into districts, and the actual canvass was started on or about January 15, 1903, but at this time of the year some sections of the country are inaccessible, and it was impossible to employ the maximum field force until May, 1903, when there were 113 agents and clerks at work in the field or in the offices of the supervisory agents in different sections of the country. This number does not include the agents and clerks on the rolls of the Geological Survey who were engaged in collecting reports or other work incident to the canvass. The schedules were therefore returned by the mining company to the local office of the field assistant, given a preliminary examination there, then forwarded to the Geological Survey, where they were again examined before being sent to the Bureau of the Census. The final examination was made at the office of the Bureau, and letters criticising the schedules or calling for additional information were forwarded to the Geological Survey, and from there sent to the field assistant, who transmitted them to the mine operators by mail or through a personal visit of a field agent, or obtained the information personally, and again returned the schedules to the Geological Survey for transmittal to the Bureau. The practice of dividing the country into districts and placing the work in each district under the supervision of a local official is the most efficient way to conduct a canvass, but it is evident that these methods when followed in the mining census must lead to a duplication of work and more or less confusion, especially when schedules are being received not only from field agents who visit the mines, but also from the operators themselves.

The fieldwork of a mining census is necessarily based on lists giving the names and addresses of mines and quarries. The preparation of a complete list is therefore a very important part of the office work. The lists used for the census of 1902 were prepared in the division of mining and mineral resources of the United States Geological Survey, and are the outgrowth of the annual reports of that division on the mineral products of the country. The annual returns secured from the mines and quarries for these reports are of assistance in revising the lists at regular intervals. The names and location of new developments are obtained from technical journals and periodicals. All publications of this character are examined and notices of new mining enterprises are clipped. New producers are corresponded with to ascertain the full name, address, location of mine, and character of mineral. Confidential copies of the completed lists are sent at regular intervals to representative producers in different sections of the country for revision and the addition of new names. One of the principal advantages of the collaboration between the Geological Survey and the Bureau of the Census was the utilization of this list.

The special agents were instructed to supplement the official lists by careful inquiries in each locality visited, and to obtain reports from all mines that were in operation during any portion of the year. Two classes were excepted from these instructions; one was the small placer gold mine operators and the other the irregular bituminous coal miners. It is impossible to locate the small placer miners. Moreover, the only statistical information that could be obtained would be the quantity and value of their product, which can be estimated or secured from other sources equally reliable. Therefore no effort was made to secure reports from mines of this class unless the agent was in the vicinity in connection with other work and the preparation of the reports for the small mine would cause no delay. The reports for the irregular bituminous coal producers were obtained by correspondence.

Next to the schedule itself, the instructions for its uniform application are of the greatest importance. Such instructions were prepared and distributed to the special agents before they entered on duty. These instructions were of a general and special character; they defined the agents' duties and described the practices to be followed in securing schedules. They were used in connection with the instructions printed on each schedule, and were followed in the preparation of all reports.

The office work on the mining census was in progress from November, 1902, to July, 1904. During the greater part of this time comparatively few clerks were employed. The greatest number, 91, was reached on October 25, 1903, when the tabulation was at its height. The cost of the office work paid for by the Bureau of the Census was $77,853.17, and of the fieldwork $98,019.78, thus making the total cost of the mining census, exclusive of the final revision of the manuscript and printing and binding, $175,872.95. The schedules for the annual report of the Geological Survey were secured in connection with those for the Bureau of the Census, and the expenditure covers the collection of schedules for the reports of both offices. In some industries omitted from the mining census, but included in the annual reports of the Survey, such as the manufacture of gas, brick, pottery, etc., schedules were collected by the Census agents and turned over to the Survey. On the other hand, considerable Census work was done by the regular employees of the Geological Survey and at the expense of that office.

After the completion of the fieldwork several of the expert special agents employed by the United States Geological Survey in the preparation of the annual reports on Mineral Resources of the United States were retained by the Bureau of the Census to prepare the historical and descriptive text which accompanies the

statistics for the principal minerals. These special agents and the minerals assigned to each are as follows:

Dr. David T. Day	Platinum and iridium.
Dr. Joseph Struthers	Asphaltum and bituminous rock. Bauxite. Borax. Graphite. Magnesite. Mineral pigments, crude. Phosphate rock. Quicksilver. Sulphur and pyrite.
Dr. Joseph Hyde Pratt	Abrasive materials: Buhrstones and millstones. Crystalline quartz. Corundum and emery. Garnet. Grindstones and pulpstones. Infusorial earth, tripoli, and pumice. Oilstones, whetstones, and scythestones. Asbestos. Fluorspar. Lithium ore. Monazite. Talc and soapstone. Barytes. Mica. Steel hardening metals: Chrome ore. Nickel and cobalt. Molybdenum. Rutile. Tungsten. Uranium and vanadium.
Mr. George F. Kunz	Precious stones.
Mr. John Birkinbine	Iron ore. Manganese ore.
Mr. E. W. Parker	Coal, anthracite. Coal, bituminous.
Mr. Jefferson Middleton	Clay.
Mr. F. H. Oliphant	Petroleum and natural gas.

In addition to the above the text for certain minerals was prepared by experts, as follows:

Dr. George P. Merrill	Limestones and dolomites. Marble. Sandstones and quartzites. Silica sand. Siliceous crystalline rocks. Slate.
Dr. I. A. Hourwich	Gold and silver. Copper ore. Lead and zinc ore.
Mr. Story B. Ladd	Cement. Feldspar. Flint. Fuller's earth. Gypsum. Marl.

As previously explained, the schedules were mailed to all mines and quarries. There were received in all 38,151 schedules. Of this number 28,569 were for productive and 7,193 for unproductive and idle properties. In addition there were 2,389 schedules for mines and quarries that were abandoned, and therefore omitted from the tabulation. While comparatively few complete schedules were received through the mail for active properties, the mailing of the blanks was of great assistance to the fieldwork in disposing of the names of idle and abandoned mines and avoiding the necessity of visits by agents. The fieldwork was in progress from about January 15, 1903, to February 1, 1904. The total cost of the fieldwork, as paid for by the Bureau of the Census, was $98,019.78, which included $13,061.10 paid to supervising agents and their assistants who did no traveling. There were in all 122 different individuals, agents, and clerks engaged in the field, but of this number 39 were in a supervising capacity or employed in the offices of supervising agents and did no traveling. There were 83 persons engaged in the collection of schedules, the maximum number, 72, being at work in May, 1903.

As the special agents collected schedules from all mines and quarries in the localities visited, irrespective of the character of the mineral, the cost of the fieldwork for a specific mineral can not be computed with exactness, but the average cost per schedule for the active properties, both productive and unproductive, was about $3. Using this average, the following statement shows the approximate cost of the fieldwork for the principal minerals:

MINERAL.	Cost of fieldwork.
Total	$98,019.78
Bituminous coal	14,423.40
Anthracite coal	944.39
Iron	1,570.98
Gold and silver	47,815.13
Copper	509.67
Lead and zinc	2,974.01
Stone (all varieties)	16,842.78
All other minerals	12,939.39

V.

CLASSIFICATION OF MINERALS.

The statistics are presented in 52 classifications, each comprising the total for a distinct mineral or group of minerals. In some cases minerals or ores yielding two or more products were obtained from the same mine or quarry, and it was impracticable to separate the employees, wages, and expenses incident to the production of each. For instance, if the ore from a mine yielded both silver and copper, the latter being of the greater value, the report was assigned to copper, and all the employees, wages, and expenses were included in the totals for that mineral. If the chief product of a quarry was sandstone the report was classified as "sandstones and quartzites," though some of the product may have been manufactured into and sold as grindstones and pulpstones. In order to avoid duplication and, at the same time, show the total production for each classification, the by-products, when they formed the finished product of the mine or quarry, were added to the classification of which they formed a part. The following statement gives the quantity and value of the by-products that it was possible to segregate, the names of the classifications to which they were added, and the classification under which the

employees, wages, and expenses incident to their production are included:

By-product.	Production.			Classification to which by-product should be added to obtain a total that is comparable with employees, wages, and expenses.
	Quantity.		Value.	
	Unit of measure.	Amount.		
Barytes	Short tons.	539	$1,618	Lead and zinc ore.
Buhrstones and millstones.	Stones	100	1,425	Siliceous crystalline rocks.
Cement			13,149	Limestones and dolomites.
Clay			400	Limestones and dolomites.
Feldspar	Short tons.	112	1,000	Flint.
Flint	Short tons.	1,254	2,593	Feldspar.
Grindstones and pulpstones.	Short tons.	35,503	403,066	Sandstones and quartzites.
Infusorial earth, tripoli, and pumice.	Short tons.	175	1,436	Talc and soapstone.
Lead and zinc ore	Pounds	1,625,813	37,212	Barytes.
Limestones and dolomites.			386	Coal, bituminous.
Limestones and dolomites.			124,687	Cement.
Limestones and dolomites.			5,100	Sandstones and quartzites.
Marble			8,433	Limestones and dolomites.
Mineral pigments, crude.			525	Slate.
Natural gas			103,112	Petroleum.
Oilstones, whetstones, and scythestones.	Short tons.	180	8,872	Sandstones and quartzites.
Oilstones, whetstones, and scythestones.	Short tons.	595	29,740	Grindstones and pulpstones.
Petroleum	Barrels	1,520	1,370	Natural gas.
Sandstones and quartzites.			1,273	Limestones and dolomites.
Sandstones and quartzites.			510	Grindstones and pulpstones.
Silica sand			50,811	Sandstones and quartzites.
Sulphur and pyrite	Long tons.	11,483	29,420	Coal, bituminous.

As shown by this statement, there are 18 of the classifications of minerals for which the values are increased by the inclusion of products obtained in connection with products included under other classifications. For instance, the total production of barytes amounted to 61,668 short tons, valued at $203,154. This includes 539 short tons, valued at $1,618, obtained as a by-product from lead and zinc mines. The employees, wages, and other expenses incident to the production of this by-product are included in the totals for lead and zinc ore. On the other hand, the production of lead and zinc was valued at $14,600,177, which includes 1,625,813 pounds, valued at $37,212, obtained as a by-product from the mining of barytes, the employees, wages, and expenses incident to the production of this by-product being included in the statistics for barytes. In other words, the products of certain mines were segregated so as to show the total production for a given mineral, irrespective of the class of mines from which it was obtained. This practice is in harmony with the methods of the United States Geological Survey, and the reason for its adoption was to obtain totals which would agree with the totals of that office. This method has been followed consistently in the statistics for all minerals except for argentiferous ores. Such a large percentage of silver, copper, lead, and zinc is obtained from the same ores that it was impracticable to segregate their values, and at the same time to present products which would be in any degree comparable for employees, wages, and expenses incident to their production. The totals for these minerals, therefore, present all of the statistics for the mines included in each classification. In treating the different ores, however, the production has been segregated so as to show the total for each metal.

While the theoretical accuracy of this method of tabulating the reports may be disputed, for the reason that it has resulted in assigning to some minerals a larger number of employees and a greater expense than are incident to their production, it is the only practicable way of presenting the data. It permits of a general summary for all minerals in each state and in the United States, and shows true conditions as to employees, wages, expenses, quantity, and value of the different products.

A similar method was followed in classifying the reports for some minerals in which a manufacturing process is carried on in connection with, and incident to, the mine or quarry. Instances of this character are, when limestone quarrying and cement manufacturing are done at a quarry and a part of the product of the quarry is sold in its crude state for building and other purposes, or when grindstones are made at a sandstone quarry and a portion of the quarried stone is sold for building or other purposes. Such quarries made only one report to the Bureau of the Census, and this was classified according to the product of chief value, the quantities and values of the different products being tabulated and presented separately in the reports on each mineral. For convenience in treatment the statistics for allied minerals or minerals used for similar purposes are grouped and discussed as a total and also individually. For instance, the report on "Abrasive materials" includes oilstones, whetstones, scythestones, grindstones, pulpstones, buhrstones, millstones, pumice, infusorial earth, tripoli, crystalline quartz, garnet, corundum, and emery.

A number of the substances usually included in reports on mineral products are the result of manufacturing processes, and therefore should not be included with statistics for mines and quarries. There are also a number of minerals that were not produced in commercial quantities in the United States during the year 1902, and therefore no statistics concerning them are given in this report.

The following summary shows the classification adopted for each mineral, the character of the substance included, and also the names and character of the substances omitted and the reasons for such omission.

Abrasive materials: This classification includes (1) abrasive materials that occur as rock formation and are cut and manufactured directly into the form desired, while retaining their original rock structure and appear-

ance, as oilstones and grindstones; (2) abrasive materials that occur as a constituent of either a rock or a vein and have to be mechanically separated from the associated minerals and cleaned, as corundum, emery, and garnet.

Buhrstones and millstones: Many varieties of stone are used in the manufacture of buhrstones and millstones, and these names are retained because the stones were formerly used for the same purposes as the regular buhr. The millstone varies from a sandstone to a quartz conglomerate. It occurs along the eastern slopes of the Appalachian mountains from New York to North Carolina and is known by different names. In New York the stone is called "Esopus stone;" in Pennsylvania it is known as "Turkey hill" and "Cocalico;" in Virginia, as "Brush mountain" stone, and in North Carolina the name in former years was "North Carolina grit."

Corundum and emery: This classification includes the varieties of corundum known as sapphire, which embraces all corundums of whatever color, that are transparent to semitransparent; also the translucent to opaque varieties of all colors, and emery, which is a mechanical admixture of corundum and magnetite or hematite. Of the total production shown for this classification a very small proportion was corundum proper, the production consisting almost entirely of the emery variety. The statistics do not include the manufacture of artificial corundum.

Crystalline quartz: Under this head is included the quartz that is used principally as a wood finisher and in the manufacture of sandpaper, scouring soaps, etc. The larger proportion of this quartz is used in the pottery and glass industry and is included with flint and feldspar.

Garnet: The statistics relate to the production consumed in the manufacture of garnet paper and emery wheels. The paper is used very extensively in the manufacture of boots and shoes. Garnet is found in many of the crystalline rocks, usually associated with mica in pegmatitic dikes.

Grindstones and pulpstones: The grindstone classification is composed almost entirely of the stones cut from the Lower Carboniferous sandstone beds of Ohio and West Virginia and the Lower Marshall series of Michigan. The Ohio and West Virginia sandstone is called the "Berea grit," because it has been so extensively quarried at Berea, in Cuyahoga county, Ohio. It is generally a fine grained and homogeneous variety. The color varies from a light drab to a light or steel blue. The pulpstones included are made from the Peninsula grit of Ohio, and are used for grinding wood pulp for the manufacture of paper.

Infusorial earth, tripoli, and pumice: Here are included all porous, siliceous earths of organic origin used in the manufacture of polishing powders and scouring soaps, water filters, fireproof building materials, etc. This classification includes also the solid pumice stone and volcanic ash which are used in the manufacture of various polishing powders and scouring stones.

Oilstones, whetstones, and scythestones: The term "oilstone" is applied to all stones used for sharpening tools to which oil is generally applied, but the same stone may be called an oilstone or a whetstone and, perhaps, a scythestone. The materials from which these stones are made are variable, but are of sedimentary origin, and include quartz-mica-schist, sandstone, novaculite, and the intermediate stones.

Aluminum: The metal is obtained by manufacturing processes, and the statistics are therefore excluded from this report. The production, which amounted to 7,300,000 pounds, is mentioned in the report on bauxite, which is the chief raw material used in its manufacture.

Antimony: This mineral is used chiefly for making alloys with lead, tin, zinc, and other metals. The supply is obtained from foreign and domestic antimony ores, hard lead, and regulus, or metal. There was no production of antimony metal from domestic ores during 1902, and therefore no statistics are presented. The quantity derived from other sources was estimated at 12,510,739 pounds.

Arsenic: Arsenious oxide (white arsenic) is obtained in the treatment of gold, silver, lead, or other arsenical ores, and being a separate manufacture is not shown in census mining statistics. The production of arsenic for 1902, as reported by the Geological Survey, was 1,353 short tons, valued at $81,180.

Asbestos: Two distinct minerals are mined and sold under this name. One is a variety of amphibole and the other is the fibrous variety of serpentine, known as chrysotile. The latter variety is the more valuable, but the production of the United States consists principally of the former. The statistics cover the production of both varieties. Asbestos is used in the manufacture of fireproof materials and wherever a nonconductor of heat is desired.

Asphaltum and bituminous rock: This classification includes the product obtained from the mining of the various kinds of hydrocarbon rocks that have an asphaltic base, and some of the purer forms of bitumen, as elaterite, gilsonite, and uintaite. The statistics do not include the asphaltum by-products of petroleum refineries, these being classed as manufactures, or the semifluid bitumen—maltha, or brea.

Ball clay: See Clay.

Barytes: What is known commercially as barytes is barite, a heavy, white mineral, used principally in the manufacture of paints and often called heavy spar, from its high specific gravity. A large proportion of this mineral is mined in an irregular manner by farmers and others who work at such times as their other employment will permit. The reports for all classes of operators are included.

Bauxite: The statistics for bauxite cover the entire production, which is consumed mainly in the manufacture of aluminum, although considerable is used for the manufacture of aluminum sulphate and crystallized alum.

Bismuth: There was no production of bismuth ore reported for 1902. The production in 1901 was reported as 318.6 short tons.

Bituminous rock: See Asphaltum and bituminous rock.

Bluestone: See Stone—Sandstones and quartzites.

Borax: The entire production of this most important salt of boric acid was obtained from the colemanite deposits in California and the marsh deposits of Nevada and Oregon. The statistics include the refining of the crude borax, which is closely allied with the mining.

Bromine: Bromine is one of the elements related in its chemical qualities to chlorine and iodine. It is a deep reddish brown liquid of a very disagreeable odor, emitting a brownish vapor at ordinary temperature. In combination it is found in minute quantities in sea water and many saline springs; occurs also in the mineral bromyrite. A large proportion of the product is obtained from deposits in Michigan. The processes are somewhat similar to those used in the production of salt. Both salt and bromine are classed as manufactures and excluded from this report.

Buhrstones: See Abrasive materials—Buhrstones and millstones.

Carbonate of soda: This product is the result of processes similar to those used in the manufacture of salt, being obtained by the solar or artificial evaporation of alkaline waters. It, as well as salt, was classed as a manufactured product at the census of 1900. The statistics, therefore, are omitted from this report. The entire production, 4,900 tons of refined soda ash, valued at $50,000, for the year 1902 was obtained from one establishment, the Inyo Development Company, of Inyo county, Cal., with general offices at Carson City, Nevada.

Carborundum: Is a product of manufactures, and, therefore, not included in this report. Its composition is, carbon, 32 per cent; silicon, 68 per cent. It comes from the furnace in the shape of black crystals, which are crushed, washed, dried, and sifted to uniform size. At the factory of the sole manufacturers, at Niagara Falls, the production in 1902 was 3,741,500 pounds.

Celestite: See Strontium ores.

Cement: The statistics relate only to the cement—Portland and natural rock—manufactured by establishments engaged in quarrying, but in addition to this product the total production of cement as reported to the Geological Survey is also mentioned. The marl excavated and used for cement is shown here, and not under Marl. The manufacture of pozzuolana, or cement from furnace slag, is not included.

Chromic iron ore: See Steel hardening metals—Chrome ore.

Clay: Includes kaolin, ball clay, fire clay, slip clay, stoneware clay, pipe clay, terra cotta, and other varieties of clay mined and sold as such. The statistics do not include the clay mined by operators who consume their output in the manufacture of brick, pottery, and other clay products.

Coal: Both the anthracite and the bituminous coal mines are included in this classification, the statistics being presented separately. Under bituminous is included semibituminous, lignite, and some coal locally known as anthracite. The anthracite is Pennsylvania anthracite, which is practically the whole production. The totals for bituminous coal include the output of the irregular, small producers.

Cobalt: See Steel hardening metals—Nickel and cobalt.

Coke: Coke is not shown, because a manufactured article and reported as such at the census of 1900.

Copper ore: The statistics of employees, wages, and expenses relate to the mines producing copper as a product of chief value; but the total quantity and value of the copper obtained from all ores, including the product of silver mines, is included, the amounts obtained from the different classes of ore being given separately. (See Gold and silver.)

Corundum: See Abrasive materials—Corundum and emery.

Crushed steel: This is a manufactured product and therefore not included in this report. It is used by granite and marble cutters; also in sawing, grinding, rubbing, and polishing stone, and by glass grinders. The sole producers manufactured 735,000 pounds in 1902.

Cryolite: There was no production of this mineral in the United States in 1902. It is a fluoride of sodium and aluminum, found almost exclusively in Greenland and sometimes called Greenland spar. It is used in the manufacture of aluminum and sodium salts.

Crystalline quartz: See Abrasive materials.

Dolomites: See Stone—Limestones and dolomites.

Emery: See Abrasive materials—Corundum and emery.

Feldspar: See Flint and feldspar.

Ferromanganese: This is an alloy of iron and manganese used in the manufacture of Bessemer steel. It is a manufactured article and therefore is not included in census mining statistics.

Fibrous talc: See Talc and soapstone.

Fire clay: See Clay.

Flint: See Flint and feldspar.

Flint and feldspar: This classification includes the flint or quartz mined as such, but does not include the crystalline quartz used for wood finishing or the manufacture of scouring soaps, which is shown under the class of Abrasive materials. Statistics are also shown for the entire production of feldspar, which is used largely in the pottery and porcelain industry and in the manufacture of scouring soaps and wood fillers.

Fluorspar: Fluorite of fluorspar is a calcium fluoride that is generally found in veins in limestones, sandstones, mica slate, clay, slate, and gneiss. The statistics cover the entire production, practically all of which is used as a fluxing material in steel works and blast furnaces.

Fuller's earth: The greatest part of this earth—a material resembling clay, but commonly lacking plasticity—is obtained in the vicinity of Quincy, Fla. The entire production is included. It is used in fulling wool and deodorizing and clarifying fats, oils, and greases. Refineries of lard, cottolene, and allied products are important consumers.

Garnet: See Abrasive materials.

Gold and silver: The statistics for gold and silver embrace both deep and placer mines and development work, and also the reduction mills and ore dressing works. In many instances gold and silver, and in some cases copper and lead, are obtained from the same ore. The statistics of employees, wages, and expenses for the precious metals are, therefore, presented in the same tables, but the production of each metal is shown separately. The value of the product is the value at the mine to the miner.

Granite: See Stone—Siliceous crystalline rocks.

Graphite: This mineral is sometimes called plumbago, black lead, or pot lead. It occurs as a form of carbon, and is the last form assumed in the natural change of vegetable matter into a mineral. The statistics include only the production and refining of the natural graphite, which is classed either as crystalline or amorphous.

Greensand marl: See Marl.

Grindstones: See Abrasive materials—Grindstones and pulpstones.

Grindstones and pulpstones: See Abrasive materials.

Gypsum: The statistics cover the crude gypsum—a calcium sulphate—marketed as such; also the product ground into land plaster and that calcined into plaster of Paris and wall or cement plaster.

Hübnerite: See Steel hardening metals—Tungsten.

Infusorial earth, tripoli, and pumice: See Abrasive materials.

Iridium: See Platinum and iridium.

Iron ore: The statistics include the different varieties of iron ore generally classed as (1) red hematite, including all anhydrous hematites, known by various names, such as red hematite, specular, micaceous, fossil, slate iron ore, martite, blue hematite, etc.; (2) brown hematite, including the varieties of hydrated sesquioxide of iron, recognized as limonite, gothite, turgite, bog ore, pipe ore, etc.; (3) magnetite, those ores in which iron occurs as magnetic oxide and including some martite, which is mined with the magnetite; (4) carbonate, those ores which contain a considerable amount of carbonic acid, such as spathic ore, blackband, siderite, clay, ironstone, etc. The statistics for manganiferous iron ores are also included. Argentiferous manganiferous iron ores are included in some cases with iron ores and in other cases with silver, according to the relative commercial value of the silver and iron contents.

Kaolin: See Clay.

Lead ore: See Lead and zinc ore.

Lead and zinc ore: Only nonauriferous and nonargentiferous lead and zinc ores are included. It is impracticable, in a majority of cases, to separate the statistics of employees, wages, and expenses incident to the production of each metal, and they are combined in the tables, but the quantity and value of each, and, in some cases, other statistics are shown separately. Totals for both lead and zinc include the dressing of the ore at the mine preparatory to its treatment at the smelter. The value is that of the contents at the mine to the miner. A considerable proportion of the lead product is obtained from silver ore, which carries with it also some gold. All the statistics relating to argentiferous lead ores, including the value of product, are given in the report for gold and silver mines, shown under Gold and silver.

Lepidolite: See Lithium ore.

Limestone: See Stone—Limestones and dolomites.

Limestones and dolomites: See Stone.

Litharge: This is a lead pigment, classed with white lead, red lead, etc., and being obtained by a process of manufacture is not included in statistics of mining.

Lithium ore: The two minerals thus far mined for their lithium contents are lepidolite and spodumene. Lepidolite is a lithia mica, in part a metasilicate of aluminum with potassium and lithium and varying amounts of fluorine and hydroxyl. Spodumene is a metasilicate of aluminum and lithium, generally containing a little sodium. It is not the metal lithium that is used in the arts, but its salts, principally lithium carbonate. This is used extensively in the preparation of mineral waters for medicinal purposes and in the manufacture of effervescing lithia tablets.

Lithographic stone: This is an even grained, compact limestone, usually of a drab or buff color, like that quarried at Solnhofen, Germany, and is used by lithographers. No production was reported for the year 1902. A report was received from a quarry in Kentucky that did only development work and prospecting. Lithographic stone has been found in Talladega county, Ala.; in Kern county, Cal.; in Illinois; at Anamosa, Jones county, and in Van Buren county, Iowa; near Elizabethtown, Hardin county, and in Clinton, Estill, Kenton, Rowan, and Wayne counties, Ky.; at Saverton, Ralls county, Mo.; in Clay and Overton counties, Tenn.; and in Llano county, Tex. The world's supply, however, has been obtained mostly from the quarries at Solnhofen, Bavaria. The imports for the year ending June 30, 1903, were valued at $131,015.

Magnesite: This is magnesium carbonate. The mining is confined to California. Only one producer re-

ported, and the statistics are grouped with All other minerals. The mineral is used especially in the manufacture of magnesite bricks for the refractory lining of furnaces and the manufacture of carbon-dioxide gas. When crude magnesite is decomposed by sulphuric acid there is a by-product of magnesium sulphate, or Epsom salts. Both crude and calcined magnesite are included in the statistics.

Manganese ore: The statistics for manganese ore include ores carrying over 44.3 per cent of metallic manganese. The manganiferous iron ores are treated under "Iron ores," and the manganiferous silver ores in some cases under "Silver" and in other cases under "Iron ores," according to the relative commercial value of the silver and iron contents. The chief use of manganese is in the manufacture of Bessemer steel.

Marble: See Stone.

Marl: Marl includes the green, blue, red, and yellow clayish earths used as fertilizers. The marl deposits extend from New Jersey to North Carolina, but the mines included in the statistics are in New Jersey and Virginia. In New Jersey the entire product is applied to the soil in the natural state, while in Virginia it is dried and ground for use in commercial fertilizers.

Mica: There are two varieties of commercial value—muscovite and phlogopite, but the former is more commonly found and mined. The value of mica depends on its occurrence in blocks or masses that are capable of being split into sheets a square inch or more in size, and the value of these sheets increases with their size, which varies from 1 inch square to 8 by 10 inches. Soap mica, ground to a flour, is used in the manufacture of wall papers, lubricants, fireproofing materials, novelties, etc. Sheet mica is used chiefly in stoves, for chimneys of incandescent lights, and for the insulation of electrical apparatus. The statistics embrace both sheet and scrap mica. A considerable proportion was mined by small, irregular operators, and the statistics for them are included in the total.

Millstones: See Abrasive materials—Buhrstones and millstones.

Mineral paints: See Mineral pigments, crude.

Mineral pigments, crude: Include the production of ores used in the manufacture of mineral paints. They consist of iron ores (red and brown hematites) that are ground and used in the manufacture of metallic paint, and are not included in the production of iron ores for the manufacture of iron; clay or other earths, including some mined as "Venetian red," containing iron used in making yellow, red, and brown pigments (such as ocher, umber, sienna, etc.); carbonate of zinc, slate (or shale) and soapstone, ground for pigment. No statistics of manufacture are given except such as are inseparable from the mining.

Mineral waters: The report on manufactures of the Twelfth Census and the annual reports of the Geological Survey contain statistics concerning the production and sale of mineral waters. These statistics have been omitted from the census of 1902 for the reason that mineral waters are not commercially classed as the product of a mine or quarry. They are produced under conditions that are entirely different from those prevailing in the mining industries. The employees engaged in the industry are devoted almost exclusively to the preparation of the product for the market, as there is practically no expense incident to the production of the water itself. The total production for 1902, as reported by the Geological Survey, was 64,859,451 gallons, valued at $8,793,761.

Molybdenum: See Steel hardening metals.

Monazite: This mineral is essentially an anhydrous phosphate of the rare earth metals cerium, lanthanum, and didymium. It is mined for its thoria contents, which are usually from 3 to 9 per cent, but have been found to vary from a fraction of 1 per cent to 32 per cent. The commercial deposits of monazite are found in placers of streams and rivers, also in old sand and gravel deposits of former streams, and are worked by sluicing the sands and gravels, principally by small, irregular operators, just as placer gold is washed. The thoria in the monazite and, in much smaller quantities, the lanthanum and didymium are used in the manufacture of the cylindrical hood or mantle of incandescent gaslights. The cerium oxalate obtained in the separation of the oxides is used in pharmacy.

Natural gas: The statistics relate exclusively to the production of natural gas, and the value of the product is the value at the point of consumption. The petroleum produced by gas companies and the statistics pertaining to it are included in those for petroleum.

Nickel: See Steel hardening metals—Nickel and cobalt.

Nickel and cobalt: See Steel hardening metals.

Nitrate of soda: No production of nitrate of soda was reported for the United States during the year 1902. A schedule was received from one California company owning a mine in Nevada, at which development work only was done. The world's supply is obtained principally from the natural beds of Chile. The total imports from all sources for 1902 were 661,348,800 pounds, valued at $5,996,205.

Novaculite: See Abrasive materials—Oilstones, whetstones, and scythestones.

Ocher: Ocher is a pigment used in the manufacture of mineral paints. See Mineral pigments, crude.

Oilstones: See Abrasive materials—Oilstones, whetstones, and scythestones.

Orange mineral: This is a lead oxide pigment largely used for paints. Being classed as a manufacture, it is not included in Census mining statistics.

Ozocerite: This mineral is also known as mineral wax. No production of the mineral, as such, was reported

for 1902. The entire product is obtained in the treatment of asphaltum, and therefore is classed for census purposes as a product of manufacture.

Petroleum: The statistics relate exclusively to the production of crude petroleum. Petroleum refining is classed as a manufacture, and the statistics are included in the census of manufactures of 1900. The production of natural gas by petroleum companies has been eliminated from the reports for such companies, and the statistics are included in the classification of natural gas.

Phosphate rock: This is a name given to various mineral deposits, consisting largely of calcium phosphates or iron and alumina phosphates, and used in the manufacture of commercial fertilizers. The statistics include the preparation of the rock for market when this is done at the quarry.

Pig iron: This is classed as a manufacture and was shown at the census of 1900. It is not included in mining statistics.

Pipe clay: See Clay.

Platinum: See Platinum and iridium.

Platinum and iridium: Almost the entire production of the rare metal platinum is obtained from placer gold mines. Iridium is closely associated with platinum and, not amalgamating, has not always been saved. Some platinum and iridium are also secured in the refining of gold. Platinum occurs generally in the native state. It is used chiefly in chemical manufacture and analysis and in electrical work. Iridium is used for the knife edges of balances and other hard wearing surfaces. There were no mines engaged in the production of platinum ore as a product of chief value; therefore it is impossible to show statistics of employees, wages, and expenses, such statistics being included in the report for gold. The production of platinum in 1902 from domestic mines, as reported by the United States Geological Survey, was 94 ounces, valued at $1,814, and of iridium, 20 ounces.

Pozzuolana or slag cement: This is a manufacture and is therefore not included in statistics of mining.

Precious stones: Under this heading are classed the following gems mined or found accidentally in this country in 1902: Sapphire, beryl, emerald, tourmaline, peridot, quartz, amethyst, agates, chrysoprase, silicified wood, opal, garnet, rhodolite, amazon stone, turquoise, chlorastrolite, mesolite, pyrite, anthracite, and catlinite. A considerable proportion of the product was the result of irregular work or incidental findings, and no employees, wages, or other expenses were reported for this portion.

Pulpstones: See Abrasive materials—Grindstones and pulpstones.

Pumice: See Abrasive materials—Infusorial earth, tripoli, and pumice.

Pyrite: See Sulphur and pyrite.

Quartzites: See Stone—Sandstones and quartzites.

Quicksilver: The production of this silver-white metal fluid is confined to California and Texas. The statistics include the production and the reduction of the cinnabar from which the quicksilver is principally obtained. The chief use of quicksilver, or mercury (its scientific name), is in the metallurgical treatment of gold and silver. It is also employed in the manufacture of vermilion, a pigment, in the manufacture of physical instruments, and as a medicine.

Red lead: Red lead is classed as a manufacture, and is not shown in mining statistics.

Rutile: See Steel hardening metals.

Salt: For census purposes salt is classed as a manufacture, and the statistics are included in the report on manufactures of the Twelfth Census. The total production for 1902, as reported by the Geological Survey, was 23,849,221 barrels, valued at $5,668,636. The chief salt producing states are Michigan and New York.

Sandstone: See Stone—Sandstones and quartzites.

Sandstones and quartzites: See Stone.

Scheelite: See Steel hardening metals—Tungsten.

Scythestones: See Abrasive materials—Oilstones, whetstones, and scythestones.

Sienna: Sienna is a pigment used in the manufacture of mineral paint. See Mineral pigments, crude.

Silica sand: See Stone.

Siliceous crystalline rocks: See Stone.

Silver: See Gold and silver.

Slate: See Stone.

Slate, ground for pigment: See Mineral pigments, crude.

Slip clay: See Clay.

Soapstone: See Talc and soapstone.

Spiegeleisen: This is an alloy of iron and manganese used in the manufacture of Bessemer steel, and, being a manufacture, is not included in census mining statistics.

Spodumene: See Lithium ore.

STEEL HARDENING METALS: The statistics for the several metals (except for manganese, which is shown separately) that are utilized largely, or in an experimental way, in the manufacture of steel or of steel products have been grouped under this classification. They are chromium, molybdenum, nickel, titanium, tungsten, uranium, and vanadium. Cobalt is included because it is associated with nickel in the matte. Except for nickel and cobalt, the value of which is the value of the matte at the mine, and tungsten ores, the value of which is their value more or less concentrated, the statistics are for the crude ores. Under this classification are shown chrome ore, molybdenum, nickel and cobalt, rutile, tungsten, and uranium and vanadium.

Chrome ore: This includes the statistics for chromite or chromic iron ore. Only one producer was reported. The ore is used in the manufacture of bricks for basic open-hearth furnaces, and from the metal a ferrochromium alloy is made which is em-

ployed in the manufacture of chromium steel. The chromium salts obtained are used in dyeing and in the manufacture of coloring pigments.

Molybdenum: The chief source of this metal is the mineral molybdenite, which is usually found foliated, massive or in scales, with a perfect basal cleavage and a metallic luster. Molybdenite generally occurs embedded in or disseminated through crystalline rocks, principally granite, gneiss, and granular limestone, and is found abundantly in the Western states. Besides being used in chemistry, molybdenum has in the last few years been found to give very beneficial properties to steel.

Nickel and cobalt: Most of the ores that contain one of these metals contain at least a small amount of the other, and in the smelting of the ores both the nickel and the cobalt go into the matte which is to be refined. The product is obtained principally from the smelting of lead ores at Mine La Motte, Mo. Nickel is used in the manufacture of tableware and for coinage and miscellaneous purposes, but its most important use is in the manufacture of a special steel from which armor plates, turrets, propeller shafts, etc., are made.

Rutile: Rutile is the only titanium mineral mined for commercial purposes. Considerable experimental work has been done with titanium in the manufacture of steel, but so far as known the metal has not yet been used in this way commercially. Iron has been made which contains a considerable proportion of titanium. Deposits are found in a number of states, but the beds in Virginia are the only ones that were productive in 1902. The principal use of rutile at present is as titanium oxide for coloring porcelain and in the manufacture of artificial teeth.

Tungsten: The sources of tungsten are scheelite, wolframite, and hübnerite. Of these, the one that can be used most advantageously in reducing it to the metal, or to the ferroalloy, is scheelite, a tungstate of calcium. Wolframite, which is the most abundant of the tungsten ores, is a tungstate of iron and manganese. Hübnerite is very similar to wolframite, and is essentially a manganese tungstate. The chief use of tungsten, either in the form of the alloy, as ferrotungsten, or as the powdered metal, is in the manufacture of tungsten steel.

Uranium and vanadium: The minerals that are the source of uranium are uraninite, gummite (an alteration product of uraninite), and carnotite. The last mineral contains also a considerable percentage of vanadium, a lead vanadate. Both uranium and vanadium are used in an experimental way in the manufacture of steel alloys, and increase the tensile strength and toughness of the steel. The metals are also in demand for their salts.

STONE: The statistics are shown under the following heads: Limestones and dolomites, marble, sandstones and quartzites, silica sand, siliceous crystalline rocks, and slate.

Limestones and dolomites: These include, besides the calcium carbonate (limestones), also stone containing calcium carbonate and magnesium carbonate in varying proportions (dolomites); also fossiliferous shell and coral limestones. The statistics include limestone used for iron flux and in the manufacture of lime.

Marble: Marble is limestone that by action of heat has been transformed to crystalline form. With marble is included some onyx marble, or travertine; also a small amount of serpentine or verd antique.

Sandstones and quartzites: This classification includes all consolidated sands. Among the varieties are the bluestone of New York and Pennsylvania, and calcareous sandstone; also the jasper of southern Minnesota, the lava of Douglas county, Colo.; ganister, a quartzite used as refractory material in furnaces, and some bituminous sandstone.

Silica sand: The crushing and grinding of the rock for the production of silica sand, used largely in the manufacture of glass, is in a number of cases done by sandstone quarries from which stone is sold for other purposes. But in cases where all, or practically all, of the product of the quarry was used for the manufacture of this sand it was treated as a quarry and the statistics are included under this classification. They do not include the digging of sand from sand banks, river beds, etc.

Siliceous crystalline rocks: This group of rocks includes granite, gneiss, mica schist, lava, andesite, syenite, quartz, porphyry, and trap. These are used for various purposes, such as building stone, foundation work, monumental stone, paving blocks, curbstone and flagstone, rubble and crushed stone for riprap, macadam roads, concrete, and railroad ballast. The kinds of stone treated under trap rock are trap, diabase, and diorite, which are quarried extensively in the New England states, and in New York, New Jersey, and Pennsylvania, and are used largely for paving stones and road metal; basalt, quarried in California for the same purposes; and gabbro.

Slate: Slate is quarried principally for roofing, but also for manufacture into slabs, slates, slate pencils, etc., the milling necessarily being done at the quarries while the stock is wet. Slate ground for pigment is included in Mineral pigments, crude.

Stoneware clay: See Clay.

Strontianite: See Strontium ores.

Strontium ores: The two minerals that are sources of strontium salts are celestite and strontianite. It is not the metal strontium that is used commercially, but its salts. Those that are most in demand are strontium oxide and strontium hydroxide, which are used in refining beet sugar and also in the defecation of sugar contained in molasses. Other uses are in the manufac-

ture of pyrotechnics, medicines, and chemicals. No production of strontium minerals has been reported since 1897, when 40 tons of celestite, out of 150 tons mined, was shipped from Put in Bay, Strontian Island, Ottawa county, Ohio.

Sulphur: See Sulphur and pyrite.

Sulphur and pyrite: The statistics for sulphur and pyrite, from which sulphuric acid is largely obtained, are grouped so as not to disclose the operations of a company engaged in the production of sulphur. By far the greater part of the sulphur is consumed in the manufacture of paper stock by the sulphite process.

There are two kinds of pyrite, iron pyrites and copper pyrites. Pyrite, which is mined principally for its sulphur contents, is commonly called iron pyrites, but that term includes marcasite as well as pyrrhotite. Practically all the ore is treated for the manufacture of sulphuric acid. The acid is used for medicinal and chemical purposes, and very largely in the refining of oils, manufacture of paper, fertilizers, etc. Some pyrite is mined as a by-product of coal, and this is included in the total.

Talc and soapstone: The statistics include a small production of serpentine and the production of pyrophyllite, both minerals being mined and used for the same purposes as talc. Three kinds of talc are included under this head: Foliated, from which talcum powders, tailors' pencils, etc., are made; fibrous, wholly mined in the state of New York and used in the manufacture of paper; and massive (which is steatite or soapstone), used for slabs, washtubs, sanitary work, etc. The manufacturing processes when conducted at the mines are included in the statistics.

Terra cotta: See Clay.

Tin: There was no production of tin ore in the United States during the year 1902. All the tin of commerce is obtained from the dioxide, which is called cassiterite by the mineralogist and tinstone by the miner. Some experimental or development work was done in the Black Hills region, and work was resumed on the deposits in the Santa Ana mountains in southern California. Tin is used principally in the manufacture of tin plate—sheet metal coated with tin. It also forms a part of several important alloys.

Trap rock: See Stone—Siliceous crystalline rocks.

Tripoli: See Abrasive materials—Infusorial earth, tripoli, and pumice.

Tungsten: See Steel hardening metals.

Umber: Umber is a pigment used in the manufacture of paints. See Mineral pigments, crude.

Uranium: See Steel hardening metals–Uranium and vanadium.

Uranium and vanadium: See Steel hardening metals.

Vanadium: See Steel hardening metals.

Venetian red: See Mineral pigments, crude.

Whetstones: See Abrasive materials–Oilstones, whetstones, and scythestones.

White lead: White lead is classed as a manufacture, and not shown in the census mining statistics.

Wolframite: See Steel hardening metals–Tungsten.

Zinc ore: See Lead and zinc ores.

Zinc white: This is a manufacture, and not included in the mining census.

There are many varieties of ores and metals included in the different groups or classifications. These ores and metals have been described with more or less detail in the reports for each classification, but in order to assist in the identification of the ore, the metal, and its chemical constituents, the following table, with the accompanying descriptive text relative to all ores of economic importance, is given:[1]

ORES OF ECONOMIC IMPORTANCE.

The accompanying table has been compiled from several authoritative sources,[2] the ores under each metal being arranged in the order of mineral species given in Dana's System of Mineralogy, sixth edition. The percentage compositions given in that work have been adopted and the metallic content has been calculated therefrom where necessary. In a mining region one often hears ores spoken of as running 90 per cent lead, 80 per cent zinc, and so on, when the purest crystallized minerals do not contain such amounts of the metals. The fourth column of this table shows the highest possible percentage of metal in the various ores, and the fifth column indicates the corresponding amounts of metal in the short ton (2,000 pounds) of pure ore. In a few instances the ore is of such variable or uncertain composition that the highest percentage of metal given by actual analysis has been quoted, instead of any theoretical amount. This has been indicated in the table by the use of brackets.

It must be remembered, however, that, with the exception of some ores of iron, tin, and quicksilver (mercury), the metalliferous ores as found in run of mine are not pure or unmixed minerals; on the contrary, they are in complex associations with one another. This is especially the case with silver ores (of which there are some thirty varieties, counting rare combinations), and, to a smaller degree, with ores of gold, nickel, antimony, zinc, and some other metals. Often it is the constituent of low ratio but high pecuniary value in these mixed ores that makes the mine worth working; or such a constituent may be the by-product of reduction which makes mining profitable. Furthermore, even with relatively pure ores, the accompanying gangue minerals—for instance, quartz, calcite, barite, and fluorite—seldom can be wholly removed by hand sorting or other means of concentration. These impurities and the unavoidable losses during the processes of reduction make the amount of metal actually won from an ore fall far below its theoretical chemical composition. The principal use of the table is to show the highest possible amount of metal that could be obtained from pure ores.

[1] United States Geological Survey, "Mineral Resources of the United States," 1901, page 967 ff.

[2] Lehre von den Erzlagerstätten, by Richard Beck, Berlin, 1901; Ore Deposits of the United States and Canada, by James F. Kemp, fourth edition, New York and London, 1901; A System of Mineralogy, by Edward S. Dana, sixth edition, New York, 1895.

Percentage of metal contained in ores of economic importance.

CHEMICAL NATURE.	Kind of ore.	Chemical composition.	Per cent of metal.	Pounds of metal per short ton.	Remarks.
	Aluminum.				
Fluoride	Cryolite	Na_3AlF_6	12.8	256	Used also as a source of sodium and its compounds.
Oxide	Corundum	Al_2O_3	52.9	1,058	Used, however, mostly as an abrasive.
Oxide	Bauxite	$Al_2O_3.2\ H_2O$	39.1	782	Often furnishes more aluminum through presence of other oxides in the ore. Principal ore.
Silicate	Kaolinite	$2\ H_2O.Al_2O_3.2\ SiO_2$	20.9	418	
	Antimony.				
Sulphide	Stibnite (gray antimony, antimonite)	Sb_2S_3	71.4	1,428	Chief ore; often associated with galena.
Oxide	Valentinite (white antimony, senarmontite).	Sb_2O_3	83.3	1,666	
Oxide	Stibiconite (antimony ocher)	Sb_2O_3	74.5	1,490	Often furnishes more antimony through presence of other oxides. A by-product in lead smelting.
	Arsenic.				
Metallic	Native arsenic	As	100	2,000	Contains Sb, Ni, Fe, Mn as impurities. Rare.
Sulphide	Realgar	As_2S_2	70.1	1,402	
Sulphide	Orpiment (auripigment)	As_2S_3	61	1,220	
Arsenide	Löllingite	$FeAs_2$	72.8	1,456	Grades into leucopyrite, Fe_3As_4, with As 64.1 per cent.
Sulpharsenide	Arsenopyrite (mispickel)	FeAsS	46	920	Arsenic is obtained also from some nickel and cobalt ores, particularly smaltite and cobaltite.
	Bismuth.				
Metallic	Native bismuth	Bi	100	2,000	Rare.
Sulphide	Bismuthinite (bismuth glance)	Bi_2S_3	81.2	1,624	
Oxide	Bismite (bismuth ocher)	Bi_2O_3	89.6	1,792	
Carbonate	Bismutite (carbonate of bismuth)	$3\ BiCO_5 + H_6Bi_2O_6 + aq$	80.6	1,612	Composition variable.
Silicate	Eulytite	$Bi_4Si_3O_{12}$	75	1,500	Rare.
	Cadmium.				
Sulphide	Greenockite	CdS_2	77.7	1,554	The cadmium of commerce, however, is obtained from cadmiferous sphalerite (zinc blende).
	Chromium.				
Oxide (or chromate).	Chromite (chromic iron)	$FeCr_2O_4$	52.1 (Cr_2O_3=68.0)	1,042 1,360)	Often has MgO and Fe_2O_3 replacing the FeO and Cr_2O_3.
	Cobalt.				
Sulphide	Linnaeite (cobalt pyrites)	Co_3S_4	57.9	1,158	Proportions variable. Co replaced usually to some extent by Ni, Fe, and Cu.
Arsenide	Smaltite	$CoAs_2$	28.2	564	Grades insensibly into chloanthite, $NiAs_2$.
Sulpharsenide	Cobaltite	CoAsS	35.5	710	
Arsenide	Skutterudite	$CoAs_3$	20.7	414	
Sulpharsenide	Glaucodot	(CoFe)AsS	23.8	476	Proportions variable.
Oxide	Asbolite (earthy cobalt)	Doubtful	Up to 32	640	
Arsenate	Erythrite (cobalt bloom)	$Co_3As_2O_8+8\ H_2O$	29.5	590	Cobalt is obtained also from arsenopyrite and chalcopyrite.
	Copper.				
Metallic	Native copper	Cu	100	2,000	Usually contains some silver.
Sulphide	Chalcocite (copper glance)	Cu_2S	79.8	1,596	
Sulphide	Covellite (indigo copper)	CuS	66.4	1,328	
Sulphide	Bornite (peacock ore)	Cu_3FeS_3	55.5	1,110	Often enriched by mechanical admixture of chalcocite.
Sulphide	Chalcopyrite (copper pyrites)	$CuFeS_2$	34.5	690	
Sulphantimonite	Bournonite	$(Pb, Cu_2)_2Sb_2S_6$	13	260	Contains 42.5 per cent lead and 24.7 per cent antimony.
Sulphantimonite	Tetrahedrite	$Cu_3Sb_2S_7$	52.1	1,042	Sb 24.8 per cent. Grades into tennantite, the sulpharsenite of Cu, containing Cu 57.5 per cent, As 17 per cent.
Sulpharsenite	Enargite	Cu_3AsS_4	48.3	966	As 19.1 per cent. Grades into famatinite, the sulphantimonite of Cu, containing Cu 43.3 per cent, Sb 27.4 per cent.
Chloride	Atacamite	$CuCl_2.3\ Cu\ (OH)_2$	64.5	1,290	Sometimes yields more copper, on account of admixtures.
Oxide	Cuprite (ruby copper)	Cu_2O	88.8	1,776	
Oxide	Tenorite (melaconite, black copper).	CuO	79.8	1,596	
Carbonate	Malachite (green carbonate of copper).	$CuCO_3.Cu(OH)_2$	57.4	1,148	
Carbonate	Azurite (blue carbonate of copper)	$2\ CuCO_3.Cu(OH)_2$	55.2	1,104	
Carbonate	Chrysocolla	$CuSiO_3+2\ H_2O$	36.1	722	Pyrite and pyrrhotite sometimes contain copper enough to pay for extraction.
	Gold.				
Metallic	Native gold	Au	100	2,000	Usually contains silver, up to 16 per cent. When more than 16 per cent silver is present the alloy is called electrum.
Telluride	Petzite	$(Ag, Au)_2Te$	25.5	510	Proportions variable. This percentage corresponds to ratio Ag : Au=3 : 1.
Telluride	Sylvanite	$(Au, Ag)Te_2$	24.5	490	Proportions variable. This percentage corresponds to ratio Au : Ag=1 : 1. Reported up to 29.35 Au.
Telluride	Krennerite	$(Ag, Au)Te_2$ (?)	34.8	696	Composition uncertain. Calaverite, another telluride, has yielded Au 40.92 per cent. Analyses have given from 5.8 per cent to 12.75 per cent Ag.
Sulpho-telluride	Nagyagite	$Au_2Pb_{14}Sb_3Te_7S_{17}$	7.46	149	Not common. Gold content calculated from average of recent analyses given by Dana. Gold is recovered also from pyrite, arsenopyrite, chalcopyrite, stibnite, and sphalerite (blende).
	Iridium.				
Metallic	Iridosmine	Ir Os	[40	800]	Variable.
Metallic	Platiniridium	Pt Ir	.....	.....	Variable.
	Iron.				
Oxide	Hematite (specular iron ore, red hematite).	Fe_2O_3	70	1,400	
Oxide	Martite (a variety of hematite)	Fe_2O_3	70	1,400	Replacing magnetite in Lake Superior region.
Oxide	Ilmenite (menaccanite)	$FeTiO_3$	47.3	946	Too refractory for use as a source of iron.
Oxide	Magnetite (magnetic iron ore)	Fe_3O_4	72.4	1,448	
Oxide	Franklinite	$(Fe, Zn, Mn)O.(Fe, Mn)_2O_3$	44.4	888	An important ore of zinc in northern New Jersey.
Oxide	Turgite	$2\ Fe_2O_3—H_2O$	66.2	1,324	Often confounded with hematite.
Oxide	Limonite (bog iron ore, brown hematite).	$2\ Fe_2O_3—3\ H_2O$	59.8	1,196	

Percentage of metal contained in ores of economic importance—Continued.

CHEMICAL NATURE.	Kind of ore.	Chemical composition.	Per cent of metal.	Pounds of metal per short ton.	Remarks.
	Iron—Continued.				
Oxide	Göthite	$Fe_2O_3—H_2O$	62.9	1,258	Often confounded with limonite.
Carbonate	Siderite (spathic iron ore)	$FeCO_3$	48.2	964	
Silicate	Chamosite	$FeO, MgO, Al_2O_3, SiO_2, H_2O$	47	940	Uncertain composition. Iron declines to 33 per cent.
Sulphide	Pyrite (iron pyrites)	FeS_2	46.6	932	Contain 53.4 per cent sulphur and are used in the manufacture of sulphuric acid (oil of vitriol). Sometimes treated also for gold content.
Sulphide	Marcasite (iron pyrites, mundic)				Pyrites residue (=purple ore) is a commercial source of iron.
	Lead.				
Sulphide	Galena ("lead," lead glance)	PbS	86.6	1,732	Is also a very important source of silver.
Sulphantimonite	Jamesonite (feather ore)	$Pb_2Sb_2S_5$	50.8	1,016	Contains 29.5 per cent antimony.
Sulphantimonite	Bournonite	$(Pb, Cu_2)_3Sb_2S_6$	42.5	850	Copper, 13 per cent; antimony, 24.7 per cent.
Sulphantimonite	Boulangerite	$Pb_5Sb_2S_8$	58.9	1,178	Antimony, 22.8 per cent.
Carbonate	Cerussite (white lead ore)	$PbCO_3$	77.5	1,550	
Chloro-phosphate	Pyromorphite	$3Pb_3P_2O_8.PbCl_2$	76.3	1,526	
Chloro-arsenate	Mimetite	$3Pb_3As_2O_8.PbCl_2$	69.5	1,390	
Sulphate	Anglesite (lead vitriol)	$PbSO_4$	68.3	1,366	
	Manganese.				
Oxide	Franklinite	$(Fe, Zn, Mn)O. (FeMn)_2O_3$	[20.0	400]	Proportions very variable. Important ore of zinc in northern New Jersey; manganese not saved.
Oxide	Hausmannite	Mn_3O_4	72.5	1,450	
Oxide	Braunite	$3Mn_2O_3.MnSiO_3$	63.5	1,270	
Oxide	Pollanite	MnO_2	63.1	1,262	
Oxide	Pyrolusite	MnO_2	63.1	1,262	Principal source.
Oxide	Manganite	$Mn_2O_3.H_2O$	62.4	1,248	
Manganate	Psilomelane	$H_4Mn_5O_{15}$ (?)	[58.6	1,172]	Proportions and composition variable.
Oxide	Wad	$MnO_2 + MnO + H_2O$	[69.2	1,384]	Proportions and composition variable.
Carbonate	Rhodochrosite	$MnCO_3$	47.8	956	
Silicate	Rhodonite	$MnSiO_3$	41.9	839	
	Mercury (quicksilver).				
Sulphide	Metacinnabarite	HgS	86.2	1,724	
Selenide	Tiemannite	$HgSe$	71.7	1,434	
Sulpho-selenide	Onofrite	$Hg(S, Se)$	83.8	1,676	Calculated for the ratio $S:Se = 6:1$.
Sulphide	Cinnabar	HgS	86.2	1,724	Principal source.
	Molybdenum.				
Sulphide	Molybdenite	MoS_2	60.0	1,200	Nickel and cobalt are almost always associated.
	Nickel.				
Sulphide	Millerite	NiS	64.7	1,294	
Sulphide	Pentlandite	$(Fe, Ni)S$	22.0	440	
Arsenide	Niccolite	$NiAs$	43.9	878	
Sulphide	Linnaeite	$(Co, Ni)_3S_4$	28.9	578	Proportions variable. This amount calculated for ratio $Co:Ni = 1:1$.
Arsenide	Chloanthite	$NiAs_2$	28.1	562	Grades insensibly into smaltite, $CoAs_2$.
Sulpharsenide	Gersdorffite	$NiAsS$	35.4	708	
Sulphantimonide	Ullmannite	$NiSbS$	27.8	556	
Carbonate	Zaratite	$NiCO_3.2Ni(OH)_2+4H_2O$	46.8	936	
Silicate	Genthite	$2NiO.2MgO.3SiO_2.6H_2O$	22.6	452	*Röttisite*, found in Voigtland, may be essentially the same as this.
Silicate	Garnierite	$H_2(Ni,Mg)SiO_4+aq$	[35.5	710]	Proportions very variable. This amount calculated from highest analysis given by Dana.
Arsenate	Annabergite (nickel ocher)	$Ni_3As_2O_8+8H_2O$	29.4	588	The most important nickel ore is pyrrhotite, a sulphide of iron (mostly Fe_7S_8), which sometimes contains more than 5 per cent Ni.
	Palladium.				
Metallic	Native palladium	Pd	100.0	2,000	Always alloyed with Pt, Ir, and other metals.
	Platinum.				
Metallic	Native platinum	Pt	100.0	2,000	Occurs, however, only alloyed with from 10 to 30 per cent Fe, Ir, Os, and other metals.
	Quicksilver. (See *Mercury.*)				
	Silver.				
Metallic	Native silver	Ag	100.0	2,000	Usually alloyed with gold; sometimes with copper.
Antimonide	Dyscrasite	Ag_3Sb	72.9	1,458	Other proportions cause the content of silver to range from 63.9 per cent to 94.1 per cent.
		Ag_6Sb	84.3	1,686	
Sulphide	Argentite	Ag_2S	87.1	1,742	
Telluride	Hessite	Ag_2Te	63.3	1,266	Often contains gold.
Telluride	Petzite	$(Ag,Au)_2Te$	42.0	840	Calculated for ratio, $Ag:Au = 3:1$.
Sulphide	Stromeyerite	$(Ag,Cu)_2S$	53.1	1,062	
Telluride	Sylvanite	$(AuAg)Te_2$	13.4	268	Calculated for ratio, $Ag:Au = 1:1$.
Sulphantimonite	Pyrargyrite (dark red silver ore)	Ag_3SbS_3	59.9	1,198	
Sulpharsenite	Proustite (light red silver ore)	Ag_3AsS_3	65.4	1,308	
Sulphantimonite	Stephanite (brittle silver ore)	Ag_5SbS_4	68.5	1,370	
Sulpharsenite	Polybasite	Ag_6SbS_3	75.6	1,512	Copper always replaces some of the silver.
Chloride	Cerargyrite (horn silver)	$AgCl$	75.3	1,506	
Chlorobromide	Embolite	$Ag(Cl,Br)$	65.1	1,302	Proportions of Cl to Br vary and change the total of silver present.
Bromide	Bromyrite	$AgBr$	57.4	1,148	
Iodide	Iodyrite	AgI	46.0	920	
					Much silver is obtained from galena, and it also occurs in tetrahedrite, sphalerite, pyrite, chalcopyrite, chalcocite, and other minerals in quantities of economic importance.

Percentage of metal contained in ores of economic importance—Continued.

CHEMICAL NATURE.	Kind of ore.	Chemical composition.	Per cent of metal.	Pounds of metal per short ton.	Remarks.
	Radium.				
.....	Uranite (pitchblende)	U_3O_8	.....	.....	Radium, polonium, and actinium are extracted in minute quantities from these ores, especially pitchblende.
		$K_2O.U_2O.2U_2O_3.V_2O_5.3H_2O$ (?).			
	Thorium.				
.....	Monazite	$(Ce,La,Di)PO_4 + ThSiO_6$(?)	ThO_2, 6.49	130	Amount of thoria varies up to about 15 per cent; seems to occur as a silicate mechanically present in monazite.
	Tin.				
Sulphide	Stannite (tin pyrites)	$Cu_2S.FeS.SnS_2$	27.5	550	Proportions vary.
Oxide	Cassiterite (stream tin, wood tin)	SnO_2	78.6	1,572	Principal ore.
	Tungsten.				
Tungstate	Wolframite	$(Fe,Mn)WO_4$	60.6	1,212	Grades into hübnerite, $MnWO_4$, with 60.7 per cent tungsten.
Tungstate	Scheelite	$CaWO_4$	63.4	1,268	
	Uranium.				
Oxide	Uraninite (pitchblende)	U_3O_8	84.9	1,698	Chief ore; chief source also of radium, etc.
Oxide	Gummite	$U_2O_3.3H_2O$	72.7	1,454	
	Vanadium.				
Vanadate	Vanadinite	$3Pb_3V_2O_8 + PbCl_2$	10.9	218	
Vanadate	Mottramite	$(Pb,Cu)_3V_2O_8 + 2H_2(Pb,Cu)O_2$	10.5	210	
	Zinc.				Zinc minerals often are associated with lead ores.
Sulphide	Sphalerite (blende, black jack)	ZnS	67.0	1,340	
Sulphide	Wurtzite	ZnS	67.0	1,340	
Oxide	Zincite	ZnO	80.3	1,606	
Oxide	Franklinite	$(FeZnMn)O.(Fe,Mn)_2O_3$	{18.6	372}	Variable. Highest analysis recorded by Dana.
Carbonate	Smithsonite	$ZnCO_3$	52.0	1,040	
Carbonate	Hydrozincite	$ZnCO_3.2Zn(OH)_2$(?)	60.5	1,210	Composition is uncertain and analyses vary.
Silicate	Willemite	Zn_2SiO_4	58.6	1,172	
Silicate	Calamine	$H_2Zn_2SiO_5$	54.2	1,084	

CHAPTER II.

SUMMARY AND ANALYSIS OF RESULTS.

I.

GENERAL REVIEW OF THE MINING INDUSTRY.

The statistics for the mining industries relate to the operations at mines, quarries, and petroleum and natural-gas wells, and embrace all minerals that were produced in commercial quantities during the calendar year ending December 31, 1902. These statistics are summarized in the following table:

TABLE 1.—SUMMARY: 1902.

	Total.	Coal.	Copper.	Gold and silver.	Iron ore.	Lead and zinc ore.	Petroleum and natural gas.	Stone.[1]	All other minerals.
Number of mines	151,516	5,986	144	2,992	525	559	134,477	5,764	1,069
Number of operators	46,858	4,528	144	2,992	332	557	31,489	5,470	1,346
Salaried officials, clerks, etc.:									
Number	38,128	17,427	1,208	3,480	2,405	910	4,956	5,279	2,463
Salaries	$39,020,552	$17,419,217	$1,768,456	$5,076,773	$2,113,230	$826,327	$4,797,105	$4,488,339	$2,531,105
Wage-earners:									
Average number	581,728	350,329	26,007	36,142	38,851	7,881	22,230	71,156	29,132
Wages	$369,959,060	$220,198,401	$21,151,405	$36,077,492	$21,531,792	$4,329,271	$16,178,640	$37,515,907	$12,977,052
Contract work	$20,677,938	$1,650,535	$188,768	$626,090	$425,292	$108,607	$17,415,632	$36,981	$226,633
Miscellaneous expenses	$71,771,713	$26,081,698	$1,397,465	$5,357,529	$8,257,714	$2,092,001	$21,723,983	$3,976,865	$2,881,458
Cost of supplies and materials	$123,814,967	$37,539,702	$11,083,175	$16,699,768	$9,005,608	$2,511,657	$24,388,767	$10,739,736	$11,846,554
Value of products	$796,826,417	$367,032,069	$51,178,036	$82,482,052	$65,465,321	$14,600,177	$102,265,602	$70,462,438	$43,340,722

[1] Includes limestones and dolomites, marble, sandstones and quartzites, silica sand, siliceous crystalline rocks, and slate.

The differences in the extent to which the manufacturing processes have been included in the statistics of prior censuses interfere with the comparability of the results, but in the following table the quantities and values reported for the Eleventh and Twelfth censuses have been reduced as nearly as possible to a comparable basis, and therefore the totals for copper, gold and silver, and lead and zinc for 1902 do not agree with the figures shown elsewhere in this report. The inclusion of the refined products for gold, silver, and other metals in this table has increased the value of products to $892,505,619, an excess of $95,679,202 over the $796,826,417 reported as the value of the products of the mines, quarries, and petroleum and natural-gas wells.

TABLE 2.—COMPARATIVE STATEMENT, QUANTITIES AND VALUES OF MINERALS: 1902 AND 1889.

MINERAL.	Unit of measure.	1902		1889	
		Quantity.	Value.	Quantity.	Value.
Total			[1]$892,505,619		$444,012,998
Antimony	Short tons	(2)	(2)	265	28,000
Asbestos	Short tons	2,505	46,200	30	1,800
Asphaltum and bituminous rock	Short tons	66,238	296,728	51,735	171,537
Barytes	Short tons	61,668	203,154	21,460	106,313
Bauxite	Long tons	29,222	128,206	[3]21	97,335
Borax	Short tons	19,142	2,383,614	[4]4,000	[4]500,000
Buhrstones and millstones	Stones	6,667	59,808	(5)	35,155
Cement	Barrels	24,655,360	24,268,338	[4]7,000,000	[4]5,000,000
Clay	Short tons	1,455,357	2,061,072	[4]329,665	[4]635,578
Coal, anthracite	Long tons	36,940,710	76,173,586	40,714,721	65,879,514
Coal, bituminous	Short tons	260,216,844	290,858,483	95,629,026	94,346,809
Copper[6]	*Pounds*	*639,033,392*	*71,192,014*	*231,246,214*	*26,907,809*
Corundum and emery	Short tons	4,251	104,605	2,245	105,565
Crystalline quartz	Short tons	15,104	43,085	(5)	(5)
Feldspar	Short tons	45,287	250,424	[4]7,806	[4]39,370

[1] Exclusive of duplication of value of silver content of argentiferous iron ore, amounting to $883,987.
[2] No production from domestic ores.
[3] Aluminum, quantity reduced from 47,468 pounds.
[4] Not included as a part of the census; no statistics other than production reported.
[5] Not reported.
[6] Copper contents of all ores mined.

TABLE 2.—COMPARATIVE STATEMENT, QUANTITIES AND VALUES OF MINERALS: 1902 AND 1889—Continued.

MINERAL.	Unit of measure.	1902		1889	
		Quantity.	Value.	Quantity.	Value.
Flint	Short tons	36,365	144,209	[1] 12,447	[1] 49,137
Fluorspar	Short tons	48,818	275,682	9,500	45,835
Fuller's earth	Short tons	11,492	98,144	(2)	(2)
Garnet	Short tons	3,926	132,820	(2)	(2)
Gold, coining value[3]	Troy ounces	3,645,769	75,364,690	1,590,869	32,886,744
Graphite	Short tons	27,438	227,508	7,003	72,662
Grindstones and pulpstones	Short tons	56,657	667,431	(2)	439,587
Gypsum	Short tons	681,633	2,089,341	267,769	764,118
Infusorial earth, tripoli, and pumice	Short tons	6,415	55,994	3,466	23,372
Iron ore	Long tons	[4] 35,567,410	[4] 65,465,321	14,518,041	33,351,978
Lead[5]	Short tons	338,125	18,181,013	181,141	6,467,137
Limestones and dolomites			30,441,801		19,095,179
Lithium ore	Short tons	1,245	25,750	(2)	(2)
Lithographic stone	Short tons	(6)	(6)	18	243
Manganese ore	Long tons	16,477	177,911	24,197	240,559
Marble			5,044,182		3,488,170
Marl	Short tons	12,439	12,741	156,265	63,956
Mica:					
Sheet	Pounds	373,266	118,849	49,500	52,450
Scrap and waste	Short tons	1,400		196	
Mineral pigments, crude	Short tons	35,479	360,885	[7] 38,184	[7] 483,766
Monazite	Pounds	802,000	64,160	(2)	(2)
Natural gas			30,867,863		21,097,099
Oilstones, whetstones, and scythestones	Short tons	3,876	113,968	2,991	32,980
Ozocerite, refined	Pounds	(2)	(2)	50,000	2,500
Petroleum	Barrels	89,275,302	71,397,739	35,163,513	26,963,340
Phosphate rock	Long tons	1,548,720	4,922,943	550,245	2,937,776
Platinum and iridium	Troy ounces	[8] 94	[8] 1,814	500	2,000
Precious stones			328,450		188,807
Quicksilver:					
Crude	Short tons	11,727	1,550,090	2,750	(2)
Refined	Flasks	34,291		26,484	1,190,500
Sandstones and quartzites			10,601,171		12,066,076
Silica sand	Short tons	445,903	421,289	(2)	(2)
Siliceous crystalline rocks			18,257,944		14,464,095
Silver, coining value[9]	Troy ounces	[4] 55,911,946	[4] 71,077,562	51,354,851	66,396,988
Slate			5,696,051		3,482,513
Sulphur and pyrite	Short tons	232,819	917,089	106,100	209,969
Talc and soapstone	Short tons	97,563	1,138,167	36,461	475,878
Tungsten	Short tons	184	5,975	(2)	(2)
Uranium and vanadium	Short tons	3,810	48,125	(2)	(2)
Zinc ore[10]	Short tons	527,121	9,006,361	234,503	3,049,799
All other minerals[11]	Short tons	3,536	49,256	3,151	73,000

[1] Not included as a part of the census; no statistics other than production reported.
[2] Not reported.
[3] Fine gold contents of auriferous ores and placer bullion.
[4] Silver content of argentiferous iron ore—1,621,602 troy ounces valued at $883,987, included in both iron ore and silver.
[5] Nonargentiferous lead ore and lead contents of argentiferous and copper ores.
[6] No production.
[7] Includes slate ground as a pigment, 2,000 long tons, value $20,000.
[8] Platinum only; entire production obtained in placer mining and the refining of auriferous ores.
[9] Fine silver contents of argentiferous ores and placer bullion.
[10] Zinc ore and zinc contents of auriferous and argentiferous ores.
[11] Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile for 1902, and chrome ore, nickel and cobalt, and rutile for 1889.

The reports for each census, beginning with 1850, have included statistics for mines and quarries, but prior to the census of 1870 these statistics are so interwoven with those for manufactures that it is impossible to make a satisfactory segregation. At the censuses of 1870 and 1880 the canvass for the collection of mining statistics was so defective that the results can not be used for general comparisons to show the increase in all branches of mining. A complete canvass was made at the Eleventh Census, which covered the year 1889, but the results were not summarized nor were the data, except for the quantity and value of products, compiled on uniform lines.

The only information concerning the employees, wages, and other expenses for all branches of mining published at the Eleventh Census is contained in the following statement taken from the text of the report: "In all, 636,419 persons found employment directly in the mining industry, and depended upon this industry as their regular means of support. They received in wages $265,290,643, or more than 52 per cent of the entire value of what they produced. In addition, the other expenditures aggregated $115,874,135."[1] In 1902 there were 38,128 salaried officials, clerks, etc., with salaries amounting to $39,020,552. The average number of wage-earners employed during the entire year was 581,728, and they received in wages $369,959,960. The miscellaneous expenses and cost of supplies and materials amounted to $195,586,680, and the products were valued at $796,826,417. The products reported for 1889 amounted to $587,230,662,[1] but they include salt, pig iron, and other substances omitted from the mining census of 1902. Reducing the production to a comparative basis, as shown in Table 1, by including for 1902 the value of refined copper, the coining value of gold and silver, and the lead and zinc contents of argentiferous ores, and eliminating from 1889 the products not included in the

[1] Eleventh Census. Report on Mineral Industries, page xi.

mining census of 1902, the total for 1889 becomes $444,012,998, as compared with $892,505,619 for 1902, an increase of $448,492,621, or 101 per cent. The number of persons who found employment directly in the mining industries at the Eleventh Census was evidently reported on a different basis from that used at this census. The average number shown for 1889 was the average number employed during the time the mine was in operation, while the average number shown for 1902 is the average number for the whole year, whether the mine was in operation all the year round or a part of the time only. The value of products reported for the census of 1902 is the amount received by the mine operators, and should not be confused with the value of the finished mineral product or the refined metallic contents of the ore, such as iron, antimony, and nickel. The quantity and value of the refined metallic contents and the coining value of some ores, such as gold and silver, are given for 1902 in Table 1 in order to obtain comparable totals. The separate quantity and value of gold, silver, copper, lead, or zinc, when, as frequently happens, two or more of them are obtained from the same ore, can not be definitely determined until the ore has been smelted. Smelting is a manufacturing process, and is therefore omitted from the mining census, but the metallic contents of the ore and bullion produced in continental United States during the year 1902 and the gross value of the same, as computed from the reports to the Bureau of the Census, were as follows: Gold, 3,242,039 ounces, valued at $65,628,906; silver, 55,819,946 ounces, valued at $28,166,094; copper, 639,033,392 pounds, valued at $71,192,014; lead, 338,125 short tons, valued at $18,181,013; zinc, 527,121 short tons, valued at $9,006,361. These values are the values at the mines. Gold and silver were reported at the Eleventh Census in troy ounces and coining value. Computed on the same basis, the production of continental United States for 1902 amounted to 3,242,039 ounces of gold, valued at $67,018,890, and 55,819,946 ounces of silver, valued at $72,171,227. No canvass of the gold mines of Alaska having been made by the Bureau of the Census, the estimate for Alaska made by the Director of the Mint is accepted by this office. The total production of the United States for 1902 is accordingly estimated as follows: Gold, 3,645,769 ounces, valued at $75,364,690; silver, 55,911,946 ounces, valued at $72,290,176. The Director of the Mint reports the production of gold for the United States for the calendar year 1902 as 3,870,000 ounces, valued at $80,000,000, and the production of silver as 55,500,000 ounces, valued at $71,757,575. The disparity in these results is due to the fact that the Bureau of the Census collected the data directly from the mines, while the Director of the Mint obtained the information from mints, assay offices, private refineries, and other sources. The quantities and values reported by the Director of the Mint represented the refined product, a portion of which may have been mined during the preceding year; and, moreover, since a portion of the product reported by the Bureau of the Census as mined during 1902 would be included in the report of the Director of the Mint for the following year, the totals for the two offices for the same year can not agree.

The increase that has occurred in the production of the different minerals during the thirteen years covered by Table 2 is referred to in the discussion of the statistics for each mineral on pages 393 to 1071. Reference should be made to these separate reports for more detailed information.

As no statistics for employees, wages, or expenses incident to the production of cement, clay, feldspar, flint, rutile, borax, or slate ground as a pigment are given in the report of the Eleventh Census, it was necessary to take the production for these minerals for 1889, as shown in Table 2, from the tabulation of the mineral products of the United States, apparently prepared, in some respects, independently of the regular census work, but presented in the introduction to the report.

The Eleventh Census did not present statistics of any character for bauxite, crystalline quartz, fuller's earth, lithium ore, magnesite, molybdenum, monazite, tungsten, or uranium and vanadium, these minerals not then being produced in commercial quantities. Silica sand which is usually the product of sandstone quarries was included under the classification of sandstones, while garnet was included in abrasives.

Decreases in 1902.—A decrease is shown in the production of minerals in 10 classifications enumerated in Table 2. The quantities and values of these are reproduced in the following statement:

Minerals showing a decrease in production in 1902.

MINERAL.	1902		1889	
	Short tons.	Value.	Short tons.	Value.
Antimony			265	$28,000
Corundum and emery	4,251	$104,605	2,245	105,565
Lithographic stone			18	243
Manganese ore	[1] 16,477	177,911	[1] 24,197	240,559
Marl	12,439	12,741	156,205	63,956
Mineral pigments, crude	35,479	360,885	36,184	463,766
Ozocerite			25	2,500
All other minerals[2]	440	14,617	3,151	73,000

[1] Long tons.
[2] Includes chrome ore, nickel and cobalt, and rutile.

There was no production of antimony in 1902 from domestic antimony ores, the entire product being obtained from the smelting of domestic hard lead ores, or from imported regulus or metal, and antimony ores. Antimony has not yet been uncovered in any of the states in sufficient quantity for development. The known deposits of the mineral are associated with other metals that so predominate as to prohibit the exploitation of antimony as such.

While there was a slight decrease in the value of corundum and emery produced in 1902 as compared with 1889, a great increase occurred in the tonnage. The average price per ton of the product decreased during the period of thirteen years nearly one-half. The manufacture of an artificial abrasive as a substitute for corundum and emery has had its effect upon the value of the natural material.

There was no production of lithographic stone in the United States during 1902, no beds having been found that furnished stone of sufficient purity or adequate size. The substitution of plates of zinc and other metals, and the importation of lithographic stone, principally from Bavaria, satisfied the demand.

The deposits of manganese ore found in the United States are combined with siliceous and phosphorous substances to such an extent that the production can not compete with the foreign ore. Moreover, the deposits are located in isolated places, where transportation facilities are inadequate. These disadvantages have resulted in a decrease in the production of domestic manganese ore as compared with the production of 1889, although the product in 1902 was the largest since 1891.

The decrease in the production of marl is due to the greater substitution since 1889 of fertilizers made of phosphate rock and other materials. About two-thirds of the production of 1902 was obtained from New Jersey and was consumed locally.

The indicated decrease in the production and value of crude mineral pigments is more apparent than real. The statistics for 1902 are to a considerable extent for the crude product, while the production shown for 1889 included the value of large quantities of refined material or manufactured paint. As a matter of fact, the mining of mineral pigments is progressing steadily.

Ozocerite (native paraffin), or a mineral closely related to it, was reported some years ago to have been found in Utah, but according to the report it could not be produced continuously in commercial quantities because it could not compete with the ozocerite imported from Austria. This Utah ozocerite constituted the production reported in 1889. It is said now to be exhausted. "Immense quantities are extracted from the crude petroleum found in the Pennsylvania and Lima (Ohio) fields."[1] This, as paraffin wax, is included in the products of petroleum refining.

The group of "all other minerals" shown in the above statement, includes chrome ore, nickel and cobalt, and rutile, but as there were only two operators reported for nickel and cobalt and one each for chrome ore and rutile, the production of the different minerals can not be shown without disclosing the operations of individual operators. All of these minerals show a decrease when compared with the production of 1889. Many deposits of chrome ore can not be mined on account of the low price at which the foreign ore is imported. There are only a few nickel ore deposits in the United States, and these can not be worked to advantage at the prices prevailing for refined nickel, and in competition with the more profitably worked nickel ore deposits of Canada. Cobalt is closely associated with the nickel in the ores from which these metals are obtained. A small production of rutile satisfies the demand. The quantity has increased, but there has been a large falling off in the value of the total product mined.

Early development.—Mining was not an important feature of the early development of the United States, and until comparatively recent years information concerning the mineral products of the country was very meager. Agriculture was the predominating industry of the entire country at the opening of the nineteenth century; later, manufactures received greatest attention in the Northern and agriculture in the Southern and Western states. Numerous exploring expeditions were conducted during the early history of the country for the purpose of locating mineral deposits. Reference is made in the reports of these expeditions, to the mineral deposits in the region of the Great Lakes and the Mississippi valley. "During the eighteenth century a number of mining operations were undertaken and carried on in different parts of the country, apparently with but little success."[2]

The history of coal mining in the United States affords a good illustration of the general development of the mining industry. In 1820 the first cargo of anthracite coal was sent to Philadelphia. The annual consumption of all coal in 1847 has been estimated at 3,000,000 tons;[2] in 1902 the production of anthracite coal amounted to 41,373,595 short tons and the production of bituminous coal to 260,216,844 short tons, making the total production 301,590,439 short tons.

The smelting of iron ore appears to have been carried on to some extent in Massachusetts as early as 1702.[3] The production of iron ore in 1840 has been estimated at more than 300,000 tons, and the production of pig iron from the ore in Pennsylvania amounted to 98,395 tons.[4] The Lake Superior region was opened in 1844 and about 800 tons of blooms were shipped from the region in 1853.[5] In 1902 the production of iron ore in Pennsylvania amounted to 822,932 long tons and in the Lake Superior region to 26,977,404 long tons, the production of the two districts amounting to 27,800,336 long tons, or 78.2 per cent of the 35,567,410 long tons reported for the United States.

Early in the nineteenth century gold was mined to some extent in North Carolina, and for a number of

[1] United States Geological Survey, "Mineral Resources of the United States," 1902, page 596.

[2] The Metallic Wealth of the United States, by J. D. Whitney, page xxiii.

[3] Ibid., page 460.

[4] Ibid., pages 472 and 487.

[5] Ibid., page 478.

years following 1829 considerable quantities were produced throughout the Southern states. But few attempts at regular mining were made prior to 1834.[1] The discovery of gold deposits in California in 1848 gave an impetus not only to the search for precious metals, but also to mining enterprises of all kinds throughout the country.[2] The production of domestic gold in 1853 deposited at the United States Mint and its branches was valued at $55,622,051, $55,113,487 of which value was obtained from California.[3] The production for 1902, as reported by the Director of the Mint, was valued at $80,000,000.

Operations in the copper region of Lake Superior began as early as 1771, but particular attention was not directed to that field until 1844.[4] Its production of pure copper for 1854 has been estimated at 2,000 tons.[5] The production of the same region in 1902 was 171,102,065 pounds, or 26.8 per cent of the 639,033,392 pounds reported for the United States.

Mining in the Missouri lead field appears to have begun as early as 1720, but was not followed in a regular manner until 1798. By act of Congress of March 3, 1807, all the government lands containing lead were ordered to be withheld from sale, and leases were authorized instead. The issuing of leases began in 1822. After 1834 smelters and miners refused to make payments because of the great number of illegal entries of mineral land, and in 1847 Congress authorized the Land Office to sell the lands outright. In 1839 a geological survey of the lead region of the upper Mississippi valley was authorized by Congress. In 1840 the production of the upper Mississippi and Missouri regions was estimated at 14,780 tons.[6] In 1902 these regions produced 131,606 tons. The greater part of the lead product of the United States in 1902 was obtained from argentiferous ores. The history and occurrence of the various minerals in the different states are referred to in the discussion of the statistics for each state, on pages 163 to 346.

The importance of the mining industries is due not only to the magnitude of the aggregate production, but also to the great number of different minerals mined and the numerous uses to which they are applied. The development of these industries has occurred very largely since 1880, as many of the minerals enumerated in this report were not mined in commercial quantities before that year. Exclusive of coal, pig iron, copper, lead, petroleum and natural gas, stone, quicksilver, limestone for iron flux, zinc, and the precious metals, the mineral products of the country in 1880, as reported by the Geological Survey, were valued at only $37,567,133. The corresponding value for 1902 was $82,395,444—an increase of $44,828,311, or 119.3 per cent. The existing diversity of metals is largely the result of processes applied to the reduction of the minor metalliferous minerals; while the great absolute increase in quantity and value of mining products, in number of people employed and in yearly wages paid, is due mainly to the development of the major minerals, the great variety of uses to which the minor ores and the metals derived from them can be put has furnished a constant incentive to increase their production.

Table 8 presents statistics for 52 classifications of minerals. From these, however, there are obtained a large number of metals and other substances, each distinct in character, as the result of processes applied directly to the mineral or ore. There are also a multitude of other substances obtained by their use as bases for chemical combinations and manufacturing processes.

The organization of the United States Geological Survey in 1879 was the first step in the scientific investigation of the mineral deposits of the country as a whole. The general desire for information concerning the mineral resources of the country has been satisfied in part by systematic geological investigations in several of the states, beginning as early as 1823. At a still earlier period investigations were carried on by private enterprise, generally limited to minerals of well-known market value, such as iron, gold, silver, copper, and coal. The need for information concerning the location, character, and extent of the deposits of these minerals was fully appreciated by the organizers of the Geological Survey, and it is evident from the estimate submitted to Congress for the work of the office for the fiscal year ending June 30, 1881—the second year of the Survey's existence—that exhaustive preparations were made for the collection of information concerning all classes of minerals and the geological structure of the entire country.[7]

[1] The Metallic Wealth of the United States, by J. D. Whitney, pages xxiv and xxv.
[2] Ibid., pages xxvi and 135.
[3] Ibid., page 145.
[4] Ibid., pages 247, 249, and 305.
[5] Ibid., pages 247, 249, and 421.
[6] Ibid., pages 405, 417, and 421.

[7] *Estimates of appropriations required for the service of the fiscal year ending June 30, 1881.*

Geological survey of iron and coal resources of public domain	$30,000
Extending observations on coal and iron into old states	20,000
Survey of agricultural geology on public lands of Mississippi basin	25,000
Extending observations on agricultural geology into old states	10,000
Geological survey of gold and silver in division of Rocky mountains	35,000
Geological survey of gold and silver in division of Great basin	35,000
Geological survey of gold and silver in division of Pacific	35,000
Survey of geological structure and classification of public lands in Mississippi basin	25,000
Survey of geological structure and classification of public lands in Rocky mountains	30,000
Survey of geological structure and classification of public lands in Colorado basin	40,000
Survey of geological structure and classification of public lands in Great basin	30,000
Survey of geological structure and classification of public lands in [division of] Pacific	25,000
	340,000

[Executive Documents, Forty-sixth Congress, second session, 1879-80, Vol. 15, No. 5, page 174.]

Rank of the United States in mining.—The United States holds first place in the production of most of the minerals and it is preeminent in the production of five of the great minerals that are the basis of manufactures—i. e., coal, iron, copper, lead, and gold. In the production of silver it is outranked by Mexico only. The quantities of these minerals, as far as they can be ascertained, for the principal producing countries, are given in the following table:

TABLE 3.—*Production of coal, iron ore, copper, lead, gold, and silver in the principal producing countries: 1902.*

COUNTRY.	Coal (short tons).	Iron ore (long tons).	Copper, refined[1] (long tons).	Lead, smelted[2] (short tons).	Gold[3] (fine ounces).	Silver[3] (fine ounces).
United States	301,590,439	35,567,410	294,423	377,061	3,870,000	55,500,000
Africa	.....	.....	.....	.....	1,887,773	.....
Australia	.....	.....	18,284	99,207	3,416,002	8,026,037
Austria	[4]45,417,959	[5]3,395,270	.....	.....	.....	.....
Belgium	[4]24,485,842	.....	.....	.....	.....	.....
Bolivia	.....	.....	.....	.....	.....	12,992,641
Canada	.....	.....	17,486	.....	1,003,355	4,303,774
Chile	.....	.....	28,930	.....	.....	3,536,792
France	33,286,146	[4]4,715,021	.....	.....	.....	.....
Germany	165,826,496	[6]17,679,707	21,605	154,653	.....	5,722,641
Great Britain	254,346,447	[4]12,275,198	.....	29,872	.....	.....
Italy	.....	.....	.....	29,101	.....	.....
Japan	.....	.....	29,775	.....	.....	.....
Mexico	.....	.....	40,785	112,435	.....	[7]60,176,604
Peru	.....	.....	.....	.....	.....	4,264,528
Russia	[4]17,934,201	[4]5,905,179	.....	.....	1,090,053	.....
Spain	.....	[4]7,781,566	[8]49,790	189,816	.....	3,700,189
Sweden	.....	2,850,839	.....	.....	.....	.....

[1] Circular of Henry R. Morton & Co. (Limited), cited in report of the United States Geological Survey, "Mineral Resources of the United States," 1902, pages 198 and 199.
[2] "Comparative Statistics of Lead, Copper, etc.," compiled by the Metallgesellschaft and Metallurgische Gesellschaft, A.-G., Frankfort-on-the-Main, 1903, page 2, except for the United States, which is from the United States Geological Survey, "Mineral Resources of the United States," 1902.
[3] Treasury Annual Reports, 1903; "Production of the Precious Metals," 1902, page 351.
[4] Statistics for 1901, those for iron ore in Russia estimated.
[5] Includes Bosnia and Herzegovina.
[6] Includes Luxemburg, in Belgium.
[7] Estimated as being equal to the amount of silver coined and exported; coin exports omitted.
[8] Includes Portugal.

The position of the United States as the nation of first importance in the principal mining industries is so evident from an examination of Table 3 that further illustration is unnecessary. This position is due to the development of the vast mineral deposits in the United States, many of them practically unlimited; to improved mining methods and machinery; to the development and improvement of transportation facilities; and to the stimulus given the mining and quarrying industry by the increase of manufacturing and building in the country during the past twenty-five years. If a country be regarded as having natural resources of a given extent and character, it follows that an increase in the annual production of minerals in the country must result from one or both of two causes—increase in the number of productive laborers, and improvement of their productive power. Both of these causes have been operative in the United States in a very high degree as a result of the favoring industrial conditions that have obtained during the greater part of the last quarter of a century.

The use of the steam shovel in open-cut mining, the application of electricity and chemical methods and processes to all branches of mining, and of automatic machinery to the drilling and cutting of the rock and ore have been the principal improvements in the productive power of labor. The rates of wages which, as a rule, have prevailed in the mining industries have kept the supply of labor adequate to the demand, and, with a few notable exceptions, due to labor disturbances, strikes, or lockouts, there has been a constant increase in both the productive power and the quantity of labor.

Except in the case of the leading minerals enumerated in Table 3, there has been no systematic collection of statistics in all producing countries that would permit an authentic showing of the rank of each in the production of all classes of minerals. In the absence of such information, the estimates of Mr. Michael G. Mulhall are given as follows:

In point of value no country approaches the United States, but in weight of mineral Great Britain is ahead. It may be said, as regards weight, that Great Britain raises one-third, the United States one-third, and all other nations collectively one-third of the minerals of the world. The weight and value of minerals and the number of miners in 1894 were [value reduced to dollars at $4.80 the pound, Mulhall having fixed that rate in reducing the dollars to pounds]:

COUNTRY.	Million tons.	Million dollars.	Miners.	Dollars per miner.	Tons per miner.
Total	746	1,449	3,130,000	463	240
Great Britain	240	374	840,000	446	285
United States	230	451	580,000	778	[1] 400
Germany	115	163	400,000	408	287
France	38	77	180,000	427	210
Other countries	123	384	1,130,000	340	110

[1] The exact number of miners is not known. * * * The rates in 1880 were even higher, viz, 440 tons per miner.

The money value of product per miner is higher in Great Britain than among other European nations, but is greatly surpassed by the ratio in the United States, perhaps because in the latter country the difficulties of extraction are less.[1]

Mr. Mulhall states further that coal is the great lever of industrial progress and constitutes 70 per cent of the total mineral production of all nations; also that the production has grown thirtyfold since 1820,[2] the showing for the two years for the leading nations being as follows:

COUNTRY.	1820	1894
Total	17,200,000	531,000,000
Great Britain, tons	12,500,000	188,300,000
United States, tons	500,000	152,500,000
Germany, tons	1,500,000	99,000,000
Other countries, tons	2,700,000	91,200,000

The production of coal in the United States in 1902 was 301,590,439 short tons, exceeding that of Great Britain by 47,243,992 tons. In the production of iron

[1] Industries and Wealth of Nations, by Michael G. Mulhall, edition of 1896, pages 34 and 35.
[2] Ibid., page 35.

ore Mr. Mulhall gives the United States first rank in 1894, with a production of 17,000,000 tons, as compared with 12,400,000 tons for Great Britain and Germany, respectively, which shared the second place.[1] He gives the United States the third place in 1894 in the production of gold, and the second place in the production of silver, assigning the first place to Spanish America, with a production valued at £9,900,000, as compared with £6,100,000 for the United States.[2] The production of pig iron in the United States in 1901 was 15,878,354 gross tons, as compared with 7,928,647 gross tons in Great Britain and 7,736,663 gross tons in Germany, the production of the United States thus exceeding the combined production of the two countries by 213,044 gross tons. The statistics of 1902 for Great Britain and Germany are not available, and therefore no comparative figures for that year can be given. The production of silver in the United States in 1902 was valued at $71,757,600 (coining value), as compared with $108,343,000 for Spanish America.

Increase since 1880.—The following table shows the relative increase in population and in value of manufactures, agricultural products, and mineral products since 1880, as shown in the Tenth, Eleventh, and Twelfth censuses:

TABLE 4.—INCREASE IN POPULATION AND IN VALUE OF AGRICULTURAL PRODUCTS, MANUFACTURES, AND MINERAL PRODUCTS: 1880 TO 1900.[1]

YEAR.	Population.	Agricultural products.	Manufactures.	Mineral products.	PER CENT OF INCREASE.			
					Population.	Agriculture.	Manufactures.	Mineral products.
1900	76,149,386	$4,717,078,021	$13,014,287,498	[2]$796,819,729	20.9	91.7	38.9	[illegible]
1890	62,979,766	2,460,107,454	9,372,437,283	410,760,770	25.6	11.2	71.5	[illegible]
1880	50,155,783	2,212,540,927	5,369,579,191	251,967,055	.....	.....	.....	

[1] Exclusive of Hawaii.

[2] For the calendar year 1902.

While the comparison of the population and of manufactures and agriculture in Table 4 is limited to twenty years and of mining industries to twenty-three years, it covers a period that has been quite remarkable for the development of the mining industries. The value of the mineral products increased for the whole period 216.2 per cent, as compared with an increase of 51.8 per cent for population, 142.4 per cent for manufactures, and 113.2 per cent for agriculture. In 1880 for every dollar of mineral products there were $21 of manufactures and $9 of agricultural products. In 1900 the ratios were $16 and $6 for manufactures and agriculture, respectively, to $1 for mineral products. In 1880 the per capita values of the products of manufactures, agriculture, and mining were $107, $44, and $5, respectively. By 1900 these values had increased to $171, $62, and $10, respectively.

In the absence of annual census data, yearly totals, as compiled by the United States Geological Survey, are presented in Table 5, to show the annual growth of the various industries. These totals include value of product for salt, pig iron, bromine, refined gold and silver, zinc white, and other manufactured products not taken at the census of 1902, as well as mineral waters which are not the product of regular mining operations as defined by the Bureau of the Census.

[1] Industries and Wealth of Nations, by Michael G. Mulhall, edition of 1896, page 35.

[2] Ibid., page 36.

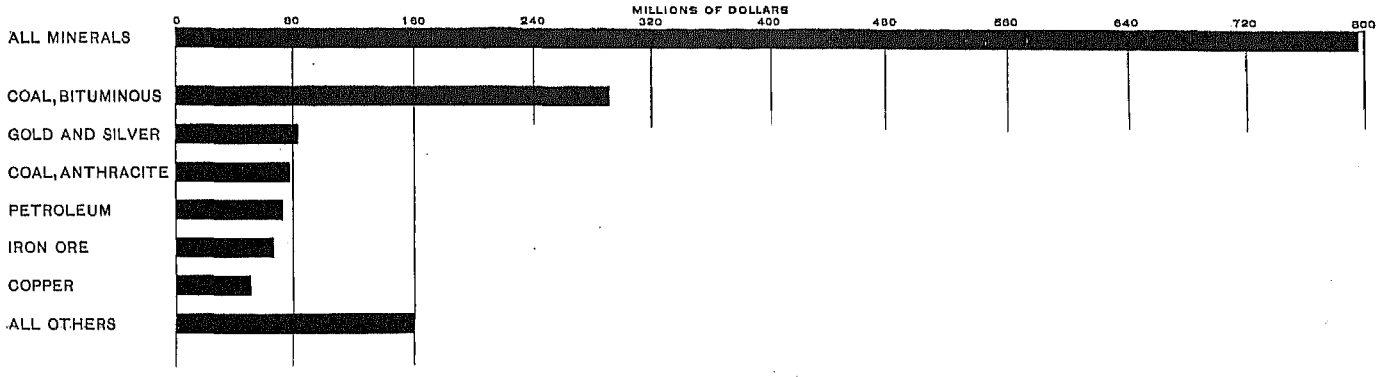
TABLE 5.—*Mineral products: 1892 to 1902.*

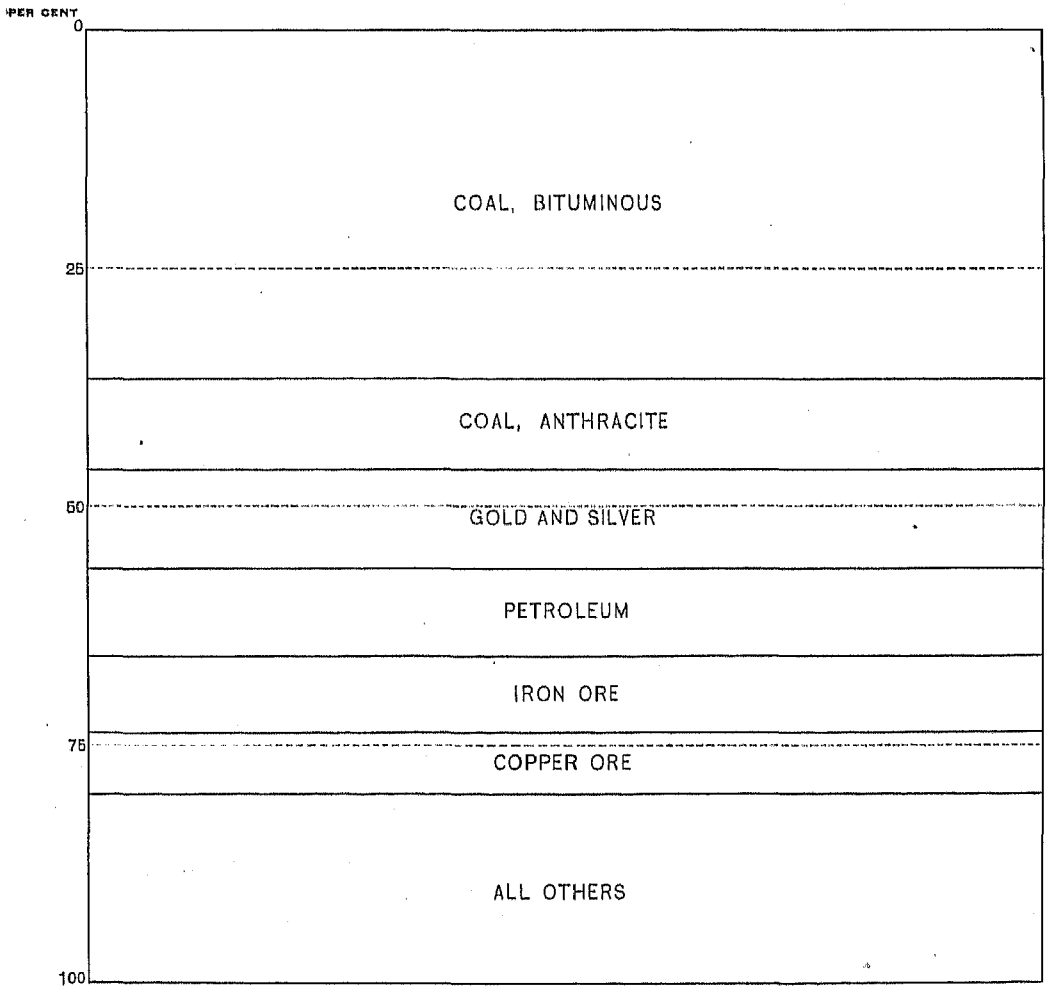
[United States Geological Survey, "Mineral Resources of the United States."]

YEAR.	Total.	Value of nonmetallic mineral products.	Value of metallic products.	Estimated value of mineral products in [illegible]
1902	$1,260,639,415	$617,380,831	$642,258,584	$[illegible]
1901	1,086,584,851	567,318,592	518,266,259	[illegible]
1900	1,063,678,053	512,252,767	550,425,286	[illegible]
1899	972,208,008	445,428,431	525,779,557	[illegible]
1898	698,596,788	353,848,520	343,748,268	[illegible]
1897	631,237,074	327,705,927	302,531,147	[illegible]
1896	622,814,265	333,954,110	287,860,155	[illegible]
1895	620,652,170	338,172,239	281,479,931	[illegible]
1894	527,079,279	307,714,785	218,382,494	[illegible]
1893	574,464,724	323,257,318	250,207,406	[illegible]
1892	648,895,031	339,958,842	307,936,189	[illegible]

With the exception of the two years from the close of 1892 to the close of 1894, there has been a yearly increase in the value of product. The average annual increase during the past eight years has been $91,695,01[illegible]. It will be noted that the production for 1902 exceeds by $463,812,998 the $796,826,417 reported by the census as the value of the products of mines, quarries, and petroleum and natural-gas wells. This excess is explained almost entirely by the difference between the value of the crude ore and the value of the metals smelted and refined from them, such as iron, gold and silver, copper, and lead and zinc. Thus, the ore classed as copper ore by the census method was valued at $51,178,036, while the value of the refined copper contents of all ores as reported by the Survey was $76,568,954. Again, the

DIAGRAM I.—VALUE OF PRODUCTS OF PRINCIPAL MINERALS AND PROPORTION EACH BEARS TO TOTAL: 1902.





value of the gold and silver as reported by the Bureau of the Census was $82,482,052 at the mine, these figures being exclusive of Alaska; but the coining value of the gold and silver reported by the Survey amounted to $151,757,575, and, in addition, platinum to the value of $1,814 was obtained. The Bureau of the Census reported iron ore valued at $65,465,321; the Survey placed in its totals for mineral products the value of the pig iron made in 1902, $372,775,000. The lead and zinc ores were valued by the Bureau of the Census at $14,600,177; the value of the refined metal was reported by the Survey at $36,765,596. These differences are explained in detail in the report for the several minerals.

Leading minerals.—While a great variety of minerals are included in the $796,826,417 reported as the value of the mining products at the Twelfth Census, the production of a few of the leading ones, such as coal, iron, copper, lead and zinc, petroleum and natural gas, and the precious metals, constitutes a large percentage of the total, and the great growth in the mining of these has been the principal cause of the increase in the number of people employed and in the value of products. The comparative importance of the principal minerals, as determined by the percentage that the totals for each form of the aggregates for the United States, is shown in the following table:

TABLE 6.—SUMMARY FOR LEADING MINERALS, AND PERCENTAGE EACH FORMED OF TOTAL: 1902.

	Number of mines, quarries, and wells.	Number of operators.	WAGE-EARNERS.		Supplies and materials, and miscellaneous expenses.	Value of product.
			Average number.	Wages.		
All minerals	151,516	46,858	581,728	$369,959,960	$195,586,680	$796,826,417
Coal, anthracite and bituminous	5,986	4,528	350,329	$220,198,401	$63,621,400	$367,[illegible]
Per cent of total	3.9	9.6	60.2	59.5	32.5	[illegible]
Copper ore	144	144	26,007	$21,151,405	$12,480,640	$51,178,[illegible]
Per cent of total	0.1	0.3	4.5	5.7	6.4	[illegible]
Gold and silver	2,992	2,992	36,142	$36,077,492	$22,057,297	$82,482,[illegible]
Per cent of total	2.0	6.4	6.2	9.8	11.3	[illegible]
Iron ore	525	332	38,851	$21,531,792	$17,263,322	$65,465,[illegible]
Per cent of total	0.3	0.7	6.7	5.8	8.8	[illegible]
Lead and zinc ore	559	557	7,881	$4,329,271	$4,603,658	$14,600,177
Per cent of total	0.4	1.2	1.4	1.2	2.4	[illegible]
Petroleum and natural gas	134,477	31,489	22,280	$16,178,640	$46,112,750	$102,[illegible]
Per cent of total	88.8	67.2	3.8	4.4	23.6	[illegible]
Stone[1]	5,764	5,470	71,156	$37,515,907	$14,716,601	$70,[illegible]
Per cent of total	3.8	11.7	12.2	10.1	7.5	[illegible]
All other minerals	1,069	1,346	29,182	$12,977,052	$14,731,012	$43,[illegible]
Per cent of total	0.7	2.9	5.0	3.5	7.5	[illegible]

[1] Includes limestones and dolomites, marble, sandstones and quartzites, siliceous crystalline rocks, slate, and silica sand.

The mining of the seven groups of leading minerals shown separately gave employment to 95 per cent of the wage-earners, and their production formed 94.6 per cent of the total production.

Less than one-tenth of the mine operators of the country were engaged in the production of ores, and their mines gave employment to less than one-fourth of the wage-earners, the value of their product being less than one-third of the total value of products.

To assist in a further analysis of the totals, and to show the concentration in certain lines of production, the statistics have been grouped according to the character of the minerals and of the metals obtained from the ore or the uses made of them. The classification of this character, made in the annual reports of the Geological Survey on the mineral resources of the United States, has, for the purpose of uniformity, been adopted by the Bureau of the Census.

A comparatively small proportion of the mineral products of the country can be classed as metalliferous, much the larger proportion consisting of coal, petroleum, natural gas, stone, borax, gypsum, phosphate rock, and other substances not of a metallic nature. In the following table the statistics are segregated so as to show the totals for metallic and nonmetallic substances:

TABLE 7.—*Summary for metallic and nonmetallic products: 1902.*

	Total.	Metallic.	Nonmetallic.
Number of mines	151,516	4,280	147,[illegible]
Number of operators	46,858	4,081	42,[illegible]
Salaried officials, clerks, etc.:			
Number	38,128	8,138	29,[illegible]
Salaries	$39,020,552	$9,948,335	$29,072,[illegible]
Wage-earners:			
Average number	581,728	110,404	471,[illegible]
Wages	$369,959,960	$84,046,224	$285,913,[illegible]
Contract work	$20,677,938	$1,371,921	$19,306,[illegible]
Miscellaneous expenses	$71,771,713	$17,168,821	$54,603,[illegible]
Cost of supplies and materials	$123,814,967	$39,639,703	$84,175,[illegible]
Value of product	$796,826,417	$215,453,587	$581,372,[illegible]

TABLE 8.—SUMMARY FOR MINERALS GROUPED ACCORDING TO CHARACTER OF ORES AND USES: 1902.

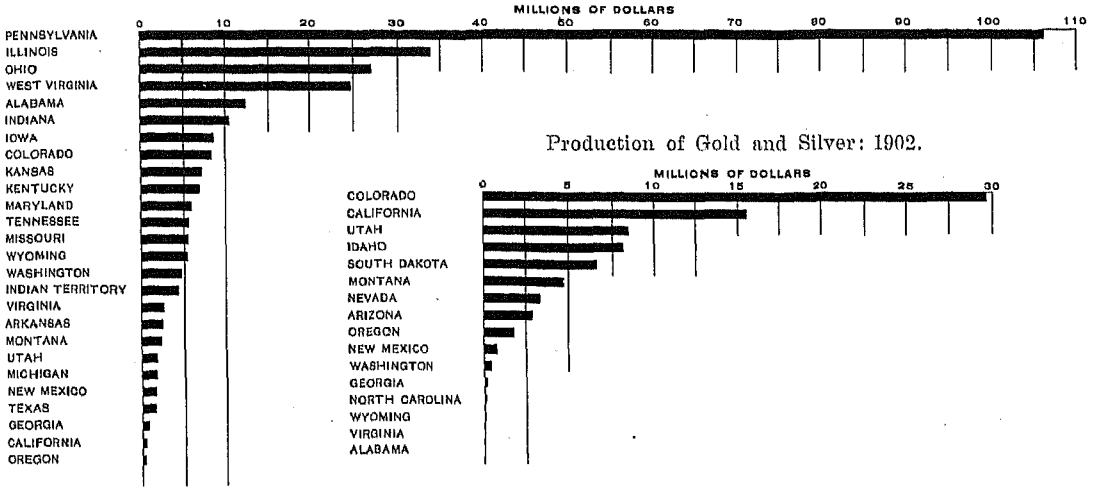
MINERALS BY GROUP.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Contract work.	Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.				
Total	151,516	46,858	38,128	$39,020,552	581,728	$360,950,960	$20,677,938	$71,771,713	$123,814,967	$796,826,417
Metallic	4,280	4,081	8,138	9,948,335	110,404	84,046,224	1,371,921	17,168,321	39,639,703	215,453,587
Copper ore	144	144	1,208	1,768,456	26,007	21,151,405	188,768	1,397,465	11,083,175	51,178,036
Gold and silver	2,992	2,992	3,480	5,076,773	36,142	36,077,492	626,090	5,357,529	16,699,768	82,482,052
Iron ore	526	332	2,405	2,113,230	38,851	21,531,792	425,292	8,257,714	9,005,608	65,465,321
Lead and zinc ore	559	557	910	826,327	7,881	4,329,271	108,607	2,092,001	2,511,657	14,600,177
Manganese ore	19	19	18	9,395	194	74,924	.....	3,845	17,228	177,911
Quicksilver	41	37	117	154,154	1,329	881,340	23,164	59,767	322,267	1,550,090
Fuels	140,463	36,017	22,383	22,216,322	372,559	236,377,041	19,066,167	47,805,681	61,928,469	469,297,671
Coal, anthracite	334	119	3,014	2,907,293	69,691	38,716,113	406,421	9,307,239	12,740,780	76,173,586
Coal, bituminous	5,652	4,409	14,413	14,511,924	280,638	181,482,288	1,244,114	16,774,459	24,798,922	290,858,483
Natural gas	15,806	1,967	1,923	1,810,337	4,678	2,936,279	4,459,001	5,912,257	6,607,255	30,867,863
Petroleum	118,671	29,522	3,033	2,986,768	17,552	13,242,361	12,956,631	15,811,726	17,781,512	71,397,739
Structural materials	6,044	5,746	6,342	5,699,130	86,295	44,654,537	60,749	5,750,482	20,072,399	96,370,559
Cement	101	93	913	1,087,514	13,041	6,328,852	10,627	1,605,520	9,098,226	24,268,338
Clay	205	203	185	150,505	2,433	958,892	13,241	126,873	272,823	2,061,072
Limestones and dolomites	3,246	3,137	2,231	1,843,747	31,547	14,750,638	34,381	1,449,081	5,403,912	30,441,801
Marble	83	75	352	341,021	4,070	2,212,640	.....	382,877	825,822	5,044,182
Sandstones and quartzites	1,304	1,211	847	713,579	10,448	6,153,060	500	878,780	1,298,190	10,601,171
Siliceous crystalline rocks	906	853	1,377	1,227,885	18,836	11,072,996	.....	810,206	2,493,065	18,257,944
Slate	199	174	437	334,879	5,920	3,177,459	.....	446,145	680,361	5,696,951
Abrasive materials	82	75	75	48,008	610	296,914	.....	42,410	80,309	1,177,711
Buhrstones and millstones	29	29	7	4,682	86	39,562	.....	1,480	1,809	59,808
Corundum and emery	5	5	9	5,900	47	32,871	.....	2,779	26,114	104,605
Crystalline quartz	6	5	8	6,030	29	13,592	.....	1,950	950	43,085
Garnet	7	7	12	9,178	118	59,632	.....	4,952	10,128	132,820
Grindstones and pulpstones	9	9	25	13,042	210	99,598	.....	24,433	31,349	667,431
Infusorial earth, tripoli, and pumice	11	10	8	4,016	35	13,682	.....	2,263	2,297	55,994
Oilstones, whetstones, and scythestones	15	10	6	5,100	85	37,977	.....	4,553	7,662	113,968
Chemical materials	228	174	750	750,953	8,835	3,313,088	161,695	741,570	1,603,348	10,618,669
Borax	6	6	14	18,128	153	114,865	.....	47,606	213,538	2,383,614
Fluorspar	22	18	42	27,311	269	110,002	300	23,602	31,374	275,682
Gypsum	62	45	249	300,420	1,472	759,258	406	200,769	341,760	2,089,341
Phosphate rock	115	87	391	355,204	5,971	1,930,093	157,402	430,475	799,414	4,922,943
Sulphur and pyrite	23	18	54	49,890	970	398,870	3,587	39,118	217,262	947,089
Pigments	84	77	91	68,752	592	236,372	1,000	60,448	65,845	564,039
Barytes	49	42	28	15,159	336	130,285	1,000	35,555	7,772	203,154
Mineral pigments, crude	35	35	63	53,593	256	106,087	.....	24,893	58,073	360,885
Miscellaneous	335	688	349	289,052	2,433	1,035,784	16,406	202,801	424,894	3,344,181
Asbestos	4	4	7	2,628	23	8,250	.....	1,758	8,233	46,200
Asphaltum and bituminous rock	24	24	52	48,233	156	79,570	10,000	19,753	21,028	236,728
Bauxite	38	7	42	33,230	150	59,763	500	14,939	40,019	128,206
Feldspar	27	26	27	20,095	252	107,444	.....	19,407	50,278	250,424
Flint	19	17	18	14,330	119	47,454	.....	14,291	18,642	144,209
Fuller's earth	4	4	14	10,000	114	33,775	4,021	2,057	28,966	98,144
Graphite	28	19	27	18,924	164	76,729	900	6,039	51,840	227,508
Lithium ore	3	3	1	600	6	3,744	.....	200	1,265	25,750
Marl	11	11	2	2,100	13	4,769	.....	1,407	2,755	12,741
Mica	49	38	21	13,444	98	41,043	.....	12,914	11,961	118,849
Monazite	23	22	3	2,100	88	25,318	.....	2,083	256	64,160
Precious stones	46	460	22	28,687	108	88,017	.....	7,481	17,781	328,450
Silica sand	26	20	35	27,228	335	149,114	100	18,776	38,386	421,289
Talc and soapstone	20	20	75	63,713	771	279,083	.....	80,186	125,932	1,188,167
Tungsten	4	4	.....	.....	2	1,260	.....	120	210	5,975
Uranium and vanadium	3	3	2	3,500	19	17,040	.....	490	3,010	48,125
All other minerals[1]	6	6	1	240	15	10,411	825	950	3,432	49,256

[1] Includes operators as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

As elsewhere explained, some of the substances included in the general groups by the Geological Survey are not covered by the census of mines and quarries. Further, the assignment of the different minerals to the respective groups should not always be accepted as an exact segregation. For instance, petroleum is assigned to the group of fuels, but a considerable proportion of the refined product is used for other purposes. In like manner, the group of "structural materials" includes all stone, although some sandstone is crushed and used in the pulverized form in the manufacture of glass, and a considerable amount of limestone is used for iron flux, for the manufacture of lime, and for roadmaking. There is, in fact, but slight connection between the totals for any of the groups other than their general relation to the industrial progress of the country. It is interesting, however, to note the proportion which each of these groups contributes to the general totals for all mines and quarries. These proportions are shown in Table 9.

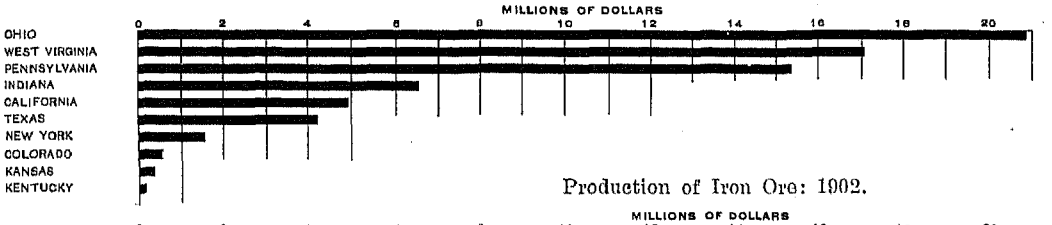
DIAGRAM II.—PRODUCTION OF PRINCIPAL MINERALS, BY STATES AND TERRITORIES: 1902.

Production of Bituminous Coal: 1902.

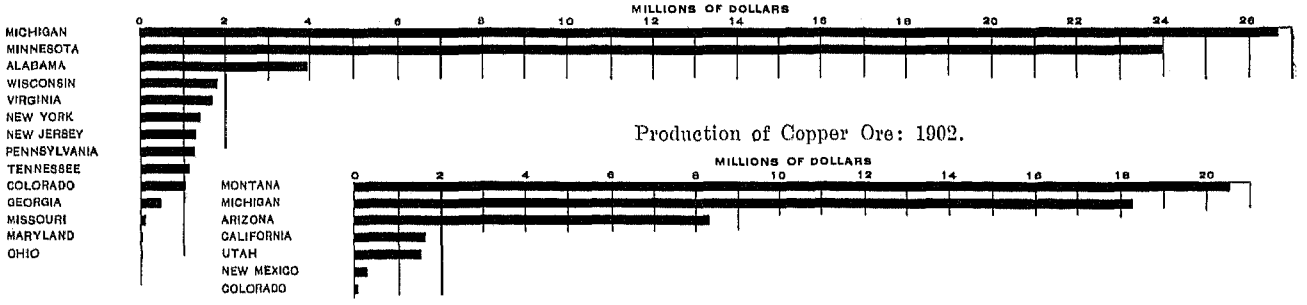


Production of Gold and Silver: 1902.

Production of Petroleum: 1902.

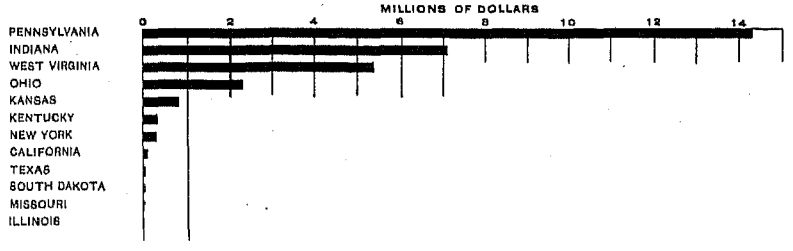


Production of Iron Ore: 1902.



Production of Copper Ore: 1902.

Production of Natural Gas: 1902.



Production of Cement: 1902.

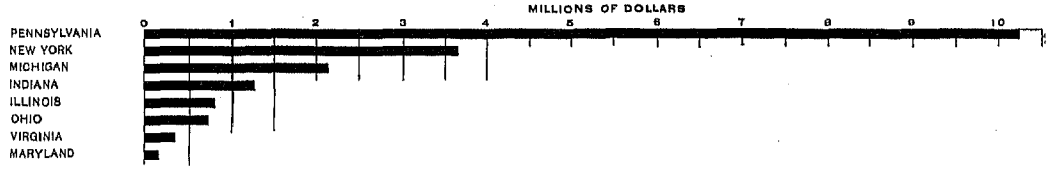


DIAGRAM II.—PRODUCTION OF PRINCIPAL MINERALS, BY STATES AND TERRITORIES: 1902—Continued.

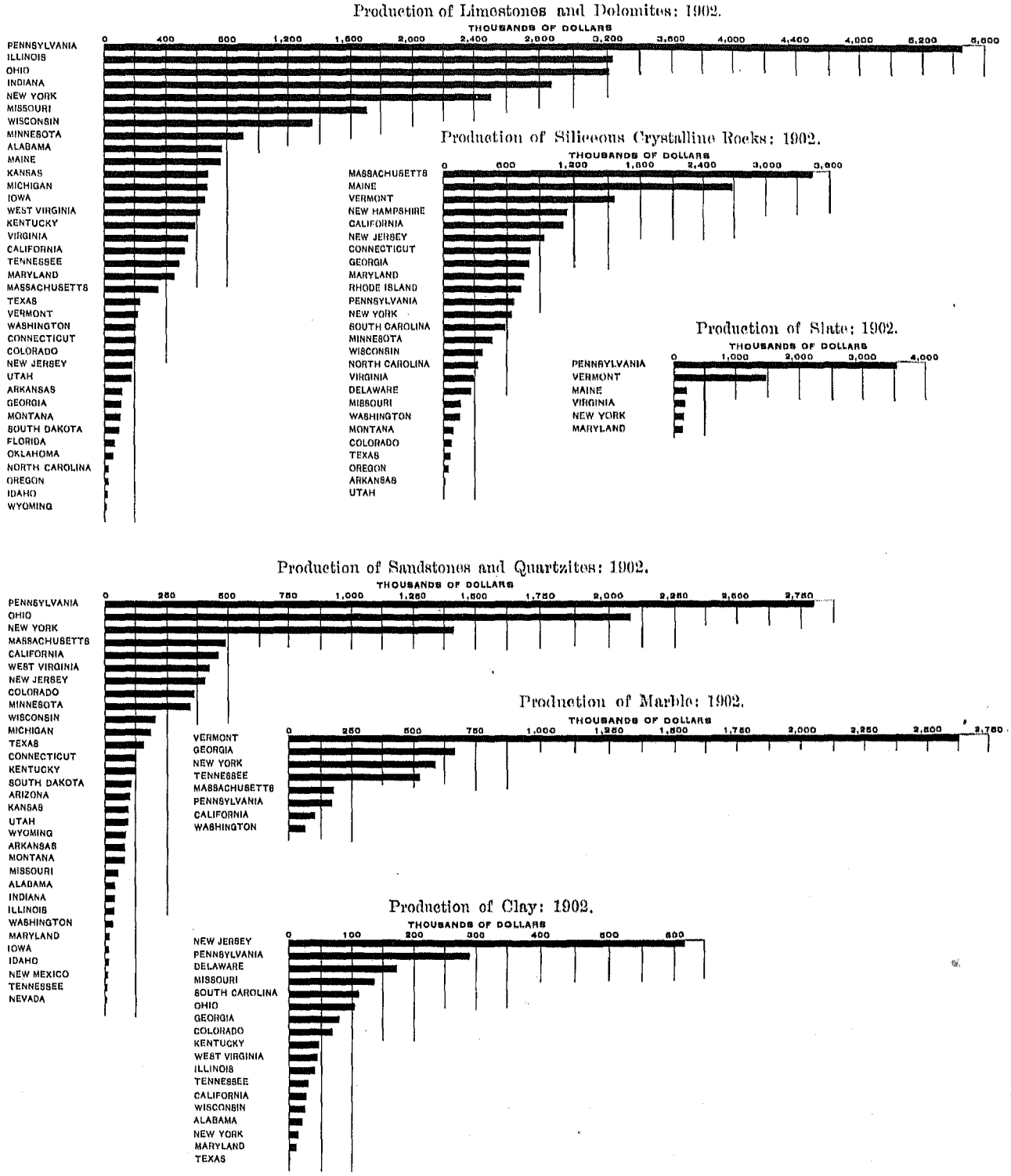


TABLE 9.—PERCENTAGE EACH GROUP OF MINERALS FORMS OF TOTAL: 1902.

GROUP.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Contract work.	Miscellaneous expenses.	Cost of supplies and materials.	Value of products.
			Number.	Salaries.	Average number.	Wages.				
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	[illegible]
Metallic	2.8	8.7	21.4	25.5	19.0	22.7	6.6	23.9	32.0	[illegible]
Fuels	92.7	76.9	58.7	56.9	64.1	63.9	92.2	66.6	50.0	[illegible]
Structural materials	4.0	12.3	16.6	14.6	14.8	12.0	0.3	8.0	16.2	[illegible]
Abrasive materials	0.1	0.1	0.2	0.1	0.1	0.1	.....	0.1	0.1	[illegible]
Chemical materials	0.1	0.4	2.0	1.9	1.5	0.9	0.8	1.0	1.3	[illegible]
Pigments	0.1	0.1	0.2	0.2	0.1	0.1	(1)	0.1	0.1	[illegible]
Miscellaneous	0.2	1.5	0.9	0.8	0.4	0.3	0.1	0.3	0.3	[illegible]

[1] Less than one-tenth of 1 per cent.

Fuels are by far the most important group of minerals. Their production gave employment to 64.1 per cent of the wage-earners, and the value of the products belonging to the group formed 58.9 per cent of the total value reported for all minerals. The production of coal alone gave employment to more than 100,000 wage-earners in excess of the number employed in the production of all other minerals combined; the wages paid by operators of coal mines exceeded those paid by all other operators by $70,436,842; and the value of the annual production of coal was within $62,762,279 of the value of all other minerals.

The metalliferous minerals rank next in importance. The value of the crude metallic products constituted 27 per cent of the total value of products, and their production gave employment to 19 per cent of the wage-earners. This group is composed of the various ores and metals enumerated under the term "metallic" in Table 9. Of these, iron ore is the most important from the standpoint of wage-earners, and gold and silver the most important measured by value of products. Of the 110,404 wage-earners reported for the group, 38,851, or 35.2 per cent, were employed in the production of iron ore, and they received $21,531,792, or 25.6 per cent of the total wages for the group. The value of the iron ore produced was reported at $65,465,321, or 30.4 per cent of the total for the group. The gold and silver was valued at the mine at $82,482,052, which is 38.3 per cent of the total for the group, exceeding the value of the iron ore by $17,016,731. But on the other hand the number of wage-earners engaged in the production of iron ore exceeded the number for precious metals by 2,709. The wages, however, for precious metals exceeded those paid for iron ore by $14,545,700.

Structural materials ranked third in importance. This group includes marble, granite, and other stones and embraces a great variety of products. The production of structural materials gave employment to 14.8 per cent of all wage-earners engaged in the mining industries, and the wages of these employees formed 12 per cent of the total wages. The value of structural materials quarried amounted to 12.1 per cent of the total value of the products of all mining operations.

While the other groups enumerated in Table 9—abrasive materials, chemical materials, pigments, and miscellaneous substances—are important from the standpoint of the variety of their products and the uses made of them, the wage-earners engaged in their production and the value of their products form a very small proportion of the totals for all minerals.

Mineral products by states.—The contribution of each mineral and group of minerals to the aggregate for the United States having been considered, it may be of interest to examine the contribution of each state to this aggregate, irrespective of the character of the minerals produced. Mineral production is necessarily concentrated in the states containing the most extensive and most favorably situated deposits. The deposits located conveniently for utilization of the products have been developed to the detriment of those in less favored sections. These conditions have stimulated the development of the mineral deposits in certain states, and it frequently occurs that practically the entire product of a state is represented by a single mineral. The totals for the different states are presented in Tables 10 and 11, and the proportions are graphically shown in the accompanying diagram. Table 10 shows the general totals for all minerals in each state and territory, while Table 11 presents the value of the mineral products in each state and territory in comparison with the population and the gross value of the products of agriculture and manufactures as reported at the Twelfth Census, and also the rank of the state and the per capita value for each class of products. In addition to the gross value of products this table shows the net value of the manufactured products; i. e., the gross value less the cost of materials purchased in a partially manufactured form.[1]

[1] For method of computing net product, see Twelfth Census Report on Manufactures, Part I, page cxxxix.

DIAGRAM III.—VALUE OF ALL MINERAL PRODUCTS, AND VALUE OF EACH GROUP: 1902.

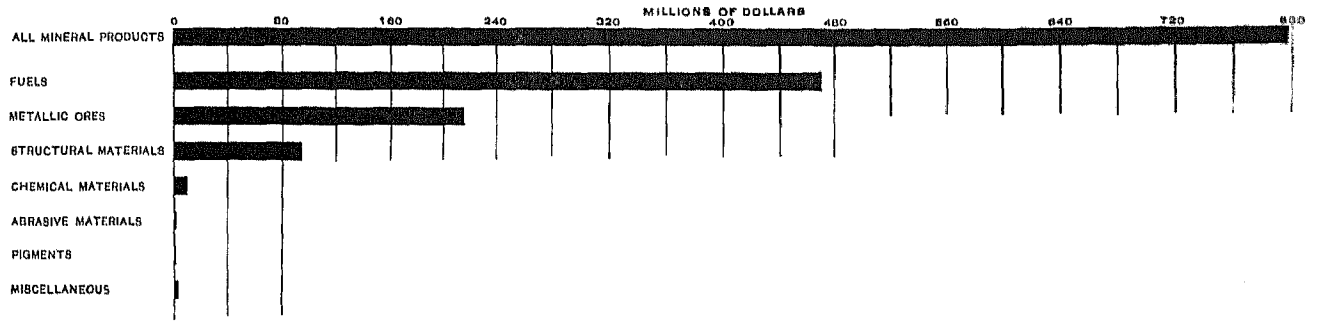


DIAGRAM IV.—PRODUCTION OF PRINCIPAL MINERALS: 1902.

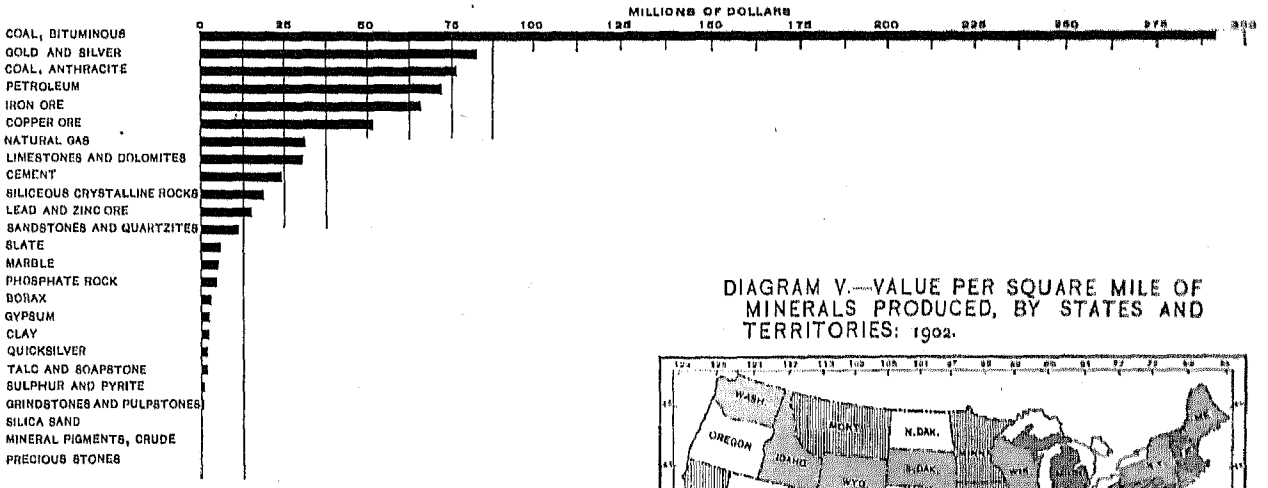


DIAGRAM V.—VALUE PER SQUARE MILE OF MINERALS PRODUCED, BY STATES AND TERRITORIES: 1902.

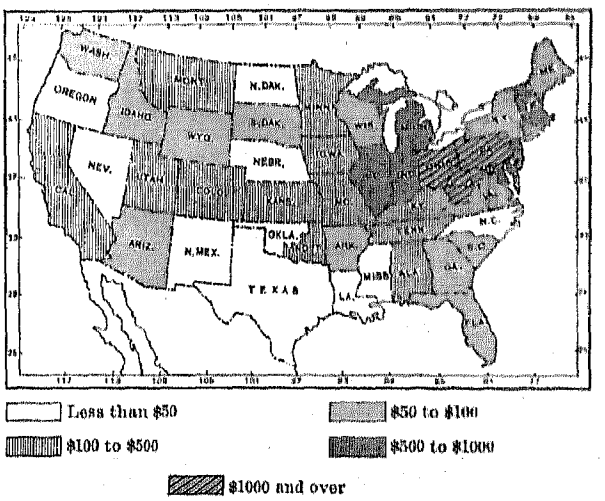


TABLE 10.—SUMMARY BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Contract work.	Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.				
United States	151,516	46,858	38,128	$39,020,552	581,728	$369,959,960	$20,677,938	$71,771,713	$123,814,907	$796,826,[illegible]
Alabama	260	172	947	979,117	19,132	10,345,148	267,279	858,851	2,043,914	17,367,[illegible]
Arizona	113	158	445	710,183	5,323	5,059,065	159,942	392,495	3,060,521	11,197,[illegible]
Arkansas	120	131	210	191,528	2,944	1,945,479	860	95,481	244,379	2,840,[illegible]
California[1]	4,037	1,552	1,432	1,887,860	12,964	11,050,666	520,894	1,783,790	5,673,755	28,870,[illegible]
Colorado	1,147	1,011	1,898	2,663,333	20,519	18,874,836	393,985	3,032,544	7,006,846	40,003,[illegible]
Connecticut	90	78	151	132,095	1,497	808,772	.....	59,918	236,075	1,425,[illegible]
Delaware	12	12	29	28,047	504	222,622	.....	39,278	45,361	418,[illegible]
Florida	71	46	218	228,868	3,146	1,082,030	4,021	304,142	618,057	2,943,[illegible]
Georgia	149	127	304	209,281	2,820	1,085,047	122,619	231,145	566,067	3,117,[illegible]
Idaho	292	290	354	576,690	3,563	3,903,504	43,442	636,409	1,626,153	8,214,[illegible]
Illinois	1,116	1,013	1,869	1,910,940	40,523	26,986,397	26,016	1,543,903	3,515,833	38,234,[illegible]
Indian Territory	79	39	260	253,171	4,814	3,183,322	78,639	366,332	329,063	4,321,[illegible]
Indiana	16,825	3,909	1,662	1,430,538	16,473	10,729,767	2,164,380	3,387,668	3,810,666	28,224,[illegible]
Iowa	625	589	610	500,126	10,437	6,791,161	48,106	373,252	961,996	9,676,[illegible]
Kansas	1,259	398	565	527,242	8,726	5,680,593	213,182	767,069	1,374,535	10,700,[illegible]
Kentucky	1,142	665	854	666,360	10,654	5,193,792	224,923	600,613	1,207,771	8,533,[illegible]
Louisiana	8	3	8	7,533	61	34,444	105,858	25,820	7,354	279,[illegible]
Maine	135	141	208	193,814	3,684	2,284,789	.....	121,556	476,964	3,656,[illegible]
Maryland	232	209	398	465,665	6,826	4,323,939	8,499	443,170	859,755	7,313,[illegible]
Massachusetts	251	234	360	309,978	4,242	2,525,405	1,853	273,791	762,335	4,671,[illegible]
Michigan	203	146	1,585	1,840,132	31,951	20,103,616	77,047	3,869,461	9,341,409	50,157,[illegible]
Minnesota	176	255	675	577,336	9,760	6,391,184	339,244	4,242,854	2,868,340	25,720,[illegible]
Missouri	1,045	973	1,438	1,233,811	15,351	8,757,367	172,514	2,118,436	2,859,018	20,284,[illegible]
Montana	281	271	571	912,477	10,539	11,812,150	64,636	893,258	5,007,102	28,265,[illegible]
Nebraska	36	35	12	8,001	178	95,9[illegible]5	.....	2,790	11,173	148,[illegible]
Nevada	114	121	146	222,098	1,132	1,205,565	7,944	177,355	623,457	3,518,[illegible]
New Hampshire	56	62	92	68,971	1,253	806,494	.....	26,993	134,128	1,176,[illegible]
New Jersey	162	151	420	357,000	5,645	2,658,727	10,770	303,669	2,235,964	6,600,[illegible]
New Mexico	161	207	175	209,569	2,275	1,646,833	48,381	140,055	497,949	2,686,[illegible]
New York	9,768	2,921	791	788,382	9,560	5,099,753	355,113	1,276,232	3,002,554	13,340,[illegible]
North Carolina	126	137	120	84,224	1,556	517,765	9,000	76,842	118,782	927,[illegible]
North Dakota	48	48	52	43,980	298	196,534	2,795	23,012	88,867	351,[illegible]
Ohio	44,934	11,338	2,530	2,551,083	37,173	23,222,680	2,701,557	7,711,026	10,126,452	57,186,[illegible]
Oklahoma	21	17	18	12,223	128	64,545	.....	15,830	31,934	186,[illegible]
Oregon	294	293	153	189,103	1,166	1,038,075	19,522	143,748	408,112	2,087,[illegible]
Pennsylvania	48,672	12,266	9,368	9,592,910	190,935	114,122,437	5,598,074	23,218,856	33,111,903	236,871,[illegible]
Rhode Island	22	22	56	56,150	667	435,224	.....	25,938	85,127	771,[illegible]
South Carolina	38	42	148	126,992	2,694	891,787	.....	109,890	342,379	1,834,[illegible]
South Dakota	77	77	167	242,461	3,131	3,374,776	8,349	264,452	1,992,575	6,769,[illegible]
Tennessee	241	203	773	664,379	10,890	4,864,241	174,496	720,483	850,485	9,553,[illegible]
Texas	1,067	308	1,210	664,802	3,853	2,261,639	1,387,796	923,769	1,051,457	6,981,[illegible]
Utah	177	169	410	583,305	5,688	5,072,822	37,054	758,507	1,829,158	12,340,[illegible]
Vermont	192	160	433	376,077	5,398	3,114,399	.....	382,734	1,076,148	5,904,[illegible]
Virginia	192	140	700	546,204	8,993	3,458,450	35,964	603,290	928,387	6,607,[illegible]
Washington	91	85	261	331,989	4,591	3,751,784	29,600	228,211	622,307	5,431,[illegible]
West Virginia	14,874	5,192	2,614	2,443,150	30,002	17,469,826	5,194,279	7,468,346	8,519,767	48,378,[illegible]
Wisconsin	411	392	275	232,758	3,583	1,987,565	3,758	427,847	804,142	4,427,[illegible]
Wyoming	74	50	153	188,616	4,486	3,432,059	15,547	280,602	818,496	5,084,[illegible]

[1] Includes 2 operators in Alaska and 1 in Hawaii.

TABLE 11.—RANK OF STATES AND TERRITORIES IN POPULATION, AGRICULTURE, MANUFACTURES, AND MINING.

STATE OR TERRITORY.	Population, 1900.	Rank.	Gross value of agricultural products, 1900.	Rank.	Gross value of manufactured products, 1900.	Rank.	Net value of manufactured products, 1900.	Rank.	Value of mining products, 1902.	Rank.	PER CAPITA (GROSS VALUE).		
											Agriculture.	Manufactures.	Mining.[1]
Alabama	1,828,697	18	$91,387,409	19	$80,741,449	30	$60,949,630	29	$17,367,992	12	$50	$44	$[illegible]
Arizona	122,931	48	6,997,097	47	21,315,189	41	19,294,742	41	11,197,375	15	57	173	[illegible]
Arkansas	1,311,564	25	79,649,490	22	45,197,731	38	28,810,655	37	2,840,341	36	61	34	[illegible]
California	1,482,179	21	131,690,606	14	302,874,761	12	175,425,385	13	28,844,669	7	89	204	19
Colorado	538,555	31	33,048,576	36	102,830,137	27	84,194,085	22	40,603,286	5	61	191	75
Connecticut	908,420	29	28,276,948	38	352,824,106	11	207,934,112	11	1,425,959	40	31	388	[illegible]
Delaware	184,735	46	9,290,777	46	45,387,630	37	29,378,529	36	448,467	44	50	246	[illegible]
District of Columbia	278,718	42	870,247	50	47,667,622	35	25,540,496	40	.....	.....	3	171	.....
Florida	528,542	32	18,309,104	41	36,810,243	40	27,831,890	38	2,943,806	35	35	70	[illegible]
Georgia	2,216,331	11	104,304,476	17	106,654,527	26	78,153,576	24	3,117,358	34	47	48	[illegible]
Idaho	159,147	47	18,051,625	42	4,020,532	48	2,906,144	49	8,214,671	20	113	25	[illegible]
Illinois	4,821,550	3	345,649,611	2	1,259,730,168	3	840,375,269	3	38,234,410	6	72	261	[illegible]
Indian Territory	392,960	38	27,672,002	39	3,892,181	49	3,067,274	47	4,321,380	31	.....	.....	10
Indiana	2,516,462	8	204,450,196	9	378,120,140	8	257,976,214	7	28,224,760	9	81	150	11
Iowa	2,231,468	10	365,411,528	1	164,617,877	17	120,479,720	16	9,676,424	17	164	74	[illegible]
Kansas	1,468,469	22	209,895,542	7	172,129,398	16	136,060,304	15	10,700,285	16	143	117	[illegible]
Kentucky	2,147,174	12	123,266,785	15	154,166,365	18	108,325,261	19	8,533,423	19	57	72	[illegible]
Louisiana	1,381,625	23	72,667,302	23	121,181,683	22	69,785,397	28	279,327	46	53	88	(2)
Maine	694,466	30	37,113,469	33	127,361,485	21	84,210,956	21	3,656,134	32	53	183	[illegible]
Maryland	1,188,044	26	43,823,419	29	242,552,990	14	139,056,198	14	7,313,712	21	37	204	[illegible]

[1] Based on estimates of population, Census Bulletin 7.

[2] Less than 50 cents.

TABLE 11.—RANK OF STATES AND TERRITORIES IN POPULATION, AGRICULTURE, MANUFACTURES, AND MINING—Continued.

STATE OR TERRITORY.	Population, 1900.	Rank.	Gross value of agricultural products, 1900.	Rank.	Gross value of manufactured products, 1900.	Rank.	Net value of manufactured products, 1900.	Rank.	Value of mining products, 1902.	Rank.	PER CAPITA (GROSS VALUE). Agriculture.	Manufactures.	Mining.[1]
Massachusetts	2,805,346	7	42,298,274	31	1,035,198,989	4	657,277,001	4	4,671,855	29	15	369	2
Michigan	2,420,982	9	146,547,681	13	356,944,082	10	214,559,224	10	50,157,358	3	61	147	20
Minnesota	1,741,986	19	161,217,304	11	262,665,881	13	190,314,135	12	25,729,545	10	93	151	14
Mississippi	1,551,270	20	102,492,283	18	40,431,396	39	27,813,332	39	.....	.....	66	26	.....
Missouri	3,106,665	5	219,296,970	6	385,492,784	7	256,671,811	8	20,281,656	11	71	124	6
Montana	231,559	44	28,616,957	37	57,075,824	34	50,159,514	31	28,265,085	8	124	247	106
Nebraska	1,066,300	27	162,696,386	10	143,990,102	19	115,278,644	18	148,391	48	153	135	(2)
Nevada	40,662	50	6,758,337	48	1,643,675	50	1,202,265	50	3,518,430	33	166	40	85
New Hampshire	411,588	35	21,929,988	40	118,709,308	24	77,330,702	26	1,176,312	41	53	288	3
New Jersey	1,883,669	16	43,657,529	30	614,748,933	6	355,646,950	6	6,605,402	25	23	325	3
New Mexico	195,310	45	10,155,215	45	5,605,795	46	4,122,500	46	2,686,473	37	52	29	13
New York	7,263,110	1	245,270,600	4	2,175,726,900	1	1,325,298,879	1	13,350,421	13	34	300	2
North Carolina	1,893,810	15	89,309,638	20	91,919,663	28	74,575,155	27	927,376	42	47	50	(2)
North Dakota	312,239	41	64,252,494	26	9,183,114	44	7,313,081	44	334,967	45	206	29	1
Ohio	4,157,545	4	257,065,826	3	832,438,113	5	523,249,207	5	57,186,922	2	62	200	13
Oklahoma	398,331	37	45,447,744	27	7,083,938	45	5,988,201	45	186,706	47	114	18	(2)
Oregon	409,764	36	38,090,969	32	46,900,587	36	30,383,667	35	2,087,389	38	93	112	5
Pennsylvania	6,302,034	2	207,895,600	8	1,834,700,860	2	1,104,871,630	2	236,871,417	1	33	291	36
Rhode Island	428,556	34	6,333,864	49	184,074,378	15	118,839,891	17	774,611	43	15	430	1
South Carolina	1,340,316	24	68,266,912	24	58,748,731	32	48,175,365	32	1,834,134	39	51	44	1
South Dakota	383,887	39	66,082,419	25	12,231,239	43	10,176,916	43	6,769,104	23	172	32	16
Tennessee	2,020,616	14	106,166,440	16	108,144,565	25	77,928,247	25	9,533,782	18	53	54	5
Texas	3,048,710	6	239,823,244	5	119,444,982	23	83,639,058	23	6,981,532	22	79	39	2
Utah	274,952	43	16,502,051	43	21,156,183	42	17,128,664	42	12,340,350	14	60	77	43
Vermont	343,641	40	33,570,892	35	57,623,815	33	40,760,300	34	5,904,705	26	98	168	14
Virginia	1,854,184	17	86,548,545	21	132,172,910	20	96,468,277	20	6,607,807	24	47	71	3
Washington	511,786	33	34,827,495	34	86,795,051	29	56,430,334	30	5,431,659	28	68	170	10
West Virginia	958,800	28	44,768,979	28	74,838,330	31	47,996,315	33	48,378,414	4	47	78	48
Wisconsin	2,062,916	13	157,445,713	12	360,818,942	9	245,668,466	9	4,427,813	30	76	175	2
Wyoming	90,570	49	11,907,415	44	4,301,240	47	2,974,166	48	5,684,286	27	131	47	58

[1] Based on estimates of population, Census Bulletin 7.

[2] Less than 50 cents.

While the mineral products of a state are dependent primarily on the extent and character of the deposits, their development is controlled by a number of factors, such as the proximity of the ore to the surface, nearness to markets, the extent and character of transportation facilities, the supply of labor and power, and the application of new and improved machinery and methods. The application of the steam shovel and other labor-saving devices in open cut iron mining, and of the cyanide process to the reduction of the precious metal bearing ores, are notable examples of the improvements in machinery and methods. Manufactures are largely dependent upon mineral products for fuel and raw material and their development must necessarily be preceded by a corresponding increase in mineral products. A similar, though not so intimate, interdependence exists between the products of agriculture and manufactures. The three industries are closely related, and, in the absence of far-reaching transportation facilities, there might be a certain harmony between the products of each in the different states, but the extensive, rapid, and easy means of transportation now available make it possible to utilize the minerals and agricultural products of one state in the manufactures of another, either adjoining or distant; there is, therefore, very little, if any, agreement in the relative rank of the different states in the three industries.

Accepting as comparable the statistics of population, agriculture, and manufactures for the Twelfth Census, which covered the fiscal year ending May 31, 1900, and the statistics for mineral industries, which covered the calendar year 1902, it appears that, as a rule, the value of the mineral products of the several states is far below the value of the products of agriculture and of manufactures, respectively. But in the states of Idaho, Nevada, and Wyoming and in Indian Territory the value of minerals exceeded the value of the products of manufactures; and they were in excess of the products of agriculture in the states of Colorado, Pennsylvania, and West Virginia and in Arizona and Indian Territory. Mineral products were reported for all of the states and territories with the exception of the District of Columbia and Mississippi. In many of the states, however, the value of the minerals reported was insignificant as compared with the value of the products of agriculture and manufactures. In several states—Delaware, Louisiana, Nebraska, North Carolina, North Dakota, and Rhode Island—and in the territory of Oklahoma they were less than $1,000,000, while the value of the products of agriculture and manufactures, respectively, in every state and territory exceeded $1,000,000, with the exception of the agricultural products reported for the District of Columbia. While there is not the same intimate relationship between population and mining that exists between population and agriculture and between population and manufactures, the per capita value of the mineral products has been included in Table 11 for the purpose of making a comparative showing.

Pennsylvania, which ranked second in population and manufactures, and eighth in agriculture, was the leading mining state in 1902, both in the number of

wage-earners employed and in the value of products. Its high rank was due to the production of anthracite and bituminous coal, the wage-earners reported for the coal mines forming 84.7 per cent of the 190,935 reported for all mines in the state, and the products of such mines forming 76.9 per cent of the total product of $236,871,417. The position of Pennsylvania as the leading mining state was most pronounced. Out of a total of 581,728 wage-earners engaged in mining in the United States, Pennsylvania reported 190,935, or 32.8 per cent, who received as wages $114,122,437, or 30.8 per cent of the $369,959,960 reported as the total. The value of the state's production was equally high, being $236,871,417, or 29.7 per cent of the $796,826,417 reported for the United States. Practically one-third of the whole mining industry of the United States, as measured by the persons employed and the value of products, was confined to this state. While it is true that the exploitation of its enormous coal deposits has been responsible for Pennsylvania's position as the leading mining state and that this industry has assumed overshadowing proportions, it is also true that the state has produced a large variety of minerals. Of the 52 classes of minerals reported 23 were found in Pennsylvania, the state being exceeded in this respect only by California, with 26 classes, and by Virginia, with 24.

New York, which stood first in population and in manufactures and fourth in agriculture, was thirteenth in mineral products. The state's mineral industry, employed 1.6 per cent of the wage-earners, paid them 1.4 per cent of the wages, and produced 1.7 per cent of the total value of products. The 5 leading mining industries of New York were cement, limestones and dolomites, petroleum, sandstones and quartzites, and iron ore, ranking in the order named. For each of these classes a production of over $1,000,000 was reported, and the 5 together showed a production of $10,462,663, or 78.4 per cent of the total for the state.

Ohio, which ranked fourth in population, third in agriculture, and fifth in manufactures, held the second position in value of mining products. The total value reported for the state was $57,186,922. Of this amount the product of coal mines formed $26,953,789, or 47.1 per cent. The state also held third place in the number of wage-earners, the coal mining giving employment to 25,963, or 69.8 per cent of the 37,173 reported for the state. Next to coal, petroleum is Ohio's chief mining industry, the two combined contributing over four-fifths of the state's mineral wealth.

Michigan, ninth in population, tenth in manufactures, and thirteenth in agriculture, ranked third in mineral products. With 40.8 per cent of the total value of the iron ore output of the United States credited to it, Michigan was the leading producer of this mineral, which was the chief product of its mines. This industry claimed 14,456 wage-earners, or 45.2 per cent of the 31,951 employed in all the mines of the state, yielded them in wages $9,132,763, or 45.4 per cent of the total of $20,103,616; and the product itself was valued at $26,695,860, or 53.2 per cent of the $50,157,358 representing the total value of the output. After iron ore, Michigan's most important mineral product was copper ore, its output being valued at $18,247,207, a figure that was exceeded by Montana only. It will be noted that these two ores together were credited with a total value of $44,943,067, or 89.6 per cent of the total value of the mineral output of the state.

West Virginia, twenty-eighth in population and agriculture, and thirty-first in manufactures, was fourth in mineral products. The coal mines of the state gave employment to 23,914, or 79.7 per cent of the wage-earners, and their products formed $24,748,658, or 51.2 per cent of the total value of mineral products reported for the state. In the production of coal, West Virginia ranked fourth, being outranked only by Pennsylvania, Illinois, and Ohio, and the high ranking of these states as mineral producers was due, either wholly or in great part, to this industry. After coal, West Virginia's leading minerals were petroleum, with an output valued at $17,040,317, and natural gas, valued at $5,390,181. These three industries together account for 97.5 per cent of the reported mineral values of the state. It is interesting to contrast this condition with that of Michigan, the one producing, to an almost exclusive extent, fuels, and the other an enormous preponderance of ores.

Colorado, thirty-first in population, thirty-sixth in agriculture, and twenty-seventh in manufactures, ranked fifth in mineral products. This high position was due almost exclusively to the precious metals of the state. The gold and silver produced in 1902 were valued at $29,655,974, forming 73 per cent of the total production of the state, and 36 per cent of the total value of these minerals in the United States, and thus exceeding California's production of gold and silver, valued at $15,473,091, by almost 91.7 per cent. This industry in Colorado gave employment to 11,200 wage-earners, or 54.6 per cent of the 20,519 engaged in mining in the state, and returned to them as wages $11,726,123, or 62.1 per cent of $18,874,836, the total amount paid in wages. Bituminous coal with a value of production amounting to $8,397,812 ranked second in Colorado's mining industries, and iron ore was third with a product valued at $1,084,424.

Illinois, third in population and in manufactures, and second in agriculture, was sixth in rank as a mining state. Here, also, bituminous coal was the leading mineral. Its production employed 36,617 wage-earners, or 90.4 per cent of the 40,523 wage-earners engaged in mining in the state, and paid them $24,876,201, or 92.2 per cent of the $26,986,397 paid in wages in the state; and the product itself was valued at $33,945,910, or 88.8 per cent of the $38,234,410 reported as the total

DIAGRAM VI.—VALUE OF MINERALS PRODUCED IN EACH STATE AND TERRITORY: 1902.

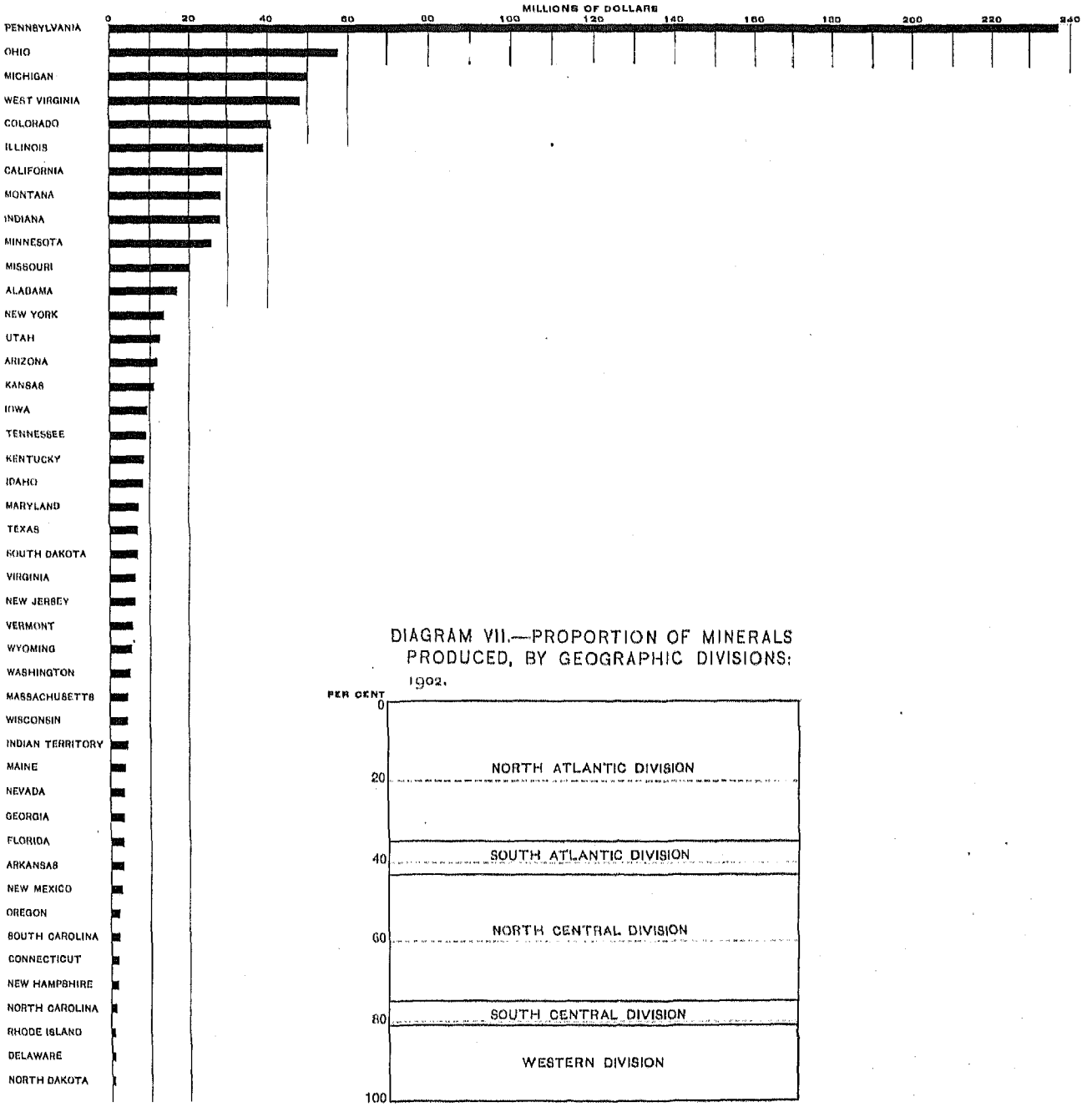


DIAGRAM VII.—PROPORTION OF MINERALS PRODUCED, BY GEOGRAPHIC DIVISIONS: 1902.

States with a production less than $300,000 not shown.

value of the state's mineral output. Limestones and dolomites, with a product valued at $3,232,123, constituted the industry second in importance.

California, twenty-first in population, fourteenth in agriculture, and twelfth in manufactures, ranked seventh in the value of mining products, but led the states in the variety of the minerals, reporting production in 26 of the 52 classes. It was unique also in the fact that at least two of its minerals, viz, chrome ore and magnesite, were mined nowhere else in the Union, and that in others, such as quicksilver and borax, its lead was so great that it may almost be said to have stood alone. The leading mineral products in California were gold and silver, valued at $15,473,091; petroleum, $4,873,617; borax, $2,370,994; copper ore, $1,599,663; quicksilver, $1,295,740; and siliceous crystalline rocks, $1,137,679. The state had 6 distinct mineral classifications, for each of which an output of over $1,000,000 was reported. Its leading mineral product, gold, although of less value than when it won for the state its title of "Golden," is still of greatest importance. In the mining of gold and silver there were employed 7,989 wage-earners, or 61.6 per cent of the state's 12,964 wage-earners engaged in mining; and these received as wages $7,101,003, or 64.3 per cent of the $11,050,666 paid as mining wages. Of the state's total output of all minerals, valued at $28,870,405, the precious metals contributed $15,473,091, or 53.6 per cent. California's production of gold and silver amounted to 18.8 per cent of the total value of the products of this industry in the United States, and was second only to that of Colorado. California produced 6.8 per cent of the country's value of petroleum; 99.5 per cent of borax; 3.1 per cent of copper ore; and 83.6 per cent of quicksilver.

Montana owes its rank as eighth among mining states almost entirely to its enormous production of copper ore, although the precious metals and bituminous coal, with outputs valued at $4,688,536 and $2,443,447, respectively, contributed about one-fourth of the value of the state's mineral products. The output of copper ore, valued at $20,563,353, or 40.2 per cent of the total for this industry, formed 72.8 per cent of the $28,265,085 reported as the total value of the state's mineral production, afforded employment to 6,388 wage-earners, or 60.6 per cent of the 10,539 mining wage-earners, and paid them $7,339,773, or 62.1 per cent of the total of $11,812,150 expended for wages. That Montana is preeminently a mining state is discernible at a glance when it is noted that in population, agriculture, and manufactures it ranked forty-third, thirty-seventh, and thirty-fourth, respectively.

Indiana, closely pressing Montana, ranked ninth in the products of mines and quarries, a position which is the result of the value of its fuel products, its leading mineral resources being bituminous coal, natural gas, and petroleum. Structural materials, as represented by limestones and dolomites and cement, also contributed much to the state's mineral wealth. The five classes of products just mentioned show a value amounting to $28,159,545, which is 99.8 per cent of the total for the state, $28,224,760. The total was distributed among the five as follows: Bituminous coal, $10,399,660, or 36.8 per cent; natural gas, $7,081,344, or 25.1 per cent; petroleum, $6,526,622, or 23.1 per cent; limestones and dolomites, $2,865,691, or 10.2 per cent; and cement, $1,286,228, or 4.6 per cent. Of the 16,473 wage-earners engaged in mining in Indiana, 10,593, or 64.3 per cent, were employed in extracting coal, receiving in wages $7,396,425, which is 68.9 per cent of the $10,729,767 paid in mining wages in the state. The state ranked ninth in agriculture, while in population and manufactures it was eighth.

Minnesota, nineteenth in population, eleventh in agriculture, and thirteenth in manufactures, was tenth in mining. The total value of its mining production was $25,729,545, of which $23,989,227, or 93.2 per cent, was credited to iron ore. There were but 6 of the different classes of minerals reported for the state, and none except iron ore had an output valued at more than $1,000,000. Of the 9,760 wage-earners employed in the state's mines, 8,256, or 84.6 per cent, were credited to the iron ore industry, receiving 84.1 per cent, or $5,376,933 of the $6,391,184 paid out as the total wages. In this industry Minnesota was exceeded by Michigan only, contributing 36.6 per cent of the total value as compared with Michigan's 40.8 per cent.

Mineral products by geographic divisions.—The mining statistics according to states and character and uses of minerals show the great preponderance of certain states and of a few ores in the forming of the totals for the country. The concentration of all, or any one, of the three productive industries—agriculture, manufactures, and mining—in any particular locality is indicative of the predominating industrial characteristics of that locality. The physical and industrial features of groups of neighboring states are in many cases so similar that a distinct advantage in clearness of presentation is realized by combining such states and treating the groups as geographic units. Such a geographic summarization brings together groups of neighboring states, each group embracing from 8 to 12 states and territories, in which the prevailing industrial conditions and the mineral and other natural resources are in many respects similar. This is especially true in the mining industries. The five geographic groups—North Atlantic, South Atlantic, North Central, South Central, and Western—are deemed sufficient to illustrate this similarity. Table 12 shows the value of the products of manufactures, agriculture, and mining for each of the geographic subdivisions and the rank of each in each industry, and also the population of each group, with its rank in population.

TABLE 12.—POPULATION, VALUE OF AGRICULTURAL PRODUCTS, MANUFACTURES (GROSS AND NET), AND MINERAL PRODUCTS, WITH RANK OF EACH, BY GEOGRAPHIC DIVISIONS.

DIVISION.	POPULATION, 1900.		AGRICULTURAL PRODUCTS, 1900.		MANUFACTURES, 1900.				MINERAL PRODUCTS, 1902.	
					Gross value.		Net value.			
	Number.	Rank.	Value.	Rank.	Amount.	Rank.	Amount.	Rank.	Value.	Rank.
Total	75,994,575	.....	$4,717,069,973	.....	$13,010,036,514	.....	$8,367,997,844	.....	[1]$796,800,681	.....
North Atlantic	21,046,695	2	666,347,164	3	6,498,058,774	1	3,972,170,421	1	274,436,816	1
South Atlantic	10,443,480	4	465,492,097	4	830,752,646	3	567,175,801	3	71,571,074	4
North Central	26,333,004	1	2,360,011,670	1	4,338,351,840	2	2,918,123,021	2	251,874,635	2
South Central	14,080,017	3	888,572,699	2	680,251,280	4	466,307,145	4	50,044,483	5
Western	4,091,349	5	336,646,343	5	653,618,974	5	444,221,456	5	148,873,673	3

[1] Exclusive of Alaskan coal and Hawaiian stone products.

The table enables the reader to grasp at a glance the leading industries of the different sections of the country. It should be borne in mind, however, that this treatment does not take into consideration the production of the fisheries, which in some sections assumes proportions of considerable magnitude.

The leading group in the mineral industries is the North Atlantic, with a value of products amounting to 34.4 per cent of the total. This group is followed, in order, by the North Central, with 31.6 per cent of the total; the Western, with 18.7 per cent; the South Atlantic, with 9 per cent; and the South Central, with 6.3 per cent.

The North Atlantic division owes its ranking position primarily to the enormous coal production of Pennsylvania. Illinois and Ohio, with their output of coal, and Minnesota and Michigan, with their iron and copper ores, explain the second rank held by the North Central division. The Western group ranks third chiefly because of Colorado's gold and silver and bituminous coal, and because of California's production of the precious metals, petroleum, borax, etc.

II.

DEVELOPMENT WORK.

For census purposes all mines, quarries, and petroleum and natural-gas wells were classed as either "productive" or "unproductive," the latter being regarded as engaged in development work. Development work is an incident in the operation of all mines and quarries, but there were 4,126 properties reported in which the work during 1902 was entirely of this class. The labor employed in this development work and the expenses incident to it form a part of the mining operations of the country, and should be included in the statistics; but, in order to preserve harmony among the items—number of employees, wages, expenses, and quantity and value of product—the productive and unproductive classes have been treated separately. In making this separation it was necessary to classify as "development work" all mines for which labor, but no product, was reported; and it is probable that some of them were not engaged in development work at all, but were idle, the employees being engaged simply in preserving and caring for the property. It is difficult to trace the line of demarcation between development work and other mining operations. A large proportion of the employees of a mining company may be engaged in sinking new shafts or making new tunnels to reach undeveloped deposits, and yet if even a small production is reported the mine is necessarily classed as a producing property; but, on the other hand, the sinking of new shafts may be only incidental to the working of new deposits from which valuable products are obtained. The employees engaged in surveying, drilling wells, clearing ground, building flumes, making shafts or tunnels, and, in fact, in doing any work except the actual digging and delivery of the ore, may, on a strict interpretation, be classed as doing development work. Undoubtedly a great deal of development and exploiting work was done during the year on properties that were idle and apparently abandoned at the time they were visited by the census agent. It was impracticable to obtain any information concerning the work on such mines, and therefore the statistics for development work can not be accepted as covering the entire field. A general summary of the statistics for the mines, quarries, and wells classed as "productive" and "unproductive" is given in Table 13.

TABLE 13.—PRODUCTIVE AND UNPRODUCTIVE MINES, QUARRIES, AND WELLS: 1902.

MINERAL.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.		
Total	155,642	50,508	40,812	$41,714,454	595,366	$382,761,895	$23,342,464	28,202	$73,094,030	$129,968,111
Productive	151,516	46,858	38,128	39,020,552	581,728	369,959,960	20,677,938	21,183	71,771,713	123,814,967
Unproductive	4,126	3,650	2,684	2,693,902	13,638	12,801,935	2,664,526	7,019	1,322,317	6,153,144
Coal, anthracite and bituminous:										
Total	6,017	4,550	17,476	17,462,659	350,754	220,469,766	1,684,302	6,906	26,104,318	37,710,122
Productive	5,986	4,528	17,427	17,419,217	350,329	220,198,401	1,650,535	6,771	26,081,698	37,539,702
Unproductive	31	22	49	43,442	425	271,365	33,767	135	22,620	170,420
Gold and silver:										
Total	6,244	6,244	5,764	7,412,243	47,905	47,658,176	2,168,861	6,629	6,374,885	21,774,845
Productive	2,992	2,992	3,480	5,076,773	36,142	36,077,492	626,090	980	5,357,529	16,699,768
Unproductive	3,252	3,252	2,284	2,335,470	11,763	11,580,684	1,542,771	5,649	1,017,356	5,075,077
Petroleum:										
Total	119,286	29,728	3,182	3,108,518	17,723	13,431,539	13,715,064	8,702	15,929,740	18,285,193
Productive	118,671	29,522	3,033	2,986,768	17,552	13,242,361	12,956,631	7,949	15,811,726	17,781,512
Unproductive	615	206	149	121,750	171	189,178	758,433	753	118,014	503,681
Iron ore:										
Total	562	365	2,433	2,133,945	39,118	21,688,394	641,460	1,365	8,326,247	9,149,149
Productive	525	332	2,405	2,113,230	38,851	21,531,792	425,292	1,079	8,257,714	9,005,608
Unproductive	37	33	28	20,715	267	156,602	216,168	286	68,533	143,541
Copper ore:										
Total	159	159	1,263	1,832,064	26,309	21,335,829	188,968	196	1,435,995	11,219,022
Productive	144	144	1,208	1,768,456	26,007	21,151,405	188,768	195	1,397,465	11,083,175
Unproductive	15	15	55	64,208	302	184,424	200	1	38,530	135,847
Natural gas:										
Total	15,900	2,068	1,938	1,817,782	4,715	2,960,383	4,563,231	3,441	5,922,166	6,680,452
Productive	15,806	1,967	1,923	1,810,337	4,678	2,936,279	4,459,001	3,268	5,912,257	6,607,255
Unproductive	94	41	15	7,445	37	24,104	104,230	173	9,909	73,197
Limestones and dolomites:										
Total	3,249	3,140	2,235	1,846,547	31,580	14,761,068	36,381	137	1,441,156	5,409,162
Productive	3,246	3,137	2,231	1,843,747	31,547	14,750,638	36,381	137	1,440,081	5,403,912
Unproductive	3	3	4	2,800	33	10,430	.....	.....	1,075	5,250
Cement:										
Total	104	96	951	1,137,117	13,381	6,543,469	10,627	34	1,699,421	9,101,190
Productive	101	93	913	1,087,514	13,041	6,328,852	10,627	34	1,665,520	9,098,226
Unproductive	3	3	38	49,603	340	214,617	.....	.....	33,901	2,964
Siliceous crystalline rocks:										
Total	910	857	1,381	1,231,485	18,919	11,117,636	.....	.....	810,656	2,494,565
Productive	906	853	1,377	1,227,885	18,836	11,072,996	.....	.....	810,206	2,493,065
Unproductive	4	4	4	3,600	83	44,640	.....	.....	450	1,500
Lead and zinc ore:										
Total	581	582	934	842,086	7,952	4,372,968	116,756	240	2,093,446	2,529,827
Productive	559	557	910	826,327	7,881	4,329,271	108,607	223	2,092,001	2,511,657
Unproductive	25	25	24	15,759	71	43,697	8,149	17	1,445	18,170
All other minerals:										
Total	2,627	2,779	3,255	2,889,408	37,010	18,422,667	216,814	552	2,956,000	5,614,584
Productive	2,580	2,733	3,221	2,860,298	36,864	18,340,473	216,006	547	2,945,516	5,591,087
Unproductive	47	46	34	29,110	146	82,194	808	5	10,484	23,497

The 4,126 mines and quarries classed as unproductive were controlled by 3,650 operators. There were, on the average, 13,638 wage-earners employed by these operators during the year, and the total annual wages amounted to $12,801,935. The development work done on contract during the year amounted to $2,664,526; and, in addition, $2,693,902 was paid as salaries, and $7,475,461 was spent for miscellaneous expenses, supplies, and materials, making a total of $25,635,824 expended in development work, for which there was absolutely no return in production. Of this total, $21,551,358, or 84.1 per cent, was reported for the precious metals, the amount being expended by 3,252 operators. The remainder, $4,084,466, or 15.9 per cent, was expended by 398 operators engaged in exploiting and development work for a variety of minerals. Table 14 presents the statistics for development work in each state and territory.

TABLE 14.—DEVELOPMENT WORK, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.						CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.
					Total.		Above ground.		Below ground.					
			Number.	Salaries.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Amount paid.	Number of employees.		
United States	4,126	3,650	2,684	$2,693,992	13,638	$12,801,935	4,364	$3,768,337	9,274	$9,033,598	$2,664,526	7,019	$1,322,317	$6,153,144
Alabama	5	5	10	9,010	45	15,244	36	11,332	9	3,912			889	1,048
Arizona	381	381	386	459,452	2,246	2,329,945	607	640,801	1,639	1,689,144	197,324	317	124,849	924,313
Arkansas	6	3	1	900	1	350	1	350			4,500	5		50
California	492	460	319	320,189	1,575	1,426,819	530	473,895	1,045	952,924	180,596	255	171,432	826,664
Colorado	965	964	456	437,788	2,337	2,340,058	494	531,594	1,843	1,808,464	582,948	911	213,816	1,030,605
Florida	3	3	5	4,700	15	4,732	15	4,732			2,724	4	725	13,033
Georgia	9	9	7	8,868	40	15,817	10	3,863	30	11,954	200	1	485	7,287
Idaho	325	325	180	164,560	852	897,412	227	216,635	625	680,777	158,262	254	98,217	405,658
Illinois	3	3			5	2,125	5	2,125					25	2,900
Indian Territory	13	7	14	21,055	80	50,515	40	26,472	40	24,043	10,300	21	18,407	66,984
Indiana	79	12	8	2,920	1	269	1	269			21,979	47	6,417	9,118
Iowa	4	3	2	510	2	1,183	1	400	1	783	600	4	251	1,100
Kansas	108	18	16	5,892	19	16,463	9	10,295	10	6,168	97,511	78	10,956	90,685
Kentucky	243	58	40	23,481	33	25,693	33	25,693			185,733	209	22,857	67,620
Louisiana	12	9	4	1,170	9	8,610	9	8,610			65,373	37	1,489	15,800
Michigan	17	17	60	69,967	353	222,215	222	132,643	131	89,572			103,887	201,656
Minnesota	19	15	6	2,236	117	73,700	112	70,295	5	3,405	245,868	284	2,316	66,310
Missouri	32	27	20	10,220	67	43,213	27	18,551	40	24,662	12,149	26	3,225	22,352
Montana	129	128	77	83,099	520	592,626	98	110,840	422	481,786	65,797	810	37,397	275,796
Nevada	82	82	142	181,172	574	656,169	122	155,869	452	500,300	27,133	590	70,435	454,077
New Jersey	3	3	35	39,713	336	210,819	330	208,119	6	2,700			25,418	
New Mexico	159	159	107	90,121	358	270,896	66	53,621	292	217,375	73,128	1,923	34,125	128,488
New York	7	6	11	16,569	96	50,403	89	47,179	7	3,224	500	4	6,131	2,164
North Carolina	29	29	42	33,005	344	102,431	132	38,743	212	63,688			11,147	54,332
Ohio	11	8	4	6,000	204	122,722	204	122,722			14,174	27		27,912
Oklahoma	17	3	1	100							3,750	14	250	500
Oregon	192	192	139	162,184	839	805,855	213	186,275	626	619,580	75,591	137	47,191	241,161
Pennsylvania	22	13	8	3,590	44	20,752	39	18,257	5	2,495	36,332	119	4,677	39,216
South Dakota	114	114	99	114,956	522	581,163	132	147,506	390	433,657			45,210	166,585
Tennessee	15	5			5	2,000	5	2,000			16,403	16	1,910	2,627
Texas	71	51	36	37,209	48	46,766	48	46,766			245,542	230	29,912	51,679
Utah	273	273	214	162,744	966	920,624	172	165,353	794	755,271	162,745	298	133,551	468,505
Virginia	5	5	8	4,535	51	17,964	19	7,168	32	10,796	158	1	9,752	26,305
Washington	151	151	122	112,337	520	557,313	129	127,857	391	429,456	75,684	198	40,110	236,953
West Virginia	23	13	14	7,731	51	26,645	41	20,980	10	5,665	45,315	76	6,303	73,437
Wisconsin	4	4	5	4,300	7	4,025	5	2,701	2	1,324			1,078	5,250
Wyoming	98	87	79	86,984	309	318,301	107	113,208	202	205,093	86,204	123	35,120	140,754
All other states[1]	5	5	7	4,635	47	20,098	34	14,718	13	5,380			2,927	4,820

[1] Includes operators distributed as follows: Connecticut, 1; Maryland, 2; New Hampshire, 1; South Carolina, 1.

III.

LIMITATIONS OF THE USE OF CENSUS STATISTICS OF MINING.

The uses that can properly be made of the census figures are discussed in the reports on the different minerals, and also in different sections of this summary and analysis. The limitations imposed are similar to those which appear in connection with the use of the statistics of manufactures discussed in detail in Part I of the report on manufactures of the Twelfth Census.

The statistics of mines, quarries, and petroleum and natural-gas wells can be accepted as indicating the growth and relative importance of the states, and of the different sections of the country in the production of the different minerals. When possible the figures have been presented in comparative tables which embrace data reported at previous censuses. The figures can be used to ascertain the quantity and the value of the different minerals produced, the average number of persons employed in their production, and the total amount paid in wages in the different states at different census periods. The general condition of the mining industries of the country and the extent to which the mineral deposits in the different states have been developed can likewise be determined. The limitations of the use of these statistics may be summarized as follows:

1. The figures show only the total production for a period of twelve months. They do not indicate the character or extent of the mineral deposits or the proportion of these deposits that remains to be mined, nor the possible or relative advantages to be derived from mining in different sections of the country.

2. The exact relation between cost of mining and value of products can not be determined from the statistics. The Census inquiry was designed to obtain a complete statement of the more important items which make up the cost of mining, but there still remain many items of expense of which it was impossible to obtain a record. For this and other reasons the Census figures throw no light whatever upon the profits of mining, or upon the relative shares of the product which go to capital and labor, respectively. The items of expense which are presented separately in the Census reports are summarized in the following statement:

Value of products		$796,826,417
Cost of supplies and materials	$123,814,967	
Salaries, wages, and contract work	429,658,450	
Miscellaneous expenses	71,771,713	
Total cost		625,245,130
Excess of value of products over total cost		171,581,287

Such a calculation would make it appear that the profit of mining was about $170,000,000, but such a conclusion is unwarranted and improper. The figures take no cognizance of the depreciation of the plant, of expenses incident to the sale of the product, or of interest on capital invested; they ignore the element of loss due to bad debts and the element of risk and speculation incident to marketing the products. The value of the product reported to the Census is the value at the mine or quarry. It was beyond the scope of this investigation to follow the product further. The Bureau of the Census made no inquiry concerning the capital, accounts current, or assets of the mine operators, and it was impossible to determine from the schedules received whether the business had been conducted at a profit or at a loss during the year covered by the report.

3. The average earnings of employees can not be determined from these statistics. The reasons why this is not possible are given on page 95, where the statistics for employees and wages are discussed.

4. The Census figures can not be used to determine the respective shares of capital and of labor in the results of mining operations. The amount of money reported as paid out during the year in the form of wages can be taken as the contribution which the mining operators returned to the wage-earning class from the results of operations carried on, but what relation this sum bears to the interest earned on the total capital invested or to the total profits of mining it is impossible to estimate. Such relations can be determined only by special investigations of typical mines in selected lines of production.

IV.

NUMBER OF MINES, QUARRIES, AND WELLS.

A consideration of primary importance in any census investigation is the selection and proper definition of a suitable unit of enumeration. Generally the unit chosen is one that is sanctioned by common experience, as the individual in the enumeration of the population, the farm in agriculture, the establishment in manufactures, and the mine in mines and mining.

As defined by the mining laws of the United States the word "mine" applies to a single mining claim or a single shaft or other opening, and the term has been used in this sense whenever such a claim was mined separately. In the case of many mining properties, however—particularly those that were at an advanced stage of development—it was found that the property had grown beyond the boundary of one claim and included contiguous claims that frequently were connected with the original claim by underground tunnels and workings, and were so closely associated with it in their operations that even the owner or lessee could not segregate the operations of the different claims. The Bureau of the Census has designated as a mine, any claim or group of contiguous claims operated as a single property. In certain cases, however—as in that of the larger coal companies operating in the anthracite region of Pennsylvania—it was found impracticable to secure separate reports for collieries in the same county, even when noncontiguous, and in such instances, the reports were frequently made on a single schedule. On the other hand, in case of a mine worked by several lessees, each of whom operated independently, separate reports were often made, but whenever possible a single report of the operations was secured from the lessor, or the reports of the several lessees were consolidated. The operation of mines by lessees is a condition frequently found in the mining of precious metals and in the zinc mining region of southwestern Missouri.

A single oil or gas well under individual management or a number of contiguous wells under the same management were considered, for census purposes, as a single mine, but each well was also enumerated and counted in the tables as a separate unit. In the production of some minerals, such as precious stones, placer gold from small placer deposits, and monazite, mining in many instances was not carried on continuously at the same locality, and it was impossible to ascertain the number of distinct mining operations. The term "operator" represents the individual, company, or corporation that controls the mine. The distinct mining operations under the control of the same operator and located in the same county were included in one report to the Bureau of the Census, or in separate reports, to suit the convenience of the operator, but if the distinct operations were situated in different counties a separate report was made for each county.

At the census of 1880 the term "establishment of industry" was used in compiling the statistics of the mining industry. In defining this term it was said that "the term 'establishment of industry,' as used in these tables, may be taken to mean a mining operation the accounts of which are separate, and the product of which is not mingled with that of any other before it is shipped, though at the same time it may consist of numerous distinct mine openings."[1] This definition is in general, consistent with that adopted in this report, but certain important exceptions have been noted.

In the fieldwork of the present investigation special agents were instructed as follows: "It is important that a separate return be made for each mine or quarry, and that the statistics of employees, wages, expenses, and supplies entered on the schedule pertain only to

[1] Tenth Census, Vol. XV, Report on Mining Industries, page xxiv.

the mine or quarry reported. This rule should be observed in all branches of mining and quarrying except petroleum and natural-gas wells, where all the wells located in a certain group or conducted under one ownership should be reported upon the same schedule. However, if more than one mine or quarry in the same county is owned by the same company or firm, and it is impracticable to make a separate report for each, a combined report may be made which will include the operations of all. Mines or quarries, under the same ownership in different counties, must be reported on separate schedules. If a schedule includes the operations of more than one mine or quarry, a memorandum, giving the name and post office address of each mine or quarry included, should be attached to the schedule." Sometimes it was impossible to state the number of mines reporting; this was the case with precious stones which, as a rule, are not obtained from regularly operated mines but through occasional findings or through systematic search. In such cases there is no mine, and the number of operators only is shown. It was also impracticable to ascertain the number of separate mines for gold and silver, and copper, and the number given is the number of operators. This practice was also followed in lead and zinc.

In order to comply with the requirements of the law the canvass covered all mines and quarries, both large and small, and therefore included not only the commercial mines but also those worked to supply a local demand, such as the limestone quarry operated by a farmer to secure material for his own consumption or to furnish lime for the use of the immediate neighborhood, and the small, irregularly worked, bituminous coal mines. This practice has resulted in the inclusion of the large, fully equipped mining plants and the small stone quarries worked at irregular intervals. The large and small mines are given equal weight in ascertaining the number of mines and the number of operators. It is evident, therefore, that the unit, "a mine," is ambiguous and does not always signify the same thing. A thorough enumeration of the small mines or quarries worked to supply a product for local consumption is not essential to a mining census. They are incidental to the canvass, and special effort should be made to enumerate them only when they are characteristic of a locality or mineral. For instance, the enumeration of the small lead miners of Missouri or of the small bituminous coal operators of Kentucky is important, but, as explained on page 18, it is impossible to enumerate all of the small placer gold miners and their omission makes no appreciable difference in the aggregates. This is especially true when the total production of the metal can be obtained from other and more reliable sources.

The increase in the number of mines reported at different censuses is not necessarily an indication of an increase in the mining industry as a whole. The small operators might be especially active during the year of the canvass, while a number of the large mines might be idle or working on part time. Under such conditions the reports would show a larger number of mines but fewer wage-earners, less wages, and a smaller product than would be the case if the conditions were reversed. This is illustrated by the statistics for coal mining. There were 12,552 coal mines reported at the Eleventh Census, with 294,415 wage-earners, and a product valued at $160,226,323. In 1902 the number of mines reported decreased to 5,986, while the number of wage-earners increased to 350,329 and the value of the product, to $367,032,069.

No figures at previous censuses are available for a satisfactory comparison of the number of mines for all minerals, but the following statement shows the number of producing mines reported for some of the most important minerals at the censuses of 1902 and 1889:

Number of producing mines for principal minerals: 1902 and 1889.

MINERAL.	NUMBER OF MINES AND WELLS.	
	1902	1889
Coal, anthracite	334	414
Gold and silver	2,902	3,729
Iron ore	525	592
Natural gas	15,806	2,217
Petroleum	118,671	35,163
Quicksilver	41	11

The number of mines was not shown at the Eleventh Census for many of the most important minerals, such as copper, lead, zinc, and manganese, and it is impossible to determine the number of independent properties engaged at that time in the production of these minerals. The above statement indicates that there were more mines engaged in the production of iron, anthracite coal, and the precious metals in 1889 than there were in 1902, and this is probably true for iron and coal. Notwithstanding this apparent decrease in the number of mines, there has been a large increase in the amount and value of the products for all the minerals enumerated. When, as is frequently the case, more than one variety of mineral is obtained from the same mine, it is impossible to give the number of mines producing each variety, and then present totals, without some duplication. This duplication was avoided at the present census by classifying the reports according to the mineral of chief value and counting each mine as a single unit, irrespective of the number of distinct minerals obtained from it.

The mines reported for each classification have been arranged in three groups: (1) Active mines reporting production; (2) active mines reporting no production, the work being confined to development, exploitation, or care of the property; (3) mines that were idle during the entire year. The number of these different classes of mines reported for each classification of minerals is shown in Table 15.

TABLE 15.—NUMBER OF ACTIVE AND IDLE MINES BY CLASSIFICATION OF MINERALS: 1902.

MINERAL.	Total.	Active mines with production.	Active mines without production.	Idle mines.
Total	163,580	151,516	4,126	7,938
Asbestos	19	4	.....	15
Asphaltum and bituminous rock	43	24	6	13
Barytes	55	49	.....	6
Bauxite	39	38	.....	1
Borax	13	6	1	6
Buhrstones and millstones	37	29	.....	8
Cement	152	101	3	48
Chrome ore	2	1	.....	1
Clay	268	205	2	61
Coal, anthracite	353	334	2	17
Coal, bituminous	6,090	5,652	29	409
Copper ore	222	144	15	63
Corundum and emery	13	5	1	7
Crystalline quartz	10	6	.....	4
Feldspar	36	27	.....	9
Flint	25	19	.....	6
Fluorspar	25	22	2	1
Fuller's earth	6	4	.....	2
Garnet	9	7	.....	2
Gold and silver	10,201	2,992	3,252	3,957
Graphite	43	28	3	12
Grindstones and pulpstones	13	9	.....	4
Gypsum	79	62	.....	17
Infusorial earth, tripoli, and pumice	18	11	.....	7
Iron ore	782	525	37	220
Lead and zinc ore	742	559	25	158
Limestones and dolomites	4,628	3,246	3	1,379
Lithium ore	4	3	.....	1
Lithographic stone	1	.....	1	.....
Magnesite	8	1	.....	7
Manganese ore	90	19	3	68
Marble	197	83	10	104
Marl	115	11	.....	104
Mica	85	49	.....	36
Mineral pigments, crude	48	35	.....	13
Molybdenum	1	1	.....	.....
Monazite	24	23	.....	1
Natural gas	15,951	15,806	94	51
Nickel and cobalt	2	2	.....	.....
Nitrate of soda	1	.....	.....	1
Oilstones, whetstones, and scythestones	17	15	.....	2
Petroleum	119,598	118,671	615	312
Phosphate rock	136	115	2	19
Precious stones	49	46	.....	3
Quicksilver	107	41	10	56
Rutile	1	1	.....	.....
Sandstones and quartzites	1,614	1,304	1	309
Silica sand	28	26	1	1
Siliceous crystalline rocks	1,230	906	4	320
Slate	269	199	3	67
Sulphur and pyrite	32	23	1	8
Talc and soapstone	33	20	.....	13
Tin	3	.....	.....	3
Tungsten	8	4	.....	4
Uranium and vanadium	5	3	.....	2

There was no attempt to make a complete enumeration of the idle mines and quarries, and the number reported includes only those that were enumerated incidentally in the canvass of the active properties. Many idle mines are virtually abandoned, and an enumeration of them would have no significance. In addition to the 163,580 active and idle mines, quarries, and wells, reports were received from 5,511 unpatented mining claims on which only assessment work was done during the year. Of the 151,516 productive mines, quarries, and wells, 118,671, or 78.3 per cent, were petroleum wells, and only 4,280, or 2.8 per cent, were engaged in the production of ores. The remaining 28,565, or 18.9 per cent, produced fuels; structural, abrasive, and chemical materials; pigments; and miscellaneous substances.

V.

NUMBER OF OPERATORS.

The 151,516 producing mines were controlled by 46,858 operators. The term "operator," as used in this report, stands for the individual, firm, incorporated company, or association that operates the mine or combination of mines. The "operator" is a more definite unit of measurement than the "mine." It represents a distinct interest and conveys an idea of the number of separate properties. It can be applied with some degree of certainty to the employees, wages, and value of products to determine the magnitude of the individual holdings, and such a comparison is made, for the principal minerals, in the following table:

TABLE 16.—AVERAGE NUMBER OF WAGE-EARNERS, WAGES, AND VALUE OF PRODUCTS PER OPERATOR, FOR THE PRINCIPAL MINERALS: 1902.

MINERAL.	Number of operators.	WAGE-EARNERS.		WAGES.		VALUE OF PRODUCTS.	
		Average number.	Average per operator.	Total.	Average per operator.	Total.	Average per operator.
Total	46,858	581,728	12	$369,959,960	$7,895	$796,826,417	$17,005
Coal, anthracite	119	69,691	586	38,716,113	325,345	76,173,586	640,114
Coal, bituminous	4,409	280,638	64	181,482,288	41,162	290,858,483	65,969
Copper ore	144	26,007	181	21,151,405	146,885	51,178,036	355,403
Gold and silver ore	2,992	36,142	12	36,077,492	12,058	82,482,052	27,568
Iron ore	332	38,851	117	21,531,792	64,855	65,465,321	197,185
Lead and zinc ore	557	7,881	14	4,329,271	7,772	14,600,177	26,212
Marble	75	4,070	54	2,212,640	29,502	5,044,182	67,256
Natural gas	1,967	4,678	2	2,936,279	1,493	30,867,863	15,693
Petroleum	29,522	17,552	1	13,242,361	449	71,397,739	2,418
All other minerals	6,741	96,218	14	48,280,319	7,162	108,758,978	16,134

Considering all classes of minerals, each operator gave employment on the average to 12 wage-earners and paid $7,895 in wages during the year, the annual product being valued at $17,005. The production of anthracite coal shows the largest results per operator and the production of petroleum the smallest per operator. While from a statistical standpoint both petroleum and natural gas are properly classed as minerals, the methods of production and distribution differ so radically from those of all other minerals that the statistics are not

comparable and should, as far as possible, be treated separately. Excluding petroleum and natural-gas wells, there were 17,039 mines and quarries, controlled by 15,369 operators. Each operator employed on the average 36 wage-earners, paid $23,019 in wages, and reported a product valued at $45,192. Next to anthracite coal, the largest establishment per operator is shown for copper ore. In this industry 181 wage-earners were employed on the average by each operator.

Large and small operators.—These averages per operator are a general indication of the magnitude of the individual establishments for the entire country, but the large number of small operators included in the total tends to reduce the size of the average establishment without an increase in the total production corresponding to the number of operators employed. For instance, the average operator in anthracite coal gave employment to 586 wage-earners, but returns have been received from one operator in this industry who gave employment to as many as 22,662 wage-earners on the average during the busiest month of the year and who paid more than $6,000,000 in wages for the year's operation, the product being valued at more than $10,700,000. A report was also received from the operator of a copper mine who gave employment to 4,700 wage-earners during the busiest month, paid more than $2,700,000 in wages, and had an annual product valued at more than $8,800,000, whereas the average number of wage-earners employed per operator for this mineral is only 181. In the production of iron ore a single operator reported the employment of 4,664 wage-earners for the busiest month and paid more than $2,600,000 in wages, the value of his annual product amounting to over $11,700,000.

The average operator in the production of precious metals gave employment to only 12 wage-earners during the year, but the operator most largely engaged in the production of these minerals gave employment to 2,029 wage-earners during the busiest month of the year, paid in annual wages over $2,203,851, and had a product valued at the mine at more than $4,300,000.

When petroleum and natural gas are left out of consideration, the largest operator was reported for bituminous coal. This establishment gave employment to 15,629 wage-earners on the average during the year, paid more than $8,800,000 in wages, and had a product amounting to over $13,000,000.

The following table groups the operators according to the values of their products, and thus indicates the proportions of the total product obtained by large and small operators. The reports for petroleum and natural-gas companies have been excluded from this table, and the value of the by-products, referred to on page 25, have been reassigned to the total for the mineral from which they were obtained. This arrangement enables the presentation of the total value of products for each operator.

TABLE 17.—NUMBER OF OPERATORS AND VALUE OF THEIR PRODUCTS, GROUPED BY MINERALS INTO CLASSES BASED ON VALUE OF PRODUCT: 1902.

[Values have been omitted wherever they disclosed the products of individual establishments. Statistics for natural gas and petroleum are not included in this table.]

MINERALS BY GROUPS.	TOTAL.		LESS THAN $500.		$500 BUT LESS THAN $1,000.		$1,000 BUT LESS THAN $10,000.		$10,000 BUT LESS THAN $50,000.	
	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.
Total	15,369	$694,560,815	4,044	$741,229	1,450	$1,031,235	5,111	$19,658,152	2,768	$66,566,573
Metallic	4,081	215,405,012	917	194,436	506	360,702	1,511	5,512,112	657	15,757,004
Copper ore	144	51,178,036	21	4,015	9	6,523	44	155,552	25	578,766
Gold and silver	2,992	82,482,052	775	164,199	421	299,076	1,158	4,062,016	382	8,929,366
Iron ore	332	65,416,746	40	8,792	21	15,152	76	383,525	88	2,283,576
Lead and zinc ore	557	14,600,177	71	15,640	51	37,370	216	840,037	147	3,646,065
Manganese ore	19	177,911	8	1,381	3	.....	5	26,180	2	31,375
Quicksilver	37	1,550,090	2	418	1	.....	12	44,802	13	287,856
Coal	4,528	367,084,464	798	151,329	347	247,680	1,417	5,478,708	901	23,382,403
Anthracite	119	76,173,586	.....	.....	.....	.....	3	15,828	23	669,863
Bituminous	4,409	290,910,878	798	151,329	347	247,680	1,414	5,462,880	878	22,712,540
Structural materials	5,746	97,057,224	1,827	330,735	517	369,080	1,956	7,742,558	1,067	23,957,508
Cement	93	24,137,396	.....	.....	1	.....	11	67,149	21	476,358
Clay	203	2,058,653	38	7,983	18	11,236	84	328,320	55	1,204,272
Limestones and dolomites	3,137	30,570,850	1,296	224,575	306	217,965	948	3,566,608	460	10,182,691
Marble	75	5,044,182	2	.....	1	.....	18	79,524	35	866,875
Sandstones and quartzites	1,211	11,141,551	385	.....	137	100,802	481	1,741,567	164	3,696,032
Siliceous crystalline rocks	853	18,408,541	98	23,046	49	34,483	366	1,720,381	253	5,625,115
Slate	174	5,696,051	8	1,187	5	3,279	48	239,009	79	1,906,165
Abrasive materials	75	583,085	11	2,829	10	6,751	40	146,615	11	244,661
Chemical materials	174	10,638,069	12	3,185	7	5,528	44	195,866	65	1,639,033
Pigments	77	564,039	11	2,125	12	9,001	38	121,559	14	312,498
Miscellaneous	688	3,228,322	468	56,590	51	32,484	105	460,734	53	1,273,466

TABLE 17.—NUMBER OF OPERATORS AND VALUE OF THEIR PRODUCTS, GROUPED BY MINERALS INTO CLASSES BASED ON VALUE OF PRODUCT: 1902—Continued.

MINERALS BY GROUPS.	$50,000 BUT LESS THAN $100,000.		$100,000 BUT LESS THAN $250,000.		$250,000 BUT LESS THAN $500,000.		$500,000 AND OVER.		UNCLASSIFIED.	
	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.
Total	835	$60,710,340	696	$111,663,263	238	$86,686,893	211	$343,819,735	[1] 16	[2] $3,683,395
Metallic	187	13,192,317	128	20,037,323	78	28,649,585	81	128,018,138	[1] 16	[2] 3,683,395
Copper ore	6	379,162	8	1,160,687	8	3,265,037	23	45,628,294		
Gold and silver	103	7,221,740	74	10,825,929	46	15,907,681	33	33,438,219		[2] 1,633,835
Iron ore	32	2,475,397	34	6,347,899	20	8,032,103	21	45,870,302		
Lead and zinc ore	41	2,753,888	8		3		4	3,081,323	[1] 16	[2] 2,049,560
Manganese ore			1							
Quicksilver	5	362,130	3	551,030	1					
Coal	400	29,500,143	428	68,351,844	124	44,421,995	113	195,550,353		
Anthracite	20	1,657,946	31	5,365,298	16	5,740,512	26	62,724,139		
Bituminous	380	27,842,197	397	62,986,546	108	38,681,483	87	132,826,214		
Structural materials	208	15,022,986	125	20,659,250	31	11,901,063	15	17,074,044		
Cement	12	904,039	25	4,110,269	11	3,620,127	12			
Clay	8	506,842								
Limestones and dolomites	83	6,032,942	33	5,964,745	9	3,174,982	2	1,206,342		
Marble	11	783,607	6	1,022,100	2	2,290,725				
Sandstones and quartzites	31	2,367,138	10	1,746,642	2	507,214	1			
Siliceous crystalline rocks	42	2,990,946	40	6,285,219	5	1,729,351				
Slate	21	1,437,472	11	1,530,275	2	578,664				
Abrasive materials	3	182,229								
Chemical materials	28	2,169,745	12	2,083,862	4	1,364,250	2	3,177,200		
Pigments	2	118,856								
Miscellaneous	7	524,064	3	530,984	1	350,000				

[1] Custom mills which treated "sludge."
[2] Includes for lead and zinc ore the production of 16 custom mills treating "sludge" and the production of numerous small mines reported by landowners, no operators being given; and for gold and silver the production from deep and placer mines reported without operators.

In order to avoid disclosing the affairs of individual operators, the value of products is omitted from a number of the groups shown in Table 17, and for the same reason the statistics are not shown for the separate classifications under "abrasive materials," "chemical materials," "pigments," and "miscellaneous."

The following table, based on Table 17, shows the proportion that the number of operators and the value of their products for the different classes of establishments are of the totals for the United States and for each group of minerals:

TABLE 18.—NUMBER OF OPERATORS, CLASSED BY VALUE OF PRODUCT, WITH PERCENTAGE EACH CLASS IS OF TOTAL: 1902.

[Statistics for natural gas and petroleum are not included in this table.]

VALUE OF PRODUCT.	GROUPS OF MINERALS.															
	Total.				Metallic.				Coal.				Structural materials.			
	Operators.		Value of product.		Operators.		Value of product.		Operators.		Value of product.		Operators.		Value of product.	
	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.
Total	15,369	100.0	$694,560,815	100.0	4,081	100.0	$215,405,012	100.0	4,528	100.0	$367,084,464	100.0	5,746	100.0	$97,057,224	100.0
Less than $500	4,044	26.3	741,229	0.1	917	22.5	194,436	0.1	798	17.6	151,329	(1)	1,827	31.8	330,735	0.3
$500 but less than $1,000	1,450	9.4	1,031,235	0.2	506	12.4	360,702	0.2	347	7.7	247,689	0.1	517	9.0	369,080	0.4
$1,000 but less than $10,000	5,111	33.3	19,658,152	2.8	1,511	37.0	5,512,112	2.6	1,417	31.3	5,478,708	1.5	1,956	34.0	7,742,558	8.0
$10,000 but less than $50,000	2,768	18.0	66,566,573	9.6	657	16.1	15,757,004	7.3	901	19.9	23,382,403	6.4	1,067	18.6	23,957,508	24.7
$50,000 but less than $100,000	835	5.4	60,710,340	8.7	187	4.6	13,192,317	6.1	400	8.8	29,500,143	8.0	208	3.6	15,022,986	15.5
$100,000 but less than $250,000	696	4.5	111,663,263	16.1	128	3.1	20,037,323	9.3	428	9.5	68,351,844	18.6	125	2.2	20,659,250	21.3
$250,000 but less than $500,000	238	1.6	86,686,893	12.5	78	1.9	28,649,585	13.3	124	2.7	44,421,995	12.1	31	0.5	11,901,063	12.2
$500,000 and over	211	1.4	343,819,735	49.5	81	2.0	128,018,138	59.4	113	2.5	195,550,353	53.3	15	0.3	17,074,044	17.6
Unclassified[2]	16	0.1	3,683,395	0.5	16	0.4	3,683,395	1.7								

[1] Less than one-tenth of 1 per cent.
[2] Includes the production of 16 custom mills treating "sludge;" the production of numerous small mines reported by landowners, no operators being given; and the production of gold and silver ore from small mines for which no operators were reported.

TABLE 18.—NUMBER OF OPERATORS, CLASSED BY VALUE OF PRODUCT, WITH PERCENTAGE EACH CLASS IS OF TOTAL: 1902—Continued.

VALUE OF PRODUCT.	GROUPS OF MINERALS.															
	Abrasive materials.				Chemical materials.				Pigments.				Miscellaneous.			
	Operators.		Value of product.		Operators.		Value of product.		Operators.		Value of product.		Operators.		Value of product.	
	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.
Total	75	100.0	$583,085	100.0	174	100.0	$10,638,669	100.0	77	100.0	$564,039	100.0	688	100.0	$3,228,322	100.0
Less than $500	11	14.7	2,829	0.5	12	6.9	3,185	(1)	11	14.3	2,125	0.4	468	68.0	56,590	1.8
$500 but less than $1,000	10	13.3	6,751	1.2	7	4.0	5,528	0.1	12	15.6	9,001	1.6	51	7.4	32,484	1.0
$1,000 but less than $10,000	40	53.3	146,615	25.1	44	25.3	195,860	1.8	38	49.3	121,559	21.5	105	15.3	460,734	14.3
$10,000 but less than $50,000	11	14.7	244,661	42.0	65	37.4	1,639,033	15.4	14	18.2	312,498	55.4	53	7.7	1,273,466	39.4
$50,000 but less than $100,000	3	4.0	182,229	31.2	28	16.1	2,169,745	20.4	2	2.6	118,856	21.1	7	1.0	524,064	16.2
$100,000 but less than $250,000	.....	.....	.....	.....	12	6.9	2,083,862	19.6	.....	.....	.....	.....	3	0.4	530,984	16.5
$250,000 but less than $500,000	.....	.....	.....	.....	4	2.3	1,364,250	12.8	.....	.....	.....	.....	1	0.2	350,000	10.8
$500,000 and over	.....	.....	.....	.....	2	1.1	3,177,200	29.9	.....	.....	.....	.....	.....	.....	.....	.....
Unclassified[2]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[1] Less than one-tenth of 1 per cent.
[2] Includes the production of 16 custom mills treating "sludge;" the production of numerous small mines reported by landowners, no operators being given; and the production of gold and silver ore from small mines for which no operators were reported.

The total for all minerals, exclusive of petroleum and natural gas, shows that 211 operators, or 1.4 per cent of the total number, reported products aggregating $343,819,735, or 49.5 per cent of the total for all mines. Each of these operators reported a product valued at $500,000 or over. On the other hand, 5,494 operators, or 35.7 per cent of the total number, reported a product valued at $1,772,464, or only three-tenths of 1 per cent of the total; each of these operators reported a product valued at less than $1,000. There were 4,764 operators who reported a product valued at $10,000 or more, the total amounting to $673,130,199. They constituted only 31 per cent of the total number of operators, but their products formed 96.9 per cent of the total value of products. In other words, less than one-third of the operators produced more than nine-tenths of the mining products of the country, exclusive of petroleum and natural gas. The concentration of production is more pronounced in some of the minerals than in others. For instance, of the total for metallic substances, 3.9 per cent of the operators produced 72.7 per cent of the product; in coal mining, 5.2 per cent of the operators produced 65.4 per cent of the product; in structural materials, 25.2 per cent of the operators produced 91.3 per cent of the product; in abrasive materials, 18.7 per cent of the operators produced 73.2 per cent of the product; and in the production of all other substances, 29.1 per cent of the operators produced 88.2 per cent of the product. The table shows for each group of minerals a marked decrease in the percentage of operators in the higher value groups, accompanied by a corresponding increase in the proportion which their products formed of the total for all producers.

It has been the practice at previous censuses to omit from the tabulation the reports for all establishments showing an annual product valued at less than $500. If this practice had been followed at the mining census of 1902, there would have been omitted from the total 5,345 operators, or 29.8 per cent of all operators, their product being valued at $916,244, or one-tenth of 1 per cent of the total value of all products. These figures are exclusive of the reported values of product for several small operators connected with the Standard Oil Company, whose products, which were less than $500 each in value, are included in the returns made by that company. The omission, therefore, of the small operators would have but slight effect upon the statistics of production and labor.

The conditions in the mining industry differ radically from those in manufactures. The omission of the establishments with a product of less than $500 is made in the statistics of manufactures so as to avoid the necessity of securing and tabulating returns for small shops in which no one is employed except the owner, who may also be engaged in doing odd jobs, and would thus be more properly classed as a mechanic than as an independent manufacturer. This explanation would not apply to the statistics for mines and quarries. Many mines are operated only a part of the year, and the limited production is due to the short time of operation rather than to the size of the mine or to the extent of the deposits.

As explained on page 20, 7 returns were received from the Standard Oil Company relating to the production of petroleum and 4 relating to the production of natural gas. These schedules covered the work of 28,925 oil operators and 19 gas operators. As only 1 combined report was made for a large number of the operators, it is impossible to segregate the production of the operators so as to assign them to the different groups according to their production. The statistics of natural gas and petroleum are presented in Tables 19 and 20, the Standard Oil Company being considered as a single producer of both natural gas and petroleum.

TABLE 19.—NUMBER OF OPERATORS, NATURAL GAS AND PETROLEUM, CLASSED BY VALUE OF PRODUCT: 1902.

MINERAL.	TOTAL.		LESS THAN $500.		$500 BUT LESS THAN $1,000.		$1,000 BUT LESS THAN $10,000.	
	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.
Total	[1] 2,517	$102,265,602	1,301	$174,985	218	$151,378	647	[illegible]
Natural gas	[2] 1,949	30,867,863	1,202	149,837	137	94,173	370	[illegible]
Petroleum	[3] 598	71,397,739	99	25,148	81	57,205	277	[illegible]

MINERAL.	$10,000 BUT LESS THAN $50,000.		$50,000 BUT LESS THAN $100,000.		$100,000 BUT LESS THAN $250,000.		$250,000 BUT LESS THAN $500,000.		$500,000 AND OVER.	
	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.
Total	257	$5,392,356	52	$3,642,553	41	$6,565,769	14	$4,597,932	17	[illegible]
Natural gas	162	3,415,085	27	1,815,176	28	4,406,721	10	3,385,729	13	[illegible]
Petroleum	95	1,977,271	25	1,827,377	13	2,159,048	4	1,212,203	4	[illegible]

[1] Exclusive of 28,942 operators whose operations are included in the reports of the Standard Oil Company, which has been classed as a single operator.
[2] Exclusive of 18 operators whose operations are included in the reports of the Standard Oil Company, which has been classed as a single operator.
[3] Exclusive of 28,924 operators whose operations are included in the reports of the Standard Oil Company, which has been classed as a single operator.

TABLE 20.—NATURAL GAS AND PETROLEUM, CLASSED BY VALUE OF PRODUCT, WITH PERCENTAGE EACH CLASS IS OF TOTAL: 1902.

VALUE OF PRODUCT.	TOTAL.				NATURAL GAS.				PETROLEUM.			
	Operators.		Value of product.		Operators.		Value of product.		Operators.		Value of product.	
	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.	Number.	Per cent.	Amount.	Per cent.
Total	[1] 2,517	100.0	$102,265,602	100.0	[2] 1,949	100.0	$30,867,863	100.0	[3] 598	100.0	$71,397,739	[illegible]
Less than $500	1,301	51.1	174,985	0.2	1,202	61.7	149,837	0.5	99	16.5	25,148	[illegible]
$500 but less than $1,000	218	8.6	151,378	0.1	137	7.0	94,173	0.3	81	13.5	57,205	[illegible]
$1,000 but less than $10,000	647	25.4	2,468,915	2.4	370	19.0	1,319,305	4.3	277	46.3	1,149,610	[illegible]
$10,000 but less than $50,000	257	10.1	5,392,356	5.3	162	8.3	3,415,085	11.0	95	15.9	1,977,271	[illegible]
$50,000 but less than $100,000	52	2.0	3,642,553	3.6	27	1.4	1,815,176	5.9	25	4.2	1,827,377	[illegible]
$100,000 but less than $250,000	41	1.6	6,565,769	6.4	28	1.4	4,406,721	14.3	13	2.2	2,159,048	[illegible]
$250,000 but less than $500,000	14	0.5	4,597,932	4.5	10	0.5	3,385,729	11.0	4	0.7	1,212,203	[illegible]
$500,000 and over	17	0.7	79,271,714	77.5	13	0.7	16,281,837	52.7	4	0.7	62,989,877	[illegible]

[1] Exclusive of 28,942 operators whose operations are included in the reports of the Standard Oil Company, which has been classed as a single operator.
[2] Exclusive of 18 operators whose operations are included in the reports of the Standard Oil Company, which has been classed as a single operator.
[3] Exclusive of 28,924 operators whose operations are included in the reports of the Standard Oil Company, which has been classed as a single operator.
[4] Less than one-tenth of 1 per cent.

According to the table on page 60 the production of the average operator in natural gas was valued at $15,693 and in petroleum at $2,418, but in making these calculations the individual operators covered by the reports of the Standard Oil Company were counted as separate units. Considering the report of the Standard Oil Company as that of a single operator, it appears that seven-tenths of 1 per cent of the operators produced 77.5 per cent of the total production of petroleum and natural gas, or 52.7 per cent of the natural gas and 88.2 per cent of the petroleum.

VI.

CHARACTER OF OWNERSHIP.

The operators of mines and quarries were reported to the Census either as (1) individuals; (2) firms and limited partnerships; (3) incorporated companies; and (4) "other forms," embracing cooperative associations, municipalities, penal institutions, etc. The following table shows the number of operators and value of product under each of these classes of ownership as re-

ported for each mineral and group of minerals. In this and the succeeding tables presenting the value of product according to the character of ownership, the value of the by-products referred to on page 25 have been included as a product of the mine or quarry producing them, irrespective of their character. This is necessary in order to show the total production of each operator.

TABLE 21.—NUMBER OF OPERATORS AND VALUE OF PRODUCT, BY CHARACTER OF OWNERSHIP: 1902.

[Exclusive of petroleum.]

MINERALS, BY GROUPS.	TOTAL.		INDIVIDUAL.		FIRM AND LIMITED PARTNERSHIP.		INCORPORATED COMPANY.		OTHER FORM.	
	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.
Total	17,318	$725,428,678	8,460	$44,462,756	3,718	$52,782,143	4,951	$626,132,335	189	$2,051,444
Metallic	4,081	215,453,587	1,143	10,162,100	1,314	12,160,165	1,579	192,297,393	45	833,929
Copper ore	144	51,178,036	19	594,377	23	156,579	100	50,421,837	2	5,243
Gold and silver	2,992	82,482,052	958	[1] 5,521,139	923	8,398,221	1,079	68,327,754	32	234,938
Iron ore	332	65,465,521	83	1,319,862	33	361,489	214	63,303,407	2	477,563
Lead and zinc ore	557	14,600,177	66	[2] 2,581,011	323	3,073,822	159	8,823,159	9	119,185
Manganese ore	19	177,911	8	17,487	5	140,072	6	20,352	.....	.....
Quicksilver	37	1,550,090	9	122,224	7	26,982	21	1,400,884	.....	.....
Fuels	6,477	397,899,932	3,033	17,324,523	1,037	23,512,637	2,226	356,399,452	81	663,320
Coal, anthracite	119	76,173,586	9	1,128,330	34	5,836,032	76	69,209,224	.....	.....
Coal, bituminous	4,409	290,858,483	2,044	15,606,943	827	17,212,950	1,517	257,639,338	21	399,252
Natural gas	1,949	30,867,863	980	589,250	276	463,655	[3] 633	29,550,890	60	264,068
Structural materials	5,746	96,370,559	3,638	15,869,648	1,166	15,738,093	879	64,208,623	63	554,195
Cement	93	24,268,338	4	56,610	6	124,981	83	24,086,747	.....	.....
Clay	203	2,061,072	115	804,377	36	256,618	52	1,000,077	.....	.....
Limestones and dolomites; marble	3,212	35,485,083	2,297	7,139,210	491	5,462,914	389	22,686,393	32	197,466
Sandstones and quartzites	1,211	10,601,171	759	3,206,809	324	2,493,491	119	4,759,143	9	141,728
Siliceous crystalline rocks	853	18,257,941	436	4,045,089	219	4,966,978	176	9,039,876	22	215,001
Slate	174	5,696,051	27	617,553	87	2,433,111	60	2,645,387	.....	.....
Abrasive materials	75	1,177,711	39	158,881	17	128,435	19	890,392	.....	.....
Buhrstones and millstones	29	59,808	23	42,922	6	16,886	.....	.....	.....	.....
Corundum and emery; crystalline quartz; garnet; grindstones and pulpstones; oilstones, whetstones, and scythestones	36	1,061,909	13	110,412	7	91,701	16	859,793	.....	.....
Infusorial earth, tripoli, and pumice	10	55,994	3	5,550	4	19,846	3	30,599	.....	.....
Chemical materials	174	10,618,669	31	417,011	21	829,026	116	9,372,632	.....	.....
Borax	6	2,383,614	.....	.....	.....	.....	6	2,383,614	.....	.....
Fluorspar; sulphur and pyrite	36	1,222,771	3	72,872	5	95,445	28	1,054,454	.....	.....
Gypsum	45	2,089,341	13	114,925	6	26,775	26	1,947,641	.....	.....
Phosphate rock	87	4,922,943	18	229,214	13	706,806	56	3,986,923	.....	.....
Pigments	77	564,039	24	37,864	25	154,524	28	371,651	.....	.....
Barytes	42	203,154	16	25,448	20	102,699	6	75,007	.....	.....
Mineral pigments, crude	35	360,885	8	12,416	5	51,825	22	296,644	.....	.....
Miscellaneous	688	3,344,181	519	492,726	35	259,263	104	2,592,192	.....	.....
Asbestos; asphaltum and bituminous rock	28	282,928	3	26,682	3	8,900	22	247,346	.....	.....
Bauxite; fuller's earth	11	226,350	3	19,075	.....	.....	8	207,275	.....	.....
Feldspar	26	250,424	15	76,614	3	14,050	8	159,160	.....	.....
Flint	17	144,209	10	22,808	4	27,750	3	93,651	.....	.....
Graphite; lithium ore; marl; monazite; and precious stones	515	658,609	483	163,522	4	12,199	28	482,987	.....	.....
Mica	38	118,849	18	20,260	11	49,394	9	49,165	.....	.....
Silica sand	20	421,289	5	68,914	5	103,608	10	248,767	.....	.....
Talc and soapstone	20	1,138,167	4	39,921	3	18,655	13	1,079,591	.....	.....
Tungsten	4	5,975	4	5,975	.....	.....	.....	.....	.....	.....
Uranium and vanadium	3	48,125	3	48,125	.....	.....	.....	.....	.....	.....
All other minerals[4]	6	49,256	1	800	2	24,206	3	24,250	.....	.....

[1] Includes $1,633,835, estimated value of the product of a number of miners working irregularly from whom no reports were received.
[2] Includes $1,965,779, for which character of ownership was not reported.
[3] Standard Oil Company entered as 1 company.
[4] Includes operators as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

Of the 17,318 operators included in Table 21, 8,460, or 48.8 per cent, were individuals; 3,718, or 21.5 per cent, firms and limited partnerships; and 4,951, or 28.6 per cent, incorporated companies; while 189, or 1.1 per cent, were cooperative associations, municipalities, penal institutions, etc.

The number of operators and the value of the production of petroleum are omitted from the table, because the character of ownership was not given for 28,924 of the 29,522 operators reported for the industry. Of the 598 operators of petroleum wells for which the form of ownership was reported, 107 were individuals, 69 firms, 417 incorporated companies, and 5 were reported under various kinds embraced in "other forms." With few and unimportant exceptions, each of the different classes of minerals

enumerated was produced by operators conducting business under all three of the principal forms of ownership; i. e., individual, firm, and incorporated company. Of the 189 operators included in the group of "other forms" of ownership, 78 represent mines, quarries, or wells operated by the United States, or by city, or town governments, or by penal, or eleemosynary institutions. The remaining 111 mines, quarries, or wells were controlled by cooperative associations, receivers, lessees, religious organizations, and other miscellaneous forms of ownership. Of the 6 operators included in the group of "all other minerals," 1 was an individual, 2 were firms, and 3 were incorporated companies.

The following table shows the proportion of the operators and value of products for each mineral and group of minerals produced by individuals, firms and limited partnerships, incorporated companies, and other forms of ownership, respectively:

TABLE 22.—PER CENT DISTRIBUTION, BY CHARACTER OF OWNERSHIP, OF NUMBER OF OPERATORS, AND VALUE OF PRODUCT, FOR EACH MINERAL AND GROUP OF MINERALS: 1902.

[Exclusive of petroleum.]

MINERALS, BY GROUPS.	INDIVIDUAL.		FIRM AND LIMITED PARTNERSHIP.		INCORPORATED COMPANY.		OTHER FORM.	
	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.	Number of operators.	Value of product.
Total	48.8	6.1	21.5	7.3	28.6	86.3	1.1	0.3
Metallic	28.4	4.7	31.8	5.6	38.7	89.3	1.1	0.4
Copper ore	13.2	1.2	16.0	0.3	69.4	98.5	1.4	(1)
Gold and silver	32.0	6.7	30.8	10.2	36.1	82.8	1.1	0.3
Iron ore	25.0	2.0	9.9	0.6	64.5	96.7	0.6	0.7
Lead and zinc ore	11.9	17.7	58.0	21.1	28.5	60.4	1.6	0.8
Manganese ore	42.1	9.8	26.3	78.7	31.6	11.5	.....	.....
Quicksilver	24.3	7.9	18.9	1.7	56.8	90.4	.....	.....
Fuels	46.8	4.3	17.6	5.9	34.4	89.6	1.2	0.2
Coal, anthracite	7.5	1.5	28.6	7.7	63.9	90.8	.....	.....
Coal, bituminous	46.4	5.4	18.7	5.9	34.4	88.6	0.5	0.1
Natural gas	50.3	1.9	14.1	1.5	32.5	95.7	3.1	0.9
Structural materials	63.3	16.5	20.3	16.3	15.3	66.6	1.1	0.6
Cement	4.3	0.2	6.5	0.5	89.2	99.3	.....	.....
Clay	56.7	39.0	17.7	12.5	25.6	48.5	.....	.....
Limestones and dolomites; marble	71.5	20.1	15.4	15.4	12.1	63.9	1.0	0.6
Sandstones and quartzites	62.7	30.3	26.8	23.5	9.8	44.9	0.7	1.3
Siliceous crystalline rocks	51.1	22.1	25.7	27.2	20.6	49.5	2.6	1.2
Slate	15.5	10.8	50.0	42.7	34.5	46.5	.....	.....
Abrasive materials	52.0	13.5	22.7	10.9	25.3	75.6	.....	.....
Buhrstones and millstones	79.3	71.8	20.7	28.2	.....	.....	.....	.....
Corundum and emery; crystalline quartz; garnet; grindstones and pulpstones; oilstones, whetstones, and scythestones	36.1	10.4	19.5	8.6	44.5	81.0	.....	.....
Infusorial earth, tripoli, and pumice	30.0	9.9	40.0	35.4	30.0	54.7	.....	.....
Chemical materials	19.5	3.9	13.8	7.8	66.7	88.3	.....	.....
Borax	.....	.....	.....	.....	100.0	100.0	.....	.....
Fluorspar; sulphur and pyrite	8.3	6.0	13.9	7.8	77.8	86.2	.....	.....
Gypsum	28.9	5.5	13.3	1.3	57.8	93.2	.....	.....
Phosphate rock	20.7	4.6	14.9	14.4	64.4	81.0	.....	.....
Pigments	31.2	6.7	32.5	27.4	36.3	65.9	.....	.....
Barytes	38.1	12.5	47.6	50.6	14.3	36.9	.....	.....
Mineral pigments, crude	22.8	3.4	14.3	14.4	62.9	82.2	.....	.....
Miscellaneous	79.8	14.7	5.1	7.8	15.1	77.5	.....	.....
Asbestos; asphaltum and bituminous rock	10.7	9.4	10.7	3.2	78.6	87.4	.....	.....
Bauxite; fuller's earth	26.7	8.4	.....	.....	73.3	91.6	.....	.....
Feldspar	57.7	30.6	11.5	5.8	30.8	63.6	.....	.....
Flint	58.8	15.8	23.5	19.3	17.7	64.9	.....	.....
Graphite; lithium ore; marl; monazite; and precious stones	93.8	24.8	0.8	1.9	5.4	73.3	.....	.....
Mica	47.4	17.1	28.9	41.5	23.7	41.4	.....	.....
Silica sand	25.0	16.4	25.0	24.6	50.0	59.0	.....	.....
Talc and soapstone	20.0	3.5	15.0	1.6	65.0	94.9	.....	.....
Tungsten	100.0	100.0	.....	.....	.....	.....	.....	.....
Uranium and vanadium	100.0	100.0	.....	.....	.....	.....	.....	.....
All other minerals[2]	16.7	1.6	33.3	49.2	50.0	49.2	.....	.....

[1] Less than one-tenth of 1 per cent.

[2] Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.

Individual ownership.—This form of ownership follows the individual prospector and is peculiar to the development of small mines, large numbers of which were reported for bituminous coal, limestones and dolomites, and for other minerals well distributed and so located that they could be worked with a limited capital. Practically all of the operators in precious stones and the majority of those in natural-gas and petroleum wells were enumerated as individuals. Nearly half of all the mining operations reported were con-

ducted by individuals, and this form of ownership existed in the production of practically all kinds of minerals; but the production itself was comparatively unimportant. This is indicated by the value of product, which amounted to $44,462,756 in the case of individuals, and formed only 6.1 per cent of the total for all mines. Comparatively few individual operators conducted enterprises of great magnitude, but in the production of 13 different classes of minerals, enumerated in Table 21, the product reported for individual operators exceeded that of firms or partnerships. In no case, however, did the value of the products of individuals exceed the value of the products of incorporated companies.

Firms or partnerships.—In many instances these forms of ownership are but a step to the formation of incorporated companies. They include all firms and partnerships, whether general or limited. The 3,718 firms or partnerships formed 21.5 per cent of the total number of operators, and their products were valued at $52,782,143, or 7.3 per cent of the total value of products. The number of firms or partnerships was not as great as the number of individuals, but the value of their products exceeded the value of the products of individuals by $8,319,387, or 18.7 per cent. The product under the firm or partnership form of ownership exceeded the product under incorporated companies in the cases of manganese ore, barytes, and mica. No firms or partnerships were reported as engaged in the production of borax, bauxite, fuller's earth, tungsten, or uranium and vanadium.

Incorporated companies.—From the standpoint of value of products the incorporated form of ownership now predominates in both manufactures and mining, but especially in mining. According to the reports of the census of 1900 the value of the products of incorporated companies engaged in manufactures formed 59.5 per cent of the total gross value of products of all manufactures. In the mining industry the products of the incorporated companies formed 86.3 per cent of the total for all mines and quarries. This form of ownership includes all joint stock companies, the capitalization of which is usually divided into shares of a fixed authorized value, transferable at the option of the individual shareholders. These companies are usually incorporated under the general corporation laws of the different states, but in a number of instances the charters are obtained by a special act of the legislature. The predominating importance of the corporation in the production of the different classes of minerals is shown by Table 22. This form of ownership was reported for all of the minerals, with the exception of buhrstones and millstones, lithium ore, tungsten, and uranium and vanadium, and in all, with the exception of manganese ore, barytes, mica, slate, and "all other minerals," the value of the products of the incorporated companies was far in excess of that shown for the other forms of ownership. In the majority of cases it was more than double the value of products reported for either individuals or firms.

The great increase in the consumption of coal and the demand for raw material to meet the requirements of manufactures has resulted in a general and extensive development of the mining industries, especially those for which the deposits are confined to well-defined geographic districts. Extensive mining operations can be carried on successfully only by the employment of large capital, and the incorporated form of ownership is the most convenient method of raising such capital. Incorporated companies organized primarily for manufacturing enterprises frequently engage in mining in order to control the supply of raw material and to enable themselves to practice economy in production. The production of borax, molybdenum, and rutile was controlled entirely by incorporated companies during the census year.

The incorporated form of ownership in all branches of minerals is of such overwhelming importance that the statistics for employees, salaries, wages, expenses, and products for such companies are of great importance when compared with similar statistics for all other forms of ownership. The following table makes a comparison of this character for each class and for the different groups of minerals:

TABLE 23.—COMPARISON OF STATISTICS FOR INCORPORATED COMPANIES AND FOR ALL OTHER FORMS OF OWNERSHIP, BY MINERALS, AND GROUPS OF MINERALS: 1902.

[Exclusive of petroleum.]

MINERALS, BY INCORPORATED AND UNINCORPORATED OPERATORS.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Contract work.	Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.				
Total	32,845	17,318	35,095	$36,033,784	564,176	$356,717,599	$7,721,307	$55,959,987	$106,033,455	$725,428,675
Incorporated	19,539	4,951	29,429	$31,737,061	479,618	$306,369,622	$7,070,682	$49,707,399	$93,115,790	$626,132,335
Per cent of total	59.5	28.6	83.9	88.1	85.0	85.9	91.6	88.9	87.8	86.3
Unincorporated	13,306	12,367	5,666	$4,296,723	84,558	$50,347,977	$650,625	$6,202,588	$12,917,665	$99,296,340
Per cent of total	40.5	71.4	16.1	11.9	15.0	14.1	8.4	11.1	12.2	13.7
Metallic	4,280	4,081	8,138	$9,948,335	110,404	$84,046,224	$1,371,921	$17,168,321	$39,639,703	$215,453,587
Incorporated	1,762	1,579	7,036	$8,946,198	98,837	$74,888,135	$1,196,732	$15,074,915	$36,103,550	$192,297,394
Per cent of total	41.2	38.7	86.5	89.9	89.5	89.1	87.2	87.8	91.1	89.3
Unincorporated	2,518	2,502	1,102	$1,002,137	11,567	$9,158,089	$175,189	$2,093,406	$3,536,153	$23,156,194
Per cent of total	58.8	61.3	13.5	10.1	10.5	10.9	12.8	12.2	8.9	10.7
Copper ore	144	144	1,208	$1,768,456	26,007	$21,151,405	$188,768	$1,397,465	$11,083,175	$51,178,096
Incorporated	100	100	1,163	$1,717,966	25,456	$20,579,298	$183,568	$1,358,761	$10,809,966	$50,421,867
Per cent of total	69.4	69.4	96.3	97.1	97.9	97.3	97.2	97.2	97.5	98.5
Unincorporated	44	44	45	$50,490	551	$572,107	$5,200	$38,704	$273,209	$756,129
Per cent of total	30.6	30.6	3.7	2.9	2.1	2.7	2.8	2.8	2.5	1.5
Gold and silver	2,992	2,992	3,489	$5,076,773	36,142	$36,077,492	$626,090	$5,357,529	$16,699,768	$82,482,052
Incorporated	1,079	1,079	2,964	$4,444,818	30,217	$30,053,790	$521,921	$4,419,537	$14,677,977	$68,327,754
Per cent of total	36.1	36.1	85.2	87.6	83.6	83.3	83.4	82.5	87.9	82.8
Unincorporated	1,913	1,913	516	$631,955	5,925	$6,023,702	$104,169	$937,992	$2,021,791	$14,154,298
Per cent of total	63.9	63.9	14.8	12.4	16.4	16.7	16.6	17.5	12.1	17.2
Iron ore	525	332	2,405	$2,113,230	38,851	$21,531,792	$425,292	$8,257,714	$9,005,608	$65,465,321
Incorporated	392	214	2,212	$2,000,456	36,316	$20,504,967	$418,176	$8,144,782	$8,538,596	$63,363,467
Per cent of total	74.7	64.5	92.0	94.7	93.5	95.2	98.3	98.6	94.8	96.7
Unincorporated	133	118	193	$112,774	2,535	$1,026,825	$7,116	$112,932	$467,012	$2,161,914
Per cent of total	25.3	35.5	8.0	5.3	6.5	4.8	1.7	1.4	5.2	3.3
Lead and zinc ore	559	557	910	$826,327	7,881	$4,329,271	$108,607	$2,092,001	$2,511,657	$14,600,177
Incorporated	161	159	581	$634,177	5,541	$2,928,788	$49,903	$1,096,468	$1,771,672	$8,823,149
Per cent of total	28.8	28.5	63.8	76.7	70.3	67.7	45.9	52.4	70.5	60.4
Unincorporated	398	398	329	$192,150	2,340	$1,400,483	$58,704	$995,533	$739,985	$5,777,028
Per cent of total	71.2	71.5	36.2	23.3	29.7	32.3	54.1	47.6	29.5	39.6
Manganese ore	19	19	18	$9,395	194	$74,924	.....	$3,845	$17,228	$177,991
Incorporated	6	6	10	$4,605	107	$37,264	.....	$1,540	$9,357	$26,352
Per cent of total	31.6	31.6	55.6	49.0	55.2	49.7	.....	40.1	54.3	14.8
Unincorporated	13	13	8	$4,790	87	$37,660	.....	$2,305	$7,871	$151,639
Per cent of total	68.4	68.4	44.4	51.0	44.8	50.3	.....	59.9	45.7	85.6
Quicksilver	41	37	117	$154,154	1,329	$881,340	$23,164	$59,767	$322,267	$1,550,090
Incorporated	24	21	106	$144,176	1,200	$784,028	$23,164	$53,827	$295,982	$1,400,884
Per cent of total	58.5	56.8	90.6	93.5	90.3	89.0	100.0	90.1	91.8	90.4
Unincorporated	17	16	11	$9,978	129	$97,312	.....	$5,940	$26,285	$149,206
Per cent of total	41.5	43.2	9.4	6.5	9.7	11.0	.....	9.9	8.2	9.6
Fuels	21,792	6,477	19,350	$19,229,554	355,007	$223,134,680	$6,109,536	$31,993,955	$44,146,957	$397,890,932
Incorporated	16,330	2,226	17,198	$17,564,948	317,121	$200,161,868	$5,678,086	$29,404,865	$39,387,663	$356,399,152
Per cent of total	74.9	34.4	88.9	91.3	89.3	89.7	92.9	91.9	89.2	89.6
Unincorporated	5,462	4,251	2,152	$1,664,606	37,886	$22,972,812	$431,450	$2,589,090	$4,759,294	$41,500,480
Per cent of total	25.1	65.6	11.1	8.7	10.7	10.3	7.1	8.1	10.8	10.4
Coal, anthracite	334	119	3,014	$2,907,293	69,691	$38,716,113	$406,421	$9,307,239	$12,740,780	$76,173,586
Incorporated	285	76	2,679	$2,622,438	63,317	$35,461,348	$402,867	$8,439,021	$11,568,788	$69,269,224
Per cent of total	85.3	63.9	88.9	90.2	90.9	91.6	99.1	90.7	90.8	90.9
Unincorporated	49	43	335	$284,855	6,374	$3,254,765	$3,554	$868,218	$1,171,992	$6,964,362
Per cent of total	14.7	36.1	11.1	9.8	9.1	8.4	0.9	9.3	9.2	9.1
Coal, bituminous	5,652	4,409	14,413	$14,511,924	280,638	$181,482,288	$1,244,114	$16,774,459	$24,798,922	$290,858,483
Incorporated	2,618	1,517	12,680	$13,167,415	249,280	$161,869,598	$1,169,186	$15,156,519	$21,427,969	$257,639,538
Per cent of total	46.3	34.4	88.0	90.7	88.8	89.2	94.0	90.4	86.4	88.6
Unincorporated	3,034	2,892	1,733	$1,344,509	31,358	$19,612,690	$74,928	$1,617,940	$3,370,953	$33,219,145
Per cent of total	53.7	65.6	12.0	9.3	11.2	10.8	6.0	9.6	13.6	11.4
Natural gas	15,806	1,949	1,923	$1,810,337	4,678	$2,936,279	$4,459,001	$5,912,257	$6,607,255	$30,867,884
Incorporated	13,427	633	1,839	$1,775,095	4,524	$2,838,922	$4,106,033	$5,809,325	$6,390,906	$29,570,899
Per cent of total	84.9	32.5	95.6	98.1	96.7	96.4	92.1	98.3	96.7	95.7
Unincorporated	2,379	1,316	84	$35,242	154	$105,357	$352,968	$102,932	$216,349	$1,316,953
Per cent of total	15.1	67.5	4.4	1.9	3.3	3.6	7.9	1.7	3.3	4.3
Structural materials	6,044	5,746	6,342	$5,699,130	86,295	$44,654,537	$60,749	$5,750,482	$20,072,399	$96,370,559
Incorporated	1,060	879	4,101	$4,179,905	53,589	$27,390,121	$29,928	$4,385,332	$15,689,116	$64,208,623
Per cent of total	17.5	15.3	64.7	73.3	62.1	61.3	49.3	76.3	78.2	66.6
Unincorporated	4,984	4,867	2,241	$1,519,225	32,706	$17,264,416	$30,821	$1,365,150	$4,383,283	$32,161,936
Per cent of total	82.5	84.7	35.3	26.7	37.9	38.7	50.7	23.7	21.8	33.4
Cement	101	93	913	$1,087,514	13,041	$6,328,852	$10,627	$1,665,520	$9,098,226	$24,268,338
Incorporated	91	83	891	$1,072,926	12,861	$6,242,950	$10,627	$1,654,230	$9,048,502	$24,086,747
Per cent of total	90.1	89.2	97.6	98.7	98.6	98.6	100.0	99.3	99.5	99.3
Unincorporated	10	10	22	$14,588	180	$85,902	.....	$11,290	$49,724	$181,591
Per cent of total	9.9	10.8	2.4	1.3	1.4	1.4	.....	0.7	0.5	0.7
Clay	205	203	185	$150,505	2,433	$958,892	$13,241	$126,873	$272,823	$2,061,072
Incorporated	53	52	116	$110,655	1,160	$420,514	$4,025	$71,369	$172,258	$1,000,077
Per cent of total	25.9	25.6	62.7	73.5	47.7	43.9	30.4	56.3	63.1	48.5
Unincorporated	152	151	69	$39,850	1,273	$538,378	$9,216	$55,504	$100,565	$1,060,995
Per cent of total	74.1	74.4	37.3	26.5	52.3	56.1	69.6	43.7	36.9	51.5
Limestones and dolomites	3,246	3,137	2,231	$1,843,747	31,547	$14,750,638	$36,381	$1,440,081	$5,403,912	$30,441,801
Incorporated	439	344	1,384	$1,312,251	18,757	$8,847,313	$15,276	$960,286	$3,411,224	$18,216,602
Per cent of total	13.5	11.0	62.0	71.2	59.5	60.0	42.0	66.7	63.1	59.8
Unincorporated	2,807	2,793	847	$531,496	12,790	$5,903,325	$21,105	$479,795	$1,992,688	$12,225,199
Per cent of total	86.5	89.0	38.0	28.8	40.5	40.0	58.0	33.3	36.9	40.2
Marble	83	75	352	$341,021	4,070	$2,212,640	.....	$382,877	$825,822	$5,044,182
Incorporated	58	45	310	$308,767	3,545	$1,913,820	.....	$362,662	$785,448	$4,469,791
Per cent of total	63.9	60.0	88.1	90.5	87.1	86.5	.....	94.7	89.1	88.6
Unincorporated	30	30	42	$32,254	525	$298,820	.....	$20,215	$90,374	$574,391
Per cent of total	36.1	40.0	11.9	9.5	12.9	13.5	.....	5.3	10.9	11.4

TABLE 23.—COMPARISON OF STATISTICS FOR INCORPORATED COMPANIES AND FOR ALL OTHER FORMS OF OWNERSHIP, BY MINERALS, AND GROUPS OF MINERALS: 1902—Continued.

MINERALS, BY INCORPORATED AND UNINCORPORATED OPERATORS.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Contract work.	Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.				
Structural materials—Continued.										
Sandstones and quartzites	1,304	1,211	847	$713,579	10,448	$6,153,060	$500	$878,780	$1,298,190	$10,601,171
Incorporated	146	119	422	$431,484	4,920	$2,830,472	.....	$610,099	$796,557	$4,759,143
Per cent of total	11.2	9.8	49.8	60.5	47.1	46.0	.....	69.4	61.4	44.9
Unincorporated	1,158	1,092	425	$282,095	5,528	$3,322,588	$500	$268,681	$501,633	$5,842,028
Per cent of total	88.8	90.2	50.2	39.5	52.9	54.0	100.0	30.6	38.6	55.1
Siliceous crystalline rocks	906	853	1,377	$1,227,885	18,836	$11,072,996	.....	$810,206	$2,493,065	$18,257,944
Incorporated	212	176	728	$741,731	9,585	$5,683,837	.....	$493,946	$1,175,879	$9,030,876
Per cent of total	23.4	20.6	52.9	60.4	50.9	51.3	.....	61.0	47.2	49.5
Unincorporated	694	677	649	$486,154	9,251	$5,389,159	.....	$316,260	$1,317,186	$9,227,068
Per cent of total	76.6	79.4	47.1	39.6	49.1	48.7	.....	39.0	52.8	50.5
Slate	199	174	437	$334,879	5,920	$3,177,459	.....	$446,145	$580,361	$5,696,051
Incorporated	66	60	250	$202,091	2,761	$1,451,215	.....	$232,740	$349,218	$2,645,387
Per cent of total	33.2	34.5	57.2	60.3	46.6	45.7	.....	52.2	51.3	46.4
Unincorporated	133	114	187	$132,788	3,159	$1,726,244	.....	$213,405	$331,143	$3,050,664
Per cent of total	66.8	65.5	42.8	39.7	53.4	54.3	.....	47.8	48.7	53.6
Abrasive materials	82	75	75	$48,008	610	$296,914	.....	$42,410	$80,309	$1,177,711
Incorporated	25	19	51	$34,116	369	$181,028	.....	$33,770	$61,245	$890,392
Per cent of total	30.5	25.3	68.0	71.1	60.5	61.0	.....	79.6	80.0	75.6
Unincorporated	57	56	24	$13,892	241	$115,886	.....	$8,640	$16,064	$287,319
Per cent of total	69.5	74.7	32.0	28.9	39.5	39.0	.....	20.4	20.0	24.4
Buhrstones and millstones	29	29	7	$4,682	86	$39,562	.....	$1,480	$1,809	$59,808
Incorporated	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Per cent of total	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Unincorporated	29	29	7	$4,682	86	$39,562	.....	$1,480	$1,809	$59,808
Per cent of total	100.0	100.0	100.0	100.0	100.0	100.0	.....	100.0	100.0	100.0
Corundum and emery; crystalline quartz; and oilstones, whetstones, and scythestones	26	20	23	$17,090	161	$84,440	.....	$9,282	$34,726	$261,658
Incorporated	14	8	21	$16,316	126	$70,686	.....	$8,522	$32,481	$185,886
Per cent of total	53.8	40.0	91.3	95.5	78.3	83.7	.....	91.8	93.5	71.0
Unincorporated	12	12	2	$774	35	$13,754	.....	$760	$2,245	$75,772
Per cent of total	46.2	60.0	8.7	4.5	21.7	16.3	.....	8.2	6.5	29.0
Garnet	7	7	12	$9,178	118	$59,632	.....	$4,952	$10,128	$132,820
Incorporated	3	3	5	$4,040	37	$13,503	.....	$775	$1,511	$27,900
Per cent of total	42.9	42.9	41.7	44.0	31.4	22.6	.....	15.7	14.9	21.0
Unincorporated	4	4	7	$5,138	81	$46,129	.....	$4,177	$8,617	$104,920
Per cent of total	57.1	57.1	58.3	56.0	68.6	77.4	.....	84.3	85.1	79.0
Grindstones and pulpstones	9	9	25	$13,042	210	$99,598	.....	$24,433	$31,319	$667,131
Incorporated	5	5	22	$12,180	182	$87,349	.....	$23,123	$29,953	$646,907
Per cent of total	55.6	55.6	88.0	93.4	86.7	87.7	.....	94.6	95.5	96.8
Unincorporated	4	4	3	$862	28	$12,249	.....	$1,310	$1,396	$21,424
Per cent of total	44.4	44.4	12.0	6.6	13.3	12.3	.....	5.4	4.5	3.2
Infusorial earth, tripoli, and pumice	11	10	8	$4,016	35	$13,682	.....	$2,263	$2,297	$55,994
Incorporated	3	3	3	$1,580	24	$9,490	.....	$1,350	$300	$30,599
Per cent of total	27.3	30.0	37.5	39.3	68.6	69.4	.....	59.7	13.1	54.6
Unincorporated	8	7	5	$2,436	11	$4,192	.....	$913	$1,997	$25,395
Per cent of total	72.7	70.0	62.5	60.7	31.4	30.6	.....	40.3	86.9	45.4
Chemical materials	228	174	750	$750,953	8,835	$3,313,088	$161,695	$741,570	$1,603,348	$10,618,669
Incorporated	156	116	676	$695,707	7,481	$2,824,374	$149,855	$651,078	$1,464,224	$9,372,632
Per cent of total	68.4	66.7	90.1	92.7	84.7	85.2	92.7	87.8	91.3	88.3
Unincorporated	72	58	74	$55,186	1,354	$488,714	$11,840	$90,492	$139,124	$1,246,037
Per cent of total	31.6	33.3	9.9	7.3	15.3	14.8	7.3	12.2	8.7	11.7
Borax	6	6	14	$18,128	153	$114,865	.....	$47,606	$213,538	$2,383,614
Incorporated	6	6	14	$18,128	153	$114,865	.....	$47,606	$213,538	$2,383,614
Per cent of total	100.0	100.0	100.0	100.0	100.0	100.0	.....	100.0	100.0	100.0
Unincorporated	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Per cent of total	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Fluorspar	22	18	42	$27,311	269	$110,002	$300	$23,602	$31,374	$275,682
Incorporated	18	14	35	$23,914	215	$87,605	$300	$23,352	$14,942	$216,160
Per cent of total	81.8	77.8	83.3	87.6	79.9	79.6	100.0	98.9	47.6	78.4
Unincorporated	4	4	7	$3,397	54	$22,397	.....	$250	$16,432	$59,522
Per cent of total	18.2	22.2	16.7	12.4	20.1	20.4	.....	1.1	52.4	21.6
Gypsum	62	45	249	$300,420	1,472	$759,258	$406	$200,769	$341,760	$2,089,341
Incorporated	43	26	243	$295,428	1,405	$714,043	.....	$193,920	$322,076	$1,947,641
Per cent of total	69.4	57.8	97.6	98.3	95.4	94.0	.....	96.6	94.2	93.2
Unincorporated	19	19	6	$4,992	67	$45,215	$406	$6,849	$19,684	$141,700
Per cent of total	30.6	42.2	2.4	1.7	4.6	6.0	100.0	3.4	5.8	6.8
Phosphate rock	115	87	391	$355,204	5,971	$1,930,093	$157,402	$430,475	$799,414	$4,922,943
Incorporated	70	56	341	$316,925	4,899	$1,572,834	$147,102	$347,795	$714,070	$3,986,923
Per cent of total	60.9	64.4	87.2	89.2	82.0	81.5	93.5	80.8	89.3	81.0
Unincorporated	45	31	50	$38,279	1,072	$357,259	$10,300	$82,680	$85,344	$936,020
Per cent of total	39.1	35.6	12.8	10.8	18.0	18.5	6.5	19.2	10.7	19.0
Sulphur and pyrite	23	18	54	$49,890	970	$308,870	$3,587	$39,118	$217,262	$947,089
Incorporated	19	14	43	$41,372	809	$335,027	$2,453	$38,405	$190,598	$838,294
Per cent of total	82.6	77.8	79.6	82.9	83.4	84.0	68.4	98.2	91.9	88.5
Unincorporated	4	4	11	$8,518	161	$63,843	$1,134	$713	$17,664	$108,795
Per cent of total	17.4	22.2	20.4	17.1	16.6	16.0	31.6	1.8	8.1	11.5
Pigments	84	77	91	$68,752	592	$236,372	$1,000	$60,448	$65,845	$564,039
Incorporated	29	28	75	$60,451	286	$109,480	.....	$36,469	$51,140	$371,651
Per cent of total	34.5	36.4	82.4	87.9	48.3	46.3	.....	60.3	77.7	65.9
Unincorporated	55	49	16	$8,301	306	$126,892	$1,000	$23,979	$14,705	$192,388
Per cent of total	65.5	63.6	17.6	12.1	51.7	53.7	100.0	39.7	22.3	34.1

TABLE 23.—COMPARISON OF STATISTICS FOR INCORPORATED COMPANIES AND FOR ALL OTHER FORMS OF OWNERSHIP, BY MINERALS, AND GROUPS OF MINERALS: 1902—Continued.

MINERALS, BY INCORPORATED AND UNINCORPORATED OPERATORS.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Contract work.	Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.				
Pigments—Continued.										
Barytes	49	42	28	$15,159	336	$130,285	$1,000	$35,555	$7,772	$203,154
Incorporated	7	6	18	$11,608	79	$25,904	.....	$13,850	$3,467	$75,007
Per cent of total	14.3	14.3	64.3	76.6	23.5	19.9	.....	39.0	44.6	36.9	
Unincorporated	42	36	10	$3,551	257	$104,381	$1,000	$21,705	$4,305	$128,147
Per cent of total	85.7	85.7	35.7	23.4	76.5	80.1	100.0	61.0	55.4	63.1
Mineral pigments, crude	35	35	63	$53,593	256	$106,087	.....	$24,893	$58,073	$360,885
Incorporated	22	22	57	$48,843	207	$83,576	.....	$22,619	$47,673	$296,644
Per cent of total	62.9	62.9	90.5	91.1	80.9	78.8	.....	90.9	82.1	82.2
Unincorporated	13	13	6	$4,750	49	$22,511	.....	$2,274	$10,400	$64,241
Per cent of total	37.1	37.1	9.5	8.9	19.1	21.2	.....	9.1	17.9	17.8
Miscellaneous	335	688	349	$289,052	2,433	$1,035,784	$16,406	$202,801	$424,894	$3,344,181
Incorporated	177	104	292	$255,676	1,935	$814,616	$16,081	$170,970	$355,852	$2,592,192
Per cent of total	52.8	15.1	83.7	88.5	79.5	78.6	98.0	84.3	83.8	77.5
Unincorporated	158	584	57	$33,376	498	$221,168	$325	$31,831	$69,042	$751,989
Per cent of total	47.2	84.9	16.3	11.5	20.5	21.4	2.0	15.7	16.2	22.5
Asbestos; bauxite; fuller's earth; marl; and monazite	80	48	68	$50,058	388	$131,875	$4,521	$22,244	$80,220	$349,451
Incorporated	45	14	66	$49,270	346	$118,312	$4,521	$19,775	$78,413	$308,964
Per cent of total	56.3	29.2	97.1	98.4	89.2	89.7	100.0	88.9	97.7	88.4
Unincorporated	35	34	2	$788	42	$13,563	.....	$2,469	$1,816	$40,487
Per cent of total	43.7	70.8	2.9	1.6	10.8	10.3	.....	11.1	2.3	11.6
Asphaltum and bituminous rock	24	24	52	$48,233	156	$79,570	$10,060	$19,753	$21,928	$236,728
Incorporated	19	19	50	$47,483	139	$68,738	$10,060	$19,528	$20,328	$201,346
Per cent of total	79.2	79.2	96.2	98.4	89.1	86.4	100.0	98.9	92.7	85.1
Unincorporated	5	5	2	$750	17	$10,832	.....	$225	$1,600	$35,382
Per cent of total	20.8	20.8	3.8	1.6	10.9	13.6	.....	1.1	7.3	14.9
Feldspar	27	26	27	$20,095	252	$107,444	.....	$19,407	$50,278	$250,421
Incorporated	9	8	17	$15,563	181	$75,626	.....	$12,996	$41,821	$159,160
Per cent of total	33.3	30.8	63.0	77.4	71.8	70.4	.....	67.0	83.2	63.6
Unincorporated	18	18	10	$4,532	71	$31,818	.....	$6,411	$8,457	$91,261
Per cent of total	66.7	69.2	37.0	22.6	28.2	29.6	.....	33.0	16.8	36.4
Flint	19	17	18	$14,330	119	$47,454	.....	$14,291	$18,642	$144,209
Incorporated	5	3	13	$12,130	88	$32,866	.....	$9,447	$14,216	$93,651
Per cent of total	26.3	17.6	72.2	84.6	73.9	69.3	.....	66.1	76.3	64.9
Unincorporated	14	14	5	$2,200	31	$14,588	.....	$4,844	$4,426	$50,558
Per cent of total	73.7	82.4	27.8	15.4	26.1	30.7	.....	33.9	23.7	35.1
Graphite	28	19	27	$18,924	164	$76,729	$900	$6,039	$51,840	$227,508
Incorporated	24	15	21	$16,569	138	$67,391	$900	$5,634	$50,573	$221,508
Per cent of total	85.7	78.9	77.8	87.6	84.1	87.8	100.0	93.3	97.6	97.4
Unincorporated	4	4	6	$2,355	26	$9,338	.....	$405	$1,267	$6,000
Per cent of total	14.3	21.1	22.2	12.4	15.9	12.2	.....	6.7	2.4	2.6
Lithium ore	3	3	1	$600	6	$3,744	.....	$200	$1,265	$25,750
Incorporated	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Per cent of total	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Unincorporated	3	3	1	$600	6	$3,744	.....	$200	$1,265	$25,750
Per cent of total	100.0	100.0	100.0	100.0	100.0	100.0	.....	100.0	100.0	100.0
Mica	49	38	21	$13,444	98	$44,043	.....	$12,914	$11,961	$118,849
Incorporated	18	9	17	$11,853	50	$28,400	.....	$9,445	$9,036	$49,165
Per cent of total	36.7	23.7	81.0	88.2	51.0	64.5	.....	73.1	75.5	41.4
Unincorporated	31	29	4	$1,591	48	$15,643	.....	$3,469	$2,925	$69,684
Per cent of total	63.3	76.3	19.0	11.8	49.0	35.5	.....	26.9	24.5	58.6
Precious stones	46	460	22	$28,687	108	$88,017	.....	$7,481	$17,781	$328,450
Incorporated	27	10	17	$22,000	92	$76,938	.....	$5,795	$14,289	$205,790
Per cent of total	58.7	2.2	77.3	76.7	85.2	87.4	.....	77.5	80.4	62.7
Unincorporated	19	450	5	$6,687	16	$11,079	.....	$1,686	$3,492	$122,660
Per cent of total	41.3	97.8	22.7	23.3	14.8	12.6	.....	22.5	19.6	37.3
Silica sand	26	20	35	$27,228	335	$149,114	$100	$18,776	$38,386	$421,289
Incorporated	14	10	21	$18,285	173	$81,696	$100	$10,763	$16,704	$248,767
Per cent of total	53.8	50.0	60.0	67.2	51.6	54.8	100.0	57.3	43.5	59.0
Unincorporated	12	10	14	$8,943	162	$67,418	.....	$8,013	$21,682	$172,522
Per cent of total	46.2	50.0	40.0	32.8	48.4	45.2	.....	42.7	56.5	41.0
Talc and soapstone	20	20	75	$63,713	771	$279,083	.....	$89,136	$125,932	$1,138,167
Incorporated	13	13	69	$62,283	726	$263,613	.....	$77,462	$110,090	$1,079,591
Per cent of total	65.0	65.0	92.0	97.8	94.2	94.5	.....	86.7	87.4	94.9
Unincorporated	7	7	6	$1,430	45	$15,470	.....	$2,674	$15,842	$58,576
Per cent of total	35.0	35.0	8.0	2.2	5.8	5.5	.....	3.3	12.6	5.1
Tungsten	4	4	.....	.....	2	$1,260	.....	$120	$210	$5,975
Incorporated	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Per cent of total	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Unincorporated	4	4	.....	.....	2	$1,260	.....	$120	$210	$5,975
Per cent of total	100.0	100.0	.....	.....	100.0	100.0	.....	100.0	100.0	100.0
Uranium and vanadium	3	3	2	$3,500	19	$17,040	.....	$490	$3,010	$48,125
Incorporated	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Per cent of total	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Unincorporated	3	3	2	$3,500	19	$17,040	.....	$490	$3,010	$48,125
Per cent of total	100.0	100.0	100.0	100.0	100.0	100.0	.....	100.0	100.0	100.0
All other minerals	6	6	1	$240	15	$10,411	$825	$950	$3,482	$49,256
Incorporated	3	3	1	$240	2	$1,036	$500	$125	$382	$24,250
Per cent of total	50.0	50.0	100.0	100.0	13.3	10.0	60.6	13.2	11.1	49.2
Unincorporated	3	3	.....	.....	13	$9,375	$325	$825	$3,050	$25,006
Per cent of total	50.0	50.0	.....	.....	86.7	90.0	39.4	86.8	88.9	50.8

To avoid disclosing the operations of individual establishments it was necessary to combine in Table 23 the statistics for corundum and emery, crystalline quartz, oilstones, whetstones, and scythestones, and asbestos, bauxite, fuller's earth, marl, and monazite.

While the number of incorporated companies (4,951) formed only 28.6 per cent of the total number of operators, they gave employment to 479,618, or 85 per cent of the wage-earners, and paid $306,369,622, or 85.9 per cent of the total wages paid by all operators. These companies also paid $49,707,399, or 88.9 per cent of the miscellaneous expenses, and the cost of their supplies and materials reached $93,115,790, or 87.8 per cent of the total cost, while the value of their products, amounting to $626,132,335, was 86.3 per cent of the value of products for all mines, quarries, and wells.

Incorporated companies have assumed the greatest importance in the production of ores. They employed 98,837, or 89.5 per cent of the wage-earners in the metallic group and paid them $74,888,135, or 89.1 per cent of the wages. The products were valued at $192,297,393, forming 89.3 per cent of the total value of products in this group.

Practically the entire production of copper ore was under the control of incorporated companies, these companies employing 97.9 per cent of the wage-earners and reporting 98.5 per cent of the total value of products for this mineral. Only 144 operators were reported for this mineral and but 44 of them were unincorporated, their product forming only 1.5 per cent of the total value of the product. In the metallic group of minerals iron ore stands next to copper in the part played by incorporated companies, this form of ownership giving employment to 36,316, or 93.5 per cent of the wage-earners and reported products valued at 96.7 per cent of the total value of products for this mineral. The large number of small operators engaged in the production of lead and zinc ore in Missouri and in the production of precious metals throughout the Western states reduced the comparative importance of incorporated companies in the production of these minerals. Manganese ore was the only exception to the predominance of the corporation in the production of ores. The production of this mineral is still largely under the control of individuals and firms.

Next in importance to the ores, in the production by the incorporated form of ownership is the group of minerals classed as fuels. In the foregoing table the statistics for fuels do not include the production of petroleum. Of the 6,477 operators reported for anthracite and bituminous coal mines and natural-gas wells, only 2,226, or 34.4 per cent, were incorporated companies. These companies, however, gave employment to 317,121, or 89.3 per cent, of the 355,007 wage-earners, and their products, valued at $356,399,452, formed 89.6 per cent of the total value of products for this mineral. In this group the predominance of the incorporated form of ownership was especially pronounced in the production of natural gas, the incorporated companies employing 96.7 per cent of the total number of wage-earners, and producing 95.7 per cent of the total products. In the production of anthracite coal, 76 incorporated companies, forming 63.9 per cent of the operators, employed 63,317, or 90.9 per cent, of the wage-earners, and their products, valued at $69,209,224, formed 90.9 per cent of the total value of the products of the industry. The 1,517 incorporated companies engaged in the mining of bituminous coal gave employment to 249,280, or 88.8 per cent, of the wage-earners, and the value of their products, amounting to $257,639,338, formed 88.6 per cent of the total value of bituminous coal mined during the year.

Of the 5,746 operators reported for structural materials, 879, or only 15.3 per cent, were incorporated companies. This comparatively small proportion of incorporated operators controlled considerably more than half of the industry. Their wage-earners, numbering 53,589, formed 62.1 per cent of all wage-earners, and their products, valued at $64,208,623, formed 66.6 per cent of the products. Of the different classes of minerals included in this group the incorporated form of ownership predominated for cement, limestones and dolomites, and marble. The manufacture of cement reported by the Census was confined to establishments operating quarries. Practically the entire output obtained in this manner was produced by incorporated companies. These companies gave employment to 98.6 per cent of the wage-earners engaged in the industry, and their production formed 99.3 per cent of the value of the products. Only 10 of the 93 operators were unincorporated, and their production formed only seven-tenths of 1 per cent of the total value of the product for the industry.

The incorporated companies engaged in the production of limestones and dolomites gave employment to 59.5 per cent of the wage-earners reported for all quarries devoted to the production of these stones, and in value their products formed 59.8 per cent of the total. A greater preponderance of the incorporated form of ownership is shown for marble, the incorporated companies in this industry employing 87.1 per cent of the wage-earners, and reporting 88.6 per cent of the total value of products.

The production of clay reported by the Bureau of the Census was confined to the products sold as such, and did not include the manufacture of brick and pottery products. While the number of wage-earners and the value of the product reported for the unincorporated operators engaged in clay mining and in the quarrying of sandstones and quartzites, siliceous crystalline rocks, and slate, were slightly in excess of those reported for incorporated companies, the indica-

tions are that the incorporated form of ownership is assuming control of these industries.

The mines engaged in the production of abrasive materials and controlled by incorporated companies gave employment to 60.5 per cent of the wage-earners reported for this group, and their products formed 75.6 per cent of the total value. Only 29 quarries were reported as engaged in the production of buhrstones and millstones as their principal products. Twenty-three of these quarries were operated under the individual form of ownership and 6 by firms or partnerships. The larger proportion of buhrstones and millstones was obtained from sandstone quarries, which are included under the group of structural materials. The figures in Table 23, therefore, do not indicate the proportion of the products of this class obtained from quarries operated by incorporated companies. The incorporated form of ownership predominated in all of the other minerals included in the group of abrasive materials with the exception of garnet. In the case of garnet 3 of the 7 operators were incorporated, and they reported a product valued at $27,900, or 21 per cent of the total for this mineral.

The production of chemical materials shows a decided preponderance in favor of the incorporated form of ownership, over 78 per cent of the production of each mineral being reported by incorporated companies. Taking this group as a whole, the corporations—116 out of the 174 producers—employed 84.7 per cent of the wage-earners, paid 85.2 per cent of the wages, and reported 88.3 per cent of the total value of the product.

Of the 77 producers of pigments, 28 were incorporated. These incorporated companies employed 286, or 48.3 per cent, of the 592 wage-earners, and paid $109,480, or 46.3 per cent, of the wages, and their products amounted to $371,651, or 65.9 per cent, of the total for the group.

The miscellaneous group of minerals, taken as a whole, shows that the business of incorporated operators predominated in the proportion of about 3 to 1. They constituted 15.1 per cent of the 688 producers, employed 79.5 per cent of the 2,433 wage-earners, paid 78.6 per cent of the $1,035,784 paid in wages, and reported a product valued at $2,592,192, or 77.5 per cent, of the total for the group.

Petroleum.—As previously explained, the character of ownership was not reported for 28,924 operators engaged in the production of petroleum, and for this reason the data were excluded from the preceding tables. In the following table the report for the Standard Oil Company has been considered as that of an incorporated company covering the operations of 28,924 other operators. While this rearrangement does not show the true character of the ownership of the individual operators, it probably conveys an accurate idea of the actual control of the production.

TABLE 24.—*Summary for petroleum for incorporated and unincorporated operators: 1902.*

	Total.	Incorporated companies.	Per cent of total.	Unincorporated operators.	Per cent of total.
Number of wells	118,671	116,307	98.0	2,364	[illegible]
Number of operators	598	414	69.2	184	[illegible]
Salaried officials, clerks, etc.:					
Number	3,033	2,323	76.6	710	[illegible]
Salaries	$2,986,768	$2,927,423	98.0	$59,345	[illegible]
Wage-earners:					
Average number	17,552	17,350	98.8	202	[illegible]
Wages	$13,242,361	$13,045,370	98.5	$196,991	[illegible]
Contract work	$12,956,631	$12,465,386	96.2	$491,245	[illegible]
Miscellaneous expenses	$15,811,726	$15,651,684	99.0	$160,042	[illegible]
Cost of supplies and materials	$17,781,512	$17,398,757	97.8	$382,755	[illegible]
Value of product	$71,397,739	$69,920,060	97.9	$1,477,679	[illegible]

The operators included as incorporated companies in the above table and engaged in the production of petroleum gave employment to 17,350, or 98.8 per cent, of the wage-earners, and their wages amounted to $13,045,370, or 98.5 per cent, of the total wages paid in the industry. Their products were valued at $69,920,060, or 97.9 per cent, of the total value of product.

Industrial combinations.—The statistics presented in the preceding section indicate the extent to which the firm and the incorporated company have assumed control of the mining industries. The exigencies of production on a large scale and the desirability of controlling all or a large portion of the deposits of certain minerals, combined with the advantages of carrying on mining and manufacturing under the same management and with the use of the same capital, have led to the consolidation of formerly independent operators and the formation of what are commonly known as industrial combinations. Such combinations are a form of incorporated ownership, and the statistics for them should be considered in connection with those for incorporated companies. This form of ownership has assumed large proportions in the manufacturing industries. In presenting the statistics of combinations in these industries the following definition was given in the report of the Twelfth Census on manufactures:

> For the purpose of the Census the rule has been adopted to consider no aggregation of mills an industrial combination unless it consists of a number of formerly independent mills which have been brought together into one company under a charter obtained for that purpose. We therefore exclude from this category many large establishments comprising a number of mills which have grown up, not by combination with other mills, but by the erection of new plants or the purchase of old ones.
>
> The word "trust" was avoided in this definition, because, while it may have come to convey to the popular mind a definite idea, it stands technically for a form of organization under which the stockholders of each of the separate companies assign their stock to a certain number of trustees, thus giving to these trustees an irrevocable power of attorney to vote the stock as they see fit. This form of organization has been declared illegal by the act of July 2, 1890, Fifty-first Congress, first session, entitled "An act to protect trade and commerce against unlawful restraint of monopolies" (26 Statutes at Large, page 209), and by the statutes of many states.

While the compilation of statistics for manufactures in conformity with this definition resulted in the presentation of totals which show the extent to which formerly independent establishments have come under the same ownership, and the magnitude of their operations, they do not show the extent to which the production has become concentrated in fewer establishments. In order to show such concentration it is necessary to consider all large establishments, irrespective of the method of their formation, and this has been done for the mining industries in Sections V and VI of Chapter II. As the extent of the deposits of many minerals can be determined very accurately and the production controlled through their purchase, the mining industries hold out inducements which do not exist in other industries to the formation of industrial combinations or other forms of business organizations to control the production.

The operations of a number of corporations in the mining industry have acquired enormous proportions through the gradual purchase and development of new properties, and there are numerous cases of consolidation of small independent operators, especially in the production of gold, silver, lead, and zinc. While the object of these consolidations may sometimes be the reduction of operating expenses, such consolidations are frequently made with the intention of issuing a larger amount of capital stock than was possible under an independent form of organization. In many instances independent mining claims or prospects have been made the basis for the organization of corporations, and the claims have been capitalized on their possible production, although mining operations had not actually commenced at the time of the formation of the company.

The production of some minerals is probably controlled by a mutual understanding between the operators of the mines or between the operators and transportation companies, but it is impracticable to identify operations which are controlled by arrangements of this character.

A number of the companies included in the mining census were engaged in other industries, such as manufacturing or transportation; the mining operations were incidental to their other interests, and it was impossible to segregate the capitalization so as to assign a proper proportion to the mining interests. The Standard Oil Company, for example, is engaged primarily in the refining of petroleum and produces only a limited amount of crude material; but, as explained on page 20, this company made reports covering the operations of a large number of producers of petroleum. The United States Steel Corporation is engaged primarily in the manufacture of iron and steel products, but it also operates a number of iron ore and coal mines, limestone quarries, and natural gas wells, and its capitalization covers other interests. A number of large companies which are engaged extensively in manufacturing, as well as in mining and other industries, have reported their entire capitalization in reply to the inquiries on the mining schedule, together with all dividends and interest accrued from the profits of both the mining and manufacturing operations, declaring that it was impossible to make a separation. Notable among such companies are the Republic Iron and Steel Company, the Sloss-Sheffield Steel and Iron Company, the New Jersey Zinc Company, the Alabama Consolidated Coal and Iron Company, the Colorado Fuel and Iron Company, the Empire Steel and Iron Company, the Pacific Coast Company, the Philadelphia Company, the Tennessee Coal, Iron, and Railroad Company, and the Virginia Iron, Coal, and Coke Company. This is also true, to a greater or less degree, of most of the companies reporting capital stock, as a very small proportion of them confine their operations solely to mining.

It is evident, therefore, that while industrial combinations similar to those referred to in the report on manufactures of the Twelfth Census do exist in the mining industries, it is impracticable to compile satisfactory statistics for them. But eliminating from consideration the production of coal, petroleum, and natural gas, and compiling the statistics of the rest of the minerals in as close conformity as possible with the definition given above, it is found that industrial combinations exist in the production of several minerals. Table 25 shows for all the items discussed in this chapter the totals for all operators and for industrial combinations in the same minerals and the percentages that the industrial combinations are of the totals for all operators.

TABLE 25.—SUMMARY FOR MINERALS FOR WHICH INDUSTRIAL COMBINATIONS ARE REPORTED: 1902.

	Iron ore.	Copper ore.	Cement.	Limestones and dolomites.	All other minerals[1]
Number of mines, quarries, and wells:					
Total	525	144	101	3,246	[illegible]
Industrial combinations	118	21	17	16	[illegible]
Per cent of total	22.5	14.6	16.8	1.4	[illegible]
Salaried officials, clerks, etc.:					
Number—					
Total	2,405	1,208	913	2,231	[illegible]
Industrial combinations	1,425	443	118	134	[illegible]
Per cent of total	59.3	36.7	12.9	6.0	[illegible]
Salaries—					
Total	$2,113,230	$1,768,456	$1,087,514	$1,845,747	[illegible]
Industrial combinations	$1,254,657	$644,688	$191,312	$133,171	[illegible]
Per cent of total	59.4	36.5	17.6	7.2	[illegible]
Wage-earners:					
Average number—					
Total	38,851	26,007	13,041	31,547	[illegible]
Industrial combinations	19,148	11,318	4,319	2,596	[illegible]
Per cent of total	49.3	43.5	33.1	8.2	[illegible]
Wages—					
Total	$21,531,792	$21,151,405	$6,328,852	$14,750,638	[illegible]
Industrial combinations	$11,154,462	$9,787,476	$2,056,750	$1,113,209	[illegible]
Per cent of total	51.8	46.3	32.5	7.5	[illegible]
Contract work:					
Total	$425,292	$188,768	$10,627	$36,381	[illegible]
Industrial combinations	$148,726	$39,675	.....	.....	[illegible]
Per cent of total	35.0	21.0	.....	.....	[illegible]
Miscellaneous expenses:					
Total	$8,257,714	$1,397,465	$1,665,520	$1,440,081	[illegible]
Industrial combinations	$5,357,709	$445,344	$558,171	$59,859	[illegible]
Per cent of total	64.9	31.9	33.5	4.2	[illegible]
Cost of supplies and materials:					
Total	$9,005,608	$11,083,175	$9,098,226	$5,403,912	[illegible]
Industrial combinations	$4,832,372	$4,649,168	$3,461,249	$308,870	[illegible]
Per cent of total	53.7	41.9	38.0	5.7	[illegible]
Value of product:					
Total	$65,465,321	$51,178,036	$24,268,338	$30,441,801	[illegible]
Industrial combinations	$38,172,009	$28,502,848	$8,189,118	$2,091,225	[illegible]
Per cent of total	58.3	55.7	33.7	6.9	[illegible]

[1] Includes asphaltum and bituminous rock, corundum and emery, grindstones and pulpstones, gypsum, lead and zinc ore, oilstones, whetstones, and scythe stones, sandstones and quartzites, siliceous crystalline rocks, and talc and soapstone.

The operators classed as industrial combinations and engaged in the production of iron ore gave employment to 49.3 per cent of the wage-earners and in value their products formed 58.3 per cent of the total value of all the iron ore produced during the year. While only 14.6 per cent of the operators of copper mines were classed as industrial combinations, they gave employment to 43.5 per cent of the wage-earners and their products formed 55.7 per cent of the total value of products.

VII.

CAPITAL.

Reasons for not securing statistics.—It has been the practice at prior censuses to include in the report on mining industries statistics concerning capital invested. The object was to ascertain the value of all mining properties and money invested or used in the business, whether owned or borrowed. In order to develop these amounts the inquiries called for the value of the mine and improvements, including land, buildings, fixtures, tools, implements, live stock, machinery, etc., and were in harmony with those concerning capital included in the schedule for the manufacturing and mechanical industries, but the statistics for both branches of industry have frequently been referred to as untrustworthy and delusive. It is evident from the various inquiries made at the Eleventh Census[1] that uniform amounts were not reported for capital invested in all branches of the mining industry, and the statistics can not be accepted as representing the actual value of the mining properties or the amount of capital invested in the industry.

All of the objections to the statistics for capital in manufactures apply with greater force to the statistics for mines and quarries, and they may be summarized as follows:

1. It is impossible to define the word "capital" for statistical measurement so that it shall be tangible, restricted, and uniform.

2. The inquiry creates more prejudice and arouses more opposition to the progress of the enumeration than all of the other inquiries united.

3. The value of "fixed capital"—land and buildings is dependent upon conditions of which a census can take no cognizance.

4. The difficulties attending the collection of statistics for live capital—"cash on hand, bills receivable, unsettled accounts, etc."—preclude the possibility of reliable results.

5. It is impossible to eliminate the duplication in gross assets and credit capital.

6. Good will, patents, mining rights, etc., are forms of capital for which no satisfactory value can be obtained.

7. Many mining companies have investments other than of the amounts required to carry on their business

[1] The following indicates the character of the inquiries used at the Eleventh Census: For minor minerals the inquiries called for "total value of mine and improvements, as at present developed, distributed as follows: Land; buildings and fixtures; tools, implements, live stock, machinery, and supplies on hand; cash not reported in the foregoing items." The instructions required that the amount of capital should be stated so as to include not only the amount of capital actually invested in the business, as in land, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carry-

and yet constituting a part of their capital, such as railroads, steamships, and timber lands, and it is impossible to segregate the capital that pertains strictly to mining.

8. A number of mines are operated under leases. The lessees furnish the Census reports, but have no knowledge of the value of the mine or the capital invested by the lessor in land, shafts, machinery, etc.

9. The value of a mine is due chiefly to the character and amount of ore supposed to be in the earth, and is, therefore, largely speculative.

The act of Congress of March 3, 1899, was the first census law that specified the character of the inquiries to be embraced in the schedule for manufactures, and the "amount of capital invested" formed one of these inquiries. The same law provided for the census of mines, mining, and minerals, but in enumerating the different subjects to be included in the report, no reference was made to the capital invested. The absence of a definite provision of law and the unsatisfactory character of the statistics concerning capital collected at prior censuses, justified the omission of this inquiry from the mining census of 1902. The report for this census, therefore, contains no information concerning the value of the mining property or the actual amount of capital invested in the industry.

Capitalization of incorporated companies, by minerals.—Exclusive of the products of natural-gas and petroleum wells, 85.9 per cent of the mining products of the country during 1902 was produced by incorporated companies, and the prevalence of this form of ownership indicates the desirability of collecting statistics concerning their capitalization. While the capitalization of incorporated companies is not the true value of mining properties, nevertheless, the companies are in position to give the amount of capital stock and bonded indebtedness, and inquiries concerning such values can be answered readily. The census schedule, therefore, contained the following inquiries:

2. Capital stock, bonds, dividends, and assessments (if an incorporated company):

	BONDS.		PREFERRED STOCK.		COMMON STOCK.	
	Number.	Total par value.	Number of shares.	Total par value.	Number of shares.	Total par value.
Authorized.....	.....	$.....	.....	$.....	.....	$.....
Issued to the end of the year.....	.....	$.....	.....	$.....	.....	$.....

Dividends and interest, if any, paid during the year:

Common stock, rate.....; amount, $.....

Preferred stock, rate.....; amount, $.....

Bonds, rate .....; amount, $.....

Assessments: Total amount levied, if any, since organization of company ..... $.....

In the majority of cases the capitalization given in answer to this inquiry included values incident to the operation of all enterprises, industrial and commercial, carried on by the company reporting. For instance, if an iron company owned and operated a coal and an iron mine, the probabilities are that its total capitalization was reported, it being impossible to segregate the amount represented by each mining operation. It is probable that mining was the primary object of the formation of the majority of the companies, but in some cases mining was subservient to other interests, and, in a few instances, where the mining formed only a small proportion of the interests of the corporation, no capital stock was reported. The Pittsburg Plate Glass Company and the American Sewer Pipe Company are corporations of this character. The totals, therefore, can not be accepted as the capitalization of mining enterprises exclusively, nor can the dividends paid be accepted as the result of mining operations only.

Exclusive of those engaged in the production of natural gas and petroleum, there were 4,318 incorporated companies reported as engaged in the mining industries. Of this number, 4,045 answered the

ing on the business. This statement, to be complete, should include as capital "all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return, or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890." The inquiry for the precious metals called for separate amounts, as follows: Total present actual cash value of mine and mining plant, $——, to be distributed as follows: Present actual cash value of buildings at mine, $——; present actual cash value of railroads on surface, $——; present actual cash value of machinery of all kinds above and below ground, including pumps, engines, boilers, cars, tools, etc., $——; present actual cash value of underground improvements, including shafts, tunnels, drifts, tramways, etc., $——; present actual cash value of mine supplies of all kinds on hand December 31, 1889, $——; present actual cash value of the mine itself, exclusive of the above items, $——; cash not reported in the foregoing items, $——; value of mill, smelting, or other reduction works, exclusive of mining property; present actual cash value of buildings, $——; present actual cash value of machinery and plant of all kinds except buildings, $——; present actual cash value of supplies on hand December 31, 1889, $——. In addition to these inquiries a circular letter issued to the enumerators on May 26, 1890, instructed them that the total actual value of the entire mining plant at the close of 1889 should be given without regard to the capitalization of the corporation or firm. If the land was owned in fee or in mineral rights, the number of acres attached to the collieries and under development, together with its actual value, should be stated. In the case of leased land, it should be practicable for the lessee to give the value per acre of the tract under development, and an effort should be made by the enumerator to obtain this data either from the lessee, lessor, or other reliable authority. If several collieries were drawing coal from the same bank, the value of the acreage for the same tract should be treated on one schedule and omitted from the others.

inquiries concerning capitalization. A large proportion of the production of petroleum in Pennsylvania, New York, Ohio, Indiana, and West Virginia, and also a considerable amount of the natural gas produced in these states, was covered in the report of the Standard Oil Company. In answering these inquiries this company gave an estimate of the capital stock and bonds it considered devoted to production, eliminating, as far as possible, the stock incident to the refining and to enterprises not directly connected with production of crude petroleum. The company also reported its inability to give the number of incorporated companies whose production of petroleum bought by it was included in its schedules; therefore the number of incorporated companies given in Table 26 for petroleum can not be accepted as the actual number engaged in its production. This table presents the statistics of capitalization for all incorporated companies for each mineral and group of minerals.

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TABLE 26.—CAPITALIZATION OF INCORPORATED COM-

	MINERALS, BY GROUPS.	Number of incorporated companies.	Number of companies reporting.	Aggregate par value of stocks and bonds issued.	CAPITAL STOCK. Total. Authorized.	Issued.	Dividends.
1	Total	5,386	4,876	$3,217,719,458	$3,440,194,687	$2,902,835,544	$72,416,913
2	Metallic	1,579	1,487	1,743,885,054	2,026,640,342	1,710,436,924	33,572,160
3	Copper ore	100	97	378,315,800	441,788,125	372,240,270	14,116,002
4	Gold and silver	1,079	1,030	1,024,970,643	1,213,420,117	1,017,011,793	10,454,744
5	Iron ore	214	183	247,798,970	265,058,900	238,933,470	6,329,465
6	Lead and zinc ore	159	152	51,326,891	59,423,200	45,923,641	2,500,01[illegible]
7	Manganese ore	6	4	2,455,050	2,855,000	2,455,050	.....
8	Quicksilver	21	21	39,017,700	44,100,000	38,872,700	171,[illegible]
9	Fuels	2,661	2,350	1,240,290,833	1,162,161,215	985,284,149	35,012,270
10	Coal, anthracite	76	69	142,032,212	59,749,350	55,482,490	1,936,479
11	Coal, bituminous	1,517	1,450	655,718,025	594,106,570	513,424,186	17,359,841
12	Natural gas	651	433	111,634,737	99,400,806	92,190,870	4,944,004
13	Petroleum	[1]417	[1]398	330,905,859	408,904,489	324,186,603	10,771,9[illegible]
14	Structural materials	879	792	164,008,445	164,062,840	141,169,245	3,031,189
15	Cement	83	81	55,649,870	50,556,500	46,932,170	1,209,467
16	Clay	52	45	5,606,200	6,917,600	5,275,200	59,1[illegible]
17	Limestones and dolomites	344	311	35,509,735	34,668,900	30,165,235	754,5[illegible]
18	Marble	45	43	20,318,400	20,414,000	17,609,900	239,2[illegible]
19	Sandstones and quartzites	119	104	16,219,850	14,551,600	13,821,350	276,9[illegible]
20	Siliceous crystalline rocks	176	153	19,380,825	20,306,800	17,007,325	383,4[illegible]
21	Slate	60	55	11,323,565	16,617,440	10,358,065	111,1[illegible]
22	Abrasive materials	19	18	5,545,900	6,235,100	4,565,900	30,8[illegible]
23	Corundum and emery	4	4	2,365,800	3,600,000	1,935,800	10,8[illegible]
24	Crystalline quartz	2	2	300,000	300,000	300,000	10,0[illegible]
25	Garnet	3	3	2,412,000	1,862,000	1,862,000	.....
26	Grindstones and pulpstones	5	5	253,100	253,100	253,100	.....
27	Infusorial earth, tripoli, and pumice	3	2	130,000	130,000	130,000	10,000
28	Oilstones, whetstones, and scythestones	2	2	85,000	90,000	85,000	.....
29	Chemical materials	116	110	33,230,900	35,094,165	31,571,100	614,5[illegible]
30	Borax	6	6	3,025,000	3,175,000	3,025,000	231,[illegible]
31	Fluorspar	14	14	2,214,000	3,813,000	2,154,000	.....
32	Gypsum	26	25	10,670,965	10,576,665	10,525,965	61,[illegible]
33	Phosphate rock	56	53	13,775,935	13,269,500	12,321,135	316,2[illegible]
34	Sulphur and pyrite	14	12	3,545,000	4,260,000	3,545,000	2,4[illegible]
35	Pigments	28	23	2,105,600	12,383,300	1,861,600	14,0[illegible]
36	Barytes	6	6	1,158,900	10,983,000	979,900	2,640
37	Mineral pigments, crude	22	17	946,700	1,400,300	881,700	11,4[illegible]
38	Miscellaneous	104	96	28,652,726	33,617,725	27,946,626	141,8[illegible]
39	Asbestos	3	3	2,010,000	2,300,000	2,010,000	.....
40	Asphaltum and bituminous rock	19	17	9,760,700	10,575,000	9,760,700	13,000
41	Bauxite	5	3	148,000	225,000	148,000	.....
42	Feldspar	8	7	298,400	424,000	298,400	8,800
43	Flint	3	3	195,000	210,000	195,000	.....
44	Fuller's earth	3	2	230,000	230,000	230,000	.....
45	Graphite	15	15	2,632,800	2,914,000	2,614,800	8,7[illegible]
46	Marl	2	2	67,300	67,300	67,300	.....
47	Mica	9	8	3,254,248	5,450,000	3,254,248	.....
48	Monazite	1	1	1,000	500,000	1,000	.....
49	Precious stones	10	10	1,562,078	2,129,000	1,562,078	20,000
50	Silica sand	10	9	595,275	635,000	554,175	.....
51	Talc and soapstone	13	13	7,697,925	7,758,425	7,050,925	91,900
52	All other minerals[2]	3	3	200,000	200,000	200,000	.....

[1] The 28,925 operators reported by the Standard Oil Company are included as 1 incorporated company.
[2] Includes molybdenum, nickel and cobalt, and rutile.

PANIES, BY MINERALS AND GROUPS OF MINERALS: 1902.

CAPITAL STOCK—continued.						BONDS.			
Common.			Preferred.						
Authorized.	Issued.	Dividends.	Authorized.	Issued.	Dividends.	Authorized.	Issued.	Interest.	
$3,224,237,630	$2,718,796,984	$63,610,969	$215,957,057	$184,038,560	$8,805,944	$361,069,645	$314,883,914	$13,603,924	1
1,926,126,652	1,626,075,027	29,572,132	100,513,690	81,361,897	4,000,028	52,156,700	33,448,130	1,337,203	2
429,321,625	361,388,770	13,667,012	12,466,500	10,851,500	448,990	6,950,000	6,075,530	174,500	3
1,194,317,427	1,002,055,596	10,124,711	19,102,690	14,956,197	330,033	9,839,200	7,958,850	409,392	4
204,052,400	182,651,625	3,183,440	61,001,500	51,281,845	3,145,965	22,647,500	13,865,500	521,111	5
56,380,200	43,551,286	2,446,475	3,043,000	2,372,355	53,540	12,575,000	5,403,250	226,200	6
2,255,000	1,855,050	.....	600,000	600,000	.....	.....	.....	.....	7
39,800,000	34,572,700	150,494	4,300,000	4,300,000	21,500	145,000	145,000	6,000	8
1,080,072,388	910,864,461	30,869,484	82,088,827	74,419,688	4,142,786	273,836,645	255,006,684	11,243,708	9
58,589,350	54,692,390	1,933,251	1,160,000	790,100	3,208	87,925,222	86,549,722	3,789,145	10
518,756,363	443,749,259	13,297,536	75,350,207	69,674,927	4,062,305	153,493,556	142,293,839	6,115,828	11
98,565,806	91,385,870	4,891,134	835,000	805,000	49,900	20,642,867	19,443,867	1,041,402	12
404,160,869	321,036,942	10,744,563	4,743,620	3,149,661	27,373	11,775,000	6,719,256	297,333	13
141,145,800	125,098,570	2,576,509	22,917,040	16,070,675	451,680	28,359,400	22,839,200	909,507	14
42,003,000	38,653,520	958,307	8,553,500	8,278,650	251,300	9,578,400	8,717,700	316,962	15
6,272,600	4,637,200	55,690	675,000	638,000	3,500	436,000	331,000	18,110	16
30,594,400	27,554,775	681,353	4,074,500	2,610,460	70,181	6,206,500	5,344,500	258,362	17
16,744,000	14,151,900	139,250	3,670,000	3,458,000	100,000	4,475,000	2,708,500	93,290	18
14,526,600	13,800,750	275,732	25,000	20,600	1,221	2,586,000	2,398,500	98,485	19
19,848,300	16,650,325	383,438	458,500	357,000	.....	3,752,000	2,373,500	89,873	20
11,156,900	9,650,100	82,679	5,460,540	707,965	28,475	1,325,500	965,500	34,425	21
5,685,100	4,309,900	20,000	550,000	256,000	10,860	1,075,000	980,000	24,000	22
3,100,000	1,729,800	.....	500,000	206,000	10,860	470,000	430,000	24,000	23
300,000	300,000	10,000	.....	.....	.....	.....	.....	.....	24
1,862,000	1,862,000	.....	.....	.....	.....	600,000	550,000	.....	25
203,100	203,100	.....	50,000	50,000	.....	.....	.....	.....	26
130,000	130,000	10,000	.....	.....	.....	.....	.....	.....	27
90,000	85,000	.....	.....	.....	.....	.....	.....	.....	28
27,986,665	24,678,600	477,415	7,107,500	6,892,500	137,090	2,980,800	1,659,800	64,450	29
2,925,000	2,775,000	231,600	250,000	250,000	.....	.....	.....	.....	30
3,813,000	2,154,000	.....	.....	.....	.....	100,000	60,000	.....	31
6,046,665	5,995,965	64,300	4,530,000	4,530,000	.....	1,145,000	145,000	2,700	32
11,292,000	10,343,635	179,115	1,977,500	1,977,500	137,090	1,735,800	1,454,800	61,750	33
3,910,000	3,410,000	2,400	350,000	135,000	.....	.....	.....	.....	34
12,293,300	1,781,300	12,879	90,000	80,300	1,200	1,765,000	244,000	8,850	35
10,983,000	979,900	2,640	.....	.....	.....	1,700,000	179,000	6,000	36
1,310,300	801,400	10,239	90,000	80,300	1,200	65,000	65,000	2,850	37
30,927,725	25,989,126	82,550	2,690,000	1,957,500	59,300	901,100	706,100	16,206	38
2,000,000	1,875,000	.....	300,000	135,000	.....	.....	.....	.....	39
10,575,000	9,760,700	13,000	.....	.....	.....	110,000	.....	.....	40
225,000	148,000	.....	.....	.....	.....	.....	.....	.....	41
424,000	298,400	8,800	.....	.....	.....	.....	.....	.....	42
200,000	185,000	.....	10,000	10,000	.....	.....	.....	.....	43
130,000	130,000	.....	100,000	100,000	.....	.....	.....	.....	44
2,664,000	2,384,800	8,750	250,000	230,000	.....	20,000	18,000	1,080	45
67,300	67,300	.....	.....	.....	.....	.....	.....	.....	46
5,450,000	3,254,248	.....	.....	.....	.....	.....	.....	.....	47
500,000	1,000	.....	.....	.....	.....	.....	.....	.....	48
2,129,000	1,562,078	20,000	.....	.....	.....	.....	.....	.....	49
635,000	554,175	.....	.....	.....	.....	41,100	41,100	2,466	50
5,728,425	5,568,425	32,000	2,030,000	1,482,500	59,300	730,000	647,000	12,660	51
200,000	200,000	.....	.....	.....	.....	.....	.....	.....	52

Considering the total for the United States as shown by Table 26, it appears that of the 5,386 incorporated companies operating producing mines, 510 failed to answer the inquiry concerning capitalization. The data furnished by the 4,876 companies show that they were authorized to issue stock and bonds to the amount of $3,801,264,332. This total is composed of 1,234,500,357 shares of common and preferred stock, having a total par value of $3,440,194,687, and of bonds to the value of $361,069,645. The capital stock constituted 90.5 per cent of the total authorized capitalization and is composed of preferred stock to the value of $215,957,057 and common stock to the value of $3,224,237,630, the two forms of stock constituting 6.3 and 93.7 per cent, respectively, of the total. Of the total authorized capital stock, $2,902,835,544, or 84.4 per cent, had been issued and was outstanding at the end of the year. The par value of the common stock issued amounted to $2,718,796,984, or 84.3 per cent of such stock authorized, and the par value of the preferred stock issued amounted to $184,038,560, or 85.2 per cent of the total authorized. The par value of the bonds formed 9.5 per cent of the authorized capitalization and the par value of the bonds issued amounted to $314,883,914, or 9.8 per cent of the total capital stock and bonds issued.

Of the $72,416,913 reported as paid in dividends, $63,610,969 was paid on common stock and $8,805,944 on preferred stock, representing an average rate of 2.3 and 4.8 per cent, respectively, on all such stock issued. The interest paid on bonds amounted to $13,603,924, or 4.3 per cent on the par value of the $314,883,914 reported as issued. These percentages of dividends and interest are computed on the total amount of stock and bonds issued, irrespective of whether dividends or interest were paid by every particular corporation, and therefore the percentage of dividends is a total return on the total outstanding capitalization of the mining corporations.

Dividend paying companies.—Exclusive of natural gas and petroleum, 1,142 corporations reported the payment of dividends on common or preferred stock, or interest on bonds during the year, and the statistics for the capitalization of these companies are presented in Table 27 for each mineral.

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TABLE 27.—CAPITALIZATION OF INCORPORATED COMPANIES PAYING EITHER

[Exclusive of natural

	MINERAL.	Number of companies paying dividends or interest.	AGGREGATE CAPITALIZATION.				CAPITAL STOCK.			
			Authorized.	Issued.	Dividends and interest.		Total.			
					Amount.	Rate per cent on total capital.	Authorized.	Issued.	Dividends.	
									Amount.	Rate per cent
1	Total	1,142	$1,751,116,693	$1,524,662,218	$68,966,132	4.5	$1,454,839,275	$1,260,339,137	$56,700,943	[illegible]
2	Asphaltum and bituminous rock	2	300,000	300,000	13,000	4.3	300,000	300,000	13,000	[illegible]
3	Barytes	2	258,000	237,000	8,640	3.6	58,000	58,000	2,640	[illegible]
4	Borax	2	2,250,000	2,150,000	231,600	10.8	2,250,000	2,150,000	231,600	[illegible]
5	Cement	50	44,456,900	41,105,670	1,526,629	3.7	37,635,500	35,023,970	1,209,667	[illegible]
6	Clay	12	2,382,000	1,924,000	77,300	4.0	2,051,000	1,593,000	59,190	[illegible]
7	Coal, anthracite	36	136,658,822	133,219,772	5,725,604	4.3	50,737,400	48,673,850	1,936,459	[illegible]
8	Coal, bituminous	513	570,208,796	516,833,904	23,475,669	4.5	431,395,600	387,512,425	17,359,841	[illegible]
9	Copper ore	22	334,783,125	281,226,457	14,290,502	5.1	327,983,125	275,225,927	14,116,002	[illegible]
10	Corundum and emery	1	3,400,000	1,745,800	34,860	2.0	3,000,000	1,385,800	10,860	[illegible]
11	Crystalline quartz	1	250,000	250,000	10,000	4.0	250,000	250,000	10,000	[illegible]
12	Feldspar	2	198,000	148,000	8,800	5.9	198,000	148,000	8,800	[illegible]
13	Gold and silver	152	299,637,750	242,100,185	10,864,136	4.5	292,737,750	235,621,135	10,454,744	[illegible]
14	Graphite	2	95,000	93,000	9,830	10.6	75,000	75,000	8,750	[illegible]
15	Gypsum	8	750,000	744,000	67,000	9.0	705,000	699,000	64,300	[illegible]
16	Infusorial earth, tripoli, and pumice	1	100,000	100,000	10,000	10.0	100,000	100,000	10,000	[illegible]
17	Iron ore	52	203,125,300	176,511,570	6,850,516	3.9	182,442,800	164,474,570	6,329,405	[illegible]
18	Lead and zinc ore	49	48,222,000	34,128,550	2,726,215	8.0	36,707,000	28,858,550	2,500,015	[illegible]
19	Limestones and dolomites	99	23,878,000	20,677,135	1,009,896	4.9	18,508,500	15,934,635	751,534	[illegible]
20	Marble	10	13,900,000	10,632,600	332,540	3.1	10,495,000	8,905,100	239,250	[illegible]
21	Mineral pigments, crude	5	446,300	436,600	14,289	3.3	391,300	381,600	11,439	[illegible]
22	Phosphate rock	22	9,709,800	9,326,300	377,955	4.1	8,325,000	8,197,500	316,205	[illegible]
23	Precious stones	1	100,000	100,000	20,000	20.0	100,000	100,000	20,000	[illegible]
24	Quicksilver	7	19,515,000	19,035,500	177,994	0.9	19,400,000	18,890,500	171,994	[illegible]
25	Sandstones and quartzites	25	11,485,000	11,079,400	375,441	3.4	8,920,000	8,695,900	270,956	[illegible]
26	Siliceous crystalline rocks	43	13,009,000	10,067,800	473,311	4.7	9,872,000	7,919,300	383,438	[illegible]
27	Silica sand	1	131,100	117,975	2,466	2.1	90,000	76,875	.....	.....
28	Slate	16	4,376,800	3,602,500	145,579	4.0	3,351,300	2,937,000	111,151	[illegible]
29	Sulphur and pyrite	1	60,000	60,000	2,400	4.0	60,000	60,000	2,400	[illegible]
30	Talc and soapstone	5	7,400,000	6,708,500	103,960	1.5	6,700,000	6,091,500	91,300	[illegible]

DIVIDENDS ON STOCK OR INTEREST ON BONDS, BY MINERALS: 1902.

gas and petroleum.]

CAPITAL STOCK—continued.								BONDS.				
Common.				Preferred.						Interest.		
Authorized.	Issued.	Dividends. Amount.	Dividends. Rate per cent.	Authorized.	Issued.	Dividends. Amount.	Dividends. Rate per cent.	Authorized.	Issued.	Amount.	Rate per cent.	
$1,286,510,908	$1,109,335,428	$47,972,272	4.3	$168,328,307	$151,003,709	$8,728,671	5.8	$296,277,418	$264,323,081	$12,265,189	4.6	1
300,000	300,000	13,000	4.3	.....	.....	.....	.....	.....	.....	.....	.....	2
58,000	58,000	2,640	4.6	.....	.....	.....	.....	200,000	179,000	6,000	3.4	3
2,250,000	2,150,000	231,600	10.8	.....	.....	.....	.....	.....	.....	.....	.....	4
32,157,000	29,750,320	958,367	3.2	5,478,500	5,273,650	251,300	4.8	6,821,460	6,081,700	316,962	5.2	5
1,901,000	1,443,000	55,690	3.9	150,000	150,000	3,500	2.3	331,000	331,000	18,110	5.5	6
50,077,400	48,033,750	1,933,251	4.0	660,000	640,100	3,208	0.5	85,921,422	84,545,922	3,789,145	4.5	7
363,505,533	324,323,778	13,297,536	4.1	67,890,067	63,188,647	4,062,305	6.4	138,813,196	129,321,479	6,115,828	4.7	8
317,016,625	264,674,427	13,667,012	5.2	10,966,500	10,551,500	448,990	4.3	6,800,000	6,000,530	174,500	2.9	9
2,500,000	1,179,800	.....	.....	500,000	206,000	10,860	5.3	400,000	360,000	24,000	6.7	10
250,000	250,000	10,000	4.0	.....	.....	.....	.....	.....	.....	.....	.....	11
198,000	148,000	8,800	5.9	.....	.....	.....	.....	.....	.....	.....	.....	12
285,116,950	228,067,703	10,124,711	4.4	7,620,800	7,553,432	330,033	4.4	6,900,000	6,479,050	409,392	6.3	13
75,000	75,000	8,750	11.7	.....	.....	.....	.....	20,000	18,000	1,080	6.0	14
705,000	699,000	64,300	9.2	.....	.....	.....	.....	45,000	45,000	2,700	6.0	15
100,000	100,000	10,000	10.0	.....	.....	.....	.....	.....	.....	.....	.....	16
123,949,800	115,596,200	3,183,440	2.8	58,493,000	48,878,370	3,145,965	6.4	20,682,500	12,037,000	521,111	4.3	17
34,407,000	27,208,400	2,446,475	9.0	2,300,000	1,650,150	53,540	3.2	11,515,000	5,270,000	226,200	4.3	18
15,506,500	13,692,675	681,353	5.0	3,002,000	2,241,960	70,181	3.1	5,369,500	4,742,500	258,362	5.4	19
7,995,000	6,405,100	139,250	2.2	2,500,000	2,500,000	100,000	4.0	3,405,000	1,727,500	93,290	5.4	20
351,300	351,300	10,239	2.9	40,000	30,300	1,200	4.0	55,000	55,000	2,850	5.2	21
6,362,500	6,235,000	179,115	2.9	1,962,500	1,962,500	137,090	7.0	1,584,800	1,128,800	61,750	5.5	22
100,000	100,000	20,000	20.0	.....	.....	.....	.....	.....	.....	.....	.....	23
15,100,000	14,590,500	150,494	1.0	4,300,000	4,300,000	21,500	0.5	145,000	145,000	6,000	4.1	24
8,895,000	8,675,300	275,732	3.2	25,000	20,600	1,224	5.9	2,565,000	2,383,500	98,485	4.1	25
9,872,000	7,919,300	383,438	4.8	.....	.....	.....	.....	3,137,000	2,148,500	89,873	4.2	26
90,000	76,875	.....	.....	.....	.....	.....	.....	41,100	41,100	2,466	6.0	27
2,911,300	2,563,000	82,679	3.2	440,000	374,000	28,475	7.6	1,025,500	665,500	31,425	5.2	28
60,000	60,000	2,400	4.0	.....	.....	.....	.....	.....	.....	.....	.....	29
4,700,000	4,609,000	32,000	0.7	2,000,000	1,482,500	59,300	4.0	700,000	617,000	12,660	2.1	30

The par value of the authorized capital stock and bonds of the 1,142 companies paying either dividends or interest on all or part of their capitalization amounted to $1,751,116,693, or 46.1 per cent of the total authorized capitalization of all companies reported. The par value of the capital stock and bonds issued by these companies amounted to $1,524,662,218, or 47.4 per cent of the total amount issued by all companies. The capital stock and bonds actually issued by companies paying either dividends or interest formed 87.1 per cent of their total authorized capitalization, and the dividends and interest paid by them represented a return of 4.5 per cent on capital stock and bonds actually issued.

Table 28 shows the amount and kind of capital stock of all companies paying dividends on common or preferred stock.

TABLE 28.—CAPITAL STOCK OF INCORPORATED COMPANIES PAYING DIVIDENDS ON COMMON OR PREFERRED STOCK, BY MINERALS: 1902.

[Exclusive of natural gas and petroleum.]

MINERAL.	Number of incorporated companies.	TOTAL.			COMMON STOCK.			PREFERRED STOCK.		
		Authorized.	Issued.	Dividends.	Authorized.	Issued.	Dividends.	Authorized.	Issued.	Dividends.
Total	919	$1,218,990,475	$1,045,760,265	$56,700,943	$1,061,491,108	$904,867,965	$47,972,272	$157,499,367	$140,892,300	$8,728,671
Asphaltum and bituminous rock	2	300,000	300,000	13,000	300,000	300,000	13,000	.....	.....	.....
Barytes	2	58,000	58,000	2,640	58,000	58,000	2,640	.....	.....	.....
Borax	2	2,250,000	2,150,000	231,600	2,250,000	2,150,000	231,600	.....	.....	.....
Cement	32	25,815,500	24,374,360	1,209,667	22,037,000	20,769,360	958,367	3,778,500	3,605,000	251,300
Clay	8	601,000	378,000	59,190	551,000	328,000	55,690	50,000	50,000	3,500
Coal, anthracite	20	26,170,400	25,759,150	1,936,459	26,110,400	25,719,050	1,933,251	60,000	40,100	3,208
Coal, bituminous	409	322,968,600	285,454,508	17,359,811	258,207,533	224,916,620	13,297,536	64,761,067	60,537,888	4,062,305
Copper ore	20	320,483,125	269,350,927	14,116,002	309,516,625	258,799,427	13,667,012	10,966,500	10,551,500	448,990
Corundum and emery	1	3,000,000	1,385,800	10,860	2,500,000	1,179,800	.....	500,000	206,000	10,860
Crystalline quartz	1	250,000	250,000	10,000	250,000	250,000	10,000	.....	.....	.....
Feldspar	2	198,000	148,000	8,800	198,000	148,000	8,800	.....	.....	.....
Gold and silver	135	243,187,750	191,020,365	10,454,744	237,716,950	185,616,933	10,121,711	5,470,800	5,403,432	330,033
Graphite	2	75,000	75,000	8,750	75,000	75,000	8,750	.....	.....	.....
Gypsum	6	620,000	620,000	64,300	620,000	620,000	64,300	.....	.....	.....
Infusorial earth, tripoli, and pumice	1	100,000	100,000	10,000	100,000	100,000	10,000	.....	.....	.....
Iron ore	43	173,730,300	157,487,070	6,329,405	116,762,300	110,133,700	3,183,440	56,968,000	47,353,370	3,145,965
Lead and zinc ore	49	36,707,000	28,858,550	2,500,015	34,407,000	27,208,400	2,446,475	2,300,000	1,650,150	53,540
Limestones and dolomites	86	12,386,200	10,908,335	751,534	10,409,200	9,491,375	681,353	1,977,000	1,416,960	70,181
Marble	5	6,345,000	6,305,000	239,250	4,345,000	4,305,000	139,250	2,000,000	2,000,000	100,000
Mineral pigments, crude	4	341,300	331,600	11,439	301,300	301,300	10,239	40,000	30,300	1,200
Phosphate rock	14	5,115,000	4,987,500	316,205	3,212,500	3,085,000	179,115	1,902,500	1,902,500	137,090
Precious stones	1	100,000	100,000	20,000	100,000	100,000	20,000	.....	.....	.....
Quicksilver	7	19,400,000	18,890,500	171,994	15,100,000	14,590,500	150,494	4,300,000	4,300,000	21,500
Sandstones and quartzites	20	5,045,000	4,843,400	276,956	5,020,000	4,822,800	275,732	25,000	20,600	1,224
Siliceous crystalline rocks	34	6,472,000	5,074,900	383,438	6,472,000	5,074,900	383,438	.....	.....	.....
Slate	9	1,911,300	1,797,800	111,154	1,511,300	1,455,800	82,679	400,000	342,000	28,475
Sulphur and pyrite	1	60,000	60,000	2,400	60,000	60,000	2,400	.....	.....	.....
Talc and soapstone	3	5,300,000	4,691,500	91,300	3,300,000	3,209,000	32,000	2,000,000	1,482,500	59,300

There were 919 companies that reported the payment of dividends on either common or preferred stock. The par value of the authorized capital stock of these companies amounted to $1,218,990,475, or 35.4 per cent of the total authorized capital stock of all companies, and the par value of the stock issued amounted to $1,045,760,265, or 36.0 per cent of the total capital stock issued by all companies. The dividends which were paid on either or both of these classes of stocks amounted to $56,700,943, or a return of 5.4 per cent on the stock issued by such companies.

Common stock.—Exclusive of the companies engaged in the production of natural gas and petroleum there were 3,724 companies authorized to issue common stock to the amount of $2,721,510,955. Of this number 3,686 companies had actually issued common stock to the par value of $2,306,374,172. As shown by Table 27 the par value of the authorized common stock of companies paying either dividends on one or the other class of stock or interest on bonds amounted to $1,286,510,908, and the par value of the common stock issued by these companies amounted to $1,109,335,428; the dividends paid amounted to $47,972,272, a return of 4.3 per cent on the common stock issued. These amounts include common stock on which no dividends were paid, but which was issued by companies paying dividends on preferred stock or interest on bonds. There were 837 companies that reported the payment of dividends on common stock and the statistics for the common stock of these companies are summarized in Table 29.

TABLE 29.—*Common stock of incorporated companies paying dividends on such stock: 1902.*

[Exclusive of natural gas and petroleum.]

MINERAL.	Number of companies.	COMMON STOCK. Authorized.	COMMON STOCK. Issued.	DIVIDENDS. Amount.	DIVIDENDS. Rate per cent.
Total	837	$801,434,650	$687,810,418	$47,972,272	7.0
Asphaltum and bituminous rock	2	300,000	300,000	13,000	4.3
Barytes	2	58,000	58,000	2,693	4.6
Borax	2	2,250,000	2,150,000	231,600	10.8
Cement	26	12,567,000	11,441,910	958,367	8.4
Clay	7	501,000	278,000	55,600	20.0
Coal, anthracite	19	25,860,400	25,469,050	1,933,251	7.6
Coal, bituminous	382	184,093,200	153,584,420	13,297,536	8.7
Copper ore	15	239,150,000	210,834,330	13,667,912	6.5
Crystalline quartz	1	250,000	250,000	10,000	4.0
Feldspar	2	198,000	148,000	8,800	5.9
Gold and silver	132	235,316,950	183,466,933	10,124,711	5.5
Graphite	2	75,000	75,000	8,750	11.7
Gypsum	6	620,000	620,000	64,300	10.4
Infusorial earth, tripoli, and pumice	1	100,000	100,000	10,000	10.0
Iron ore	30	44,975,300	44,834,300	3,183,440	7.1
Lead and zinc ore	41	27,957,000	20,758,400	2,446,475	11.8
Limestones and dolomites	81	8,328,200	7,808,775	681,353	8.7
Marble	5	4,345,000	4,365,000	139,250	3.2
Mineral pigments, crude	3	241,300	241,300	10,239	4.2
Phosphate rock	9	1,410,000	1,282,500	179,115	14.0
Precious stones	1	100,000	100,000	20,000	20.0
Quicksilver	6	9,400,000	8,890,500	150,494	1.7
Sandstones and quartzites	19	4,995,000	4,810,300	275,732	5.7
Siliceous crystalline rocks	33	6,072,000	4,774,900	383,458	8.0
Slate	7	911,300	808,800	82,679	9.5
Sulphur and pyrite	1	60,000	60,000	2,400	4.0
Talc and soapstone	2	300,000	300,000	32,000	10.7

The 60 companies that paid dividends on preferred stock but no dividends on common stock had common stock issued to the value of $183,139,447, or 64.8 per cent of the total common and preferred stock issued by these companies. The dividends paid on the preferred stock of these companies amounted to $6,102,385, a return of 6.1 per cent on the par value of such stock issued.

The common stock issued and on which dividends were paid amounted to $687,810,418, or only 29.8 per cent of the total amount of common stock issued by all companies. The dividends paid on this stock amounted to $47,972,272, or a return of 7 per cent. Of the 3,686 companies reporting the issue of common stock there were 2,849 that paid no dividends on such stock. The par value of the authorized common stock of these companies amounted to $1,920,076,305, or 70.6 per cent of the total for all companies, and the amount issued was valued at $1,618,563,754, or 70.2 per cent of the total amount issued. In addition 60 companies that reported the issue of common stock paid dividends on preferred stock but no dividends on common stock, and the statistics for these companies are summarized in the following table:

TABLE 30.—CAPITALIZATION OF INCORPORATED COMPANIES PAYING DIVIDENDS ON PREFERRED STOCK BUT NOT ON COMMON STOCK: 1902.

MINERAL.	Number of companies.	AGGREGATE CAPITALIZATION. Authorized.	AGGREGATE CAPITALIZATION. Issued.	CAPITAL STOCK. Total. Authorized.	CAPITAL STOCK. Total. Issued.	CAPITAL STOCK. Common. Authorized.	CAPITAL STOCK. Common. Issued.
Total	60	$369,447,292	$314,377,787	$334,504,125	$282,624,287	$224,660,158	$183,139,447
Cement	6	13,880,000	13,385,450	12,820,000	12,532,450	9,470,000	9,327,150
Clay	1	100,000	100,000	100,000	100,000	50,000	50,000
Coal, anthracite	1	485,000	386,100	310,000	200,100	250,000	250,000
Coal, bituminous	19	151,917,667	142,722,103	124,550,000	117,621,103	74,114,333	70,661,200
Copper ore	4	88,333,125	56,516,597	88,333,125	56,516,597	77,366,625	45,965,097
Corundum and emery	1	3,400,000	1,745,800	3,000,000	1,395,800	2,500,000	1,179,800
Gold and silver	3	3,800,000	3,532,007	3,800,000	3,532,007	2,400,000	2,150,000
Iron ore	11	78,595,500	68,750,670	73,708,000	64,403,170	41,741,000	37,902,300
Lead and zinc ore	1	5,100,000	5,024,600	5,106,000	5,024,600	3,800,000	3,800,000
Limestones and dolomites	5	4,681,000	3,765,560	3,628,000	2,769,560	2,081,000	1,682,600
Mineral pigments, crude	1	100,000	90,300	100,000	90,300	60,000	60,000
Phosphate rock	2	3,005,000	3,005,000	3,005,000	3,005,000	1,502,500	1,502,500
Quicksilver	1	10,000,000	10,000,000	10,000,000	10,000,000	5,700,000	5,700,000
Sandstones and quartzites	1	50,000	33,100	50,000	33,100	25,000	12,500
Slate	2	1,000,000	929,000	1,000,000	929,000	600,000	587,000
Talc and soapstone	1	5,000,000	4,391,500	5,000,000	4,391,500	3,000,000	2,909,000

MINERAL.	CAPITAL STOCK. Preferred. Authorized.	CAPITAL STOCK. Preferred. Issued.	CAPITAL STOCK. Preferred. Dividends. Amount.	CAPITAL STOCK. Preferred. Dividends. Rate per cent.	BONDS. Authorized.	BONDS. Issued.	BONDS. Interest. Amount.	BONDS. Interest. Rate per cent.
Total	$109,843,667	$99,484,840	$6,102,385	6.1	$34,943,167	$31,753,500	$1,826,618	5.8
Cement	3,350,000	3,205,000	227,310	7.1	1,060,000	853,000	39,856	4.7
Clay	50,000	50,000	3,500	7.0	.....	.....	.....	.....
Coal, anthracite	60,000	40,100	3,208	8.0	175,000	96,000	5,835	6.1
Coal, bituminous	50,485,667	47,559,903	3,325,659	7.0	27,367,667	25,101,000	1,451,191	5.8
Copper ore	10,966,500	10,551,500	448,990	4.3	.....	.....	.....	.....
Corundum and emery	500,000	200,000	10,860	5.3	400,000	360,000	24,000	6.7
Gold and silver	1,400,000	1,382,007	90,640	6.6	.....	.....	.....	.....
Iron ore	31,967,000	26,500,870	1,720,942	6.5	4,887,500	4,347,500	255,941	5.9
Lead and zinc ore	1,300,000	1,224,600	19,496	1.6	.....	.....	.....	.....
Limestones and dolomites	1,547,000	1,086,960	49,881	4.6	1,053,000	996,000	49,822	5.0
Mineral pigments, crude	40,000	30,300	1,200	4.0	.....	.....	.....	.....
Phosphate rock	1,502,500	1,502,500	90,200	6.0	.....	.....	.....	.....
Quicksilver	4,300,000	4,300,000	21,500	0.5	.....	.....	.....	.....
Sandstones and quartzites	25,000	20,600	1,224	5.9	.....	.....	.....	.....
Slate	400,000	342,000	28,475	8.3	.....	.....	.....	.....
Talc and soapstone	2,000,000	1,482,500	59,300	4.0	.....	.....	.....	.....

Preferred stock.—Exclusive of natural gas and petroleum, there were 244 companies authorized to issue preferred stock to the value of $210,378,437. Of this number 234 companies had actually issued preferred stock to the value of $180,083,899. As shown by Table 27, the par value of the authorized preferred stock of companies paying either dividends on one class of stock or interest on bonds amounted to $168,328,367, and the par value of the preferred stock issued by these companies amounted to $151,003,709. The dividends paid amounted to $8,728,671, or a return of 5.8 per cent on the preferred stock issued. These amounts include preferred stock on which no dividends were paid but which was issued by companies paying dividends on common stock or interest on bonds. There were 87 companies that reported the payment of dividends on preferred stock, and the statistics for the preferred stock of these companies are summarized in the following table:

TABLE 31.—*Preferred stock of incorporated companies paying dividends on such stock, by minerals: 1902.*

[Exclusive of natural gas and petroleum.]

MINERAL.	Number of companies paying dividends.	PREFERRED STOCK.		DIVIDENDS.	
		Authorized.	Issued.	Amount.	Rate per cent.
Total	87	$157,450,807	$140,892,300	$8,728,671	6.2
Cement	7	3,730,000	3,605,000	251,300	7.0
Clay	1	50,000	50,000	3,500	7.0
Coal, anthracite	1	60,000	40,100	3,208	8.0
Coal, bituminous	31	64,761,007	60,537,888	4,062,305	6.7
Copper ore	4	10,966,500	10,551,500	448,990	4.3
Corundum and emery	1	500,000	206,000	10,860	5.3
Gold and silver	5	5,470,800	5,403,432	330,033	6.1
Iron ore	13	56,968,000	47,353,370	3,145,965	6.6
Lead and zinc ore	5	2,300,000	1,650,150	53,540	3.2
Limestones and dolomites	8	1,977,000	1,416,960	70,181	5.0
Marble	1	2,000,000	2,000,000	100,000	5.0
Mineral pigments, crude	1	40,000	30,300	1,200	4.0
Phosphate rock	4	1,902,500	1,902,500	137,090	7.2
Quicksilver	1	4,300,000	4,300,000	21,500	0.5
Sandstones and quartzites	1	25,000	20,600	1,224	5.9
Slate	2	400,000	342,000	28,475	8.3
Talc and soapstone	1	2,000,000	1,482,500	59,300	4.0

The preferred stock on which dividends were paid amounted to $140,892,300, or 78.2 per cent of the total amount of preferred stock issued by all companies. The dividends paid on this stock amounted to $8,728,671, a return of 6.2 per cent on the amount issued. Of the 234 companies reporting the issue of preferred stock, there were 147 that paid no dividends on such stock. The par value of the authorized preferred stock of these companies was $52,927,570, or 25.3 per cent of the total for all companies, and the amount issued $39,191,599, or 21.8 per cent.

Bonds.—The $288,720,791 shown as the par value of the bonds issued includes all bonds issued by all companies irrespective of the payment of interest or dividends. The following table presents the statistics for the 363 companies that paid interest on bonds:

TABLE 32.—*Bonds of incorporated companies paying interest on bonds, by minerals: 1902.*

[Exclusive of natural gas and petroleum.]

MINERAL.	Number of incorporated companies.	Bonds authorized.	Bonds issued.	INTEREST.	
				Amount.	Rate per cent.
Total	363	$281,115,418	$257,233,551	$12,265,189	4.8
Barytes	1	200,000	179,000	6,000	3.4
Cement	25	6,821,400	6,081,700	316,962	5.2
Clay	4	331,000	331,000	18,110	5.5
Coal, anthracite	20	85,921,422	84,545,922	3,789,145	4.5
Coal, bituminous	179	136,696,196	127,345,479	6,115,828	4.8
Copper ore	4	3,800,000	3,001,000	174,500	5.8
Corundum and emery	1	400,000	360,000	24,000	6.7
Gold and silver	21	6,900,000	6,479,050	409,392	6.3
Graphite	1	20,000	18,000	1,080	6.0
Gypsum	2	45,000	45,000	2,700	6.0
Iron ore	22	10,637,500	9,923,000	521,111	5.3
Lead and zinc ore	7	11,515,000	5,270,000	226,200	4.3
Limestones and dolomites	25	5,369,500	4,742,500	258,362	5.4
Marble	7	3,405,000	1,727,500	93,290	5.4
Mineral pigments, crude	2	55,000	55,000	2,850	5.2
Phosphate rock	11	1,384,800	1,128,800	61,750	5.5
Quicksilver	1	145,000	145,000	6,000	4.1
Sandstones and quartzites	6	2,565,000	2,383,500	98,485	4.1
Siliceous crystalline rocks	13	3,137,000	2,148,500	89,873	4.2
Silica sand	1	41,100	41,100	2,466	6.0
Slate	8	1,025,500	665,500	34,425	5.2
Talc and soapstone	2	700,000	617,000	12,660	2.1

The bonds issued on which interest was paid amounted to $257,233,551, or 89.1 per cent of the total amount of bonds issued by all companies. The interest paid on these bonds amounted to $12,265,189, or a return of 4.8 per cent on the amount issued. The 363 companies that reported the payment of interest on bonds were authorized to issue bonds to the value of $281,115,418. The amount actually issued and on which interest was paid formed 91.5 per cent of the total authorized bonded debt.

Natural gas and petroleum.—As explained on page 76, the capitalization reported for natural gas and petroleum should be considered separately from that of other minerals. Table 33 shows that the total authorized capitalization of the companies engaged in the production of these substances amounted to $540,723,162, of which $442,540,596 had been issued. This includes the capitalization reported by the Standard Oil Company. A total of $17,054,705 is reported as having been paid in dividends and interest on bonds, representing a return of 3.8 per cent on the capitalization (stock and bonds) issued. In Table 33 the capitalization shown as issued includes all stock and bonds irrespective of the payment of dividends and interest.

TABLE 33.—*Capitalization of incorporated companies producing natural gas and petroleum and reporting capitalization: 1902.*

	Total.	Natural gas.	Petroleum.
Number of companies reporting	831	433	[1] 398
Total capital stock and bonds:			
Authorized	$540,723,162	$120,043,673	$420,679,489
Issued	442,540,596	111,634,737	330,905,859
Dividends and interest	17,054,705	5,985,436	11,069,269
Capital stock—			
Total authorized	508,305,295	99,400,806	408,904,489
Total issued	416,377,473	92,190,870	324,186,603
Total dividends paid	15,715,970	4,944,034	10,771,936
Common—			
Authorized	502,726,675	98,565,806	404,160,869
Issued	412,422,812	91,385,870	321,036,942
Dividends paid	15,638,697	4,894,134	10,744,563
Preferred—			
Authorized	5,578,620	835,000	4,743,620
Issued	3,954,661	805,000	3,149,661
Dividends paid	77,273	49,900	27,373
Bonds—			
Authorized	32,417,867	20,642,867	11,775,000
Issued	26,163,123	19,443,867	6,719,256
Interest	1,338,735	1,041,402	297,333

[1] The 28,925 producers reported by the Standard Oil Company are included as 1 incorporated company.

Considering the report of the Standard Oil Company as representing a single producer for natural gas and for petroleum, the following table shows the number of operators and the capitalization of the companies reporting the payment of dividends on either common or preferred stock or interest on bonds:

TABLE 34.—*Capitalization of natural gas and petroleum companies paying dividends or interest on bonds: 1902.*

	Total.	Natural gas.	Petroleum.
Number of companies reporting dividends or interest	248	164	84
Total capital stock and bonds:			
Authorized	$323,419,247	$98,013,747	$225,405,500
Issued	$281,335,689	$94,272,929	$187,062,760
Capital stock—			
Authorized	$292,728,380	$78,072,880	$214,655,500
Issued	$256,612,860	$75,446,062	$181,166,798
Common—			
Authorized	$289,528,380	$77,272,880	$212,255,500
Issued	$253,726,423	$74,676,062	$179,050,361
Dividends paid	$15,638,697	$4,894,134	$10,744,563
Rate per cent	6.2	6.6	6.0
Preferred—			
Authorized	$3,200,000	$800,000	$2,400,000
Issued	$2,886,437	$770,000	$2,116,437
Dividends paid	$77,273	$49,900	$27,373
Rate per cent	2.7	6.5	1.3
Bonds—			
Authorized	$30,690,867	$19,940,867	$10,750,000
Issued	$24,722,829	$18,826,867	$5,895,962
Interest paid	$1,338,735	$1,041,402	$297,333
Rate per cent	5.4	5.5	5.0

The par value of the authorized capital stock and bonds of the 248 companies paying either dividends or interest on all or part of their capitalization amounted to $323,419,247, or 59.8 per cent of the total authorized capitalization of all companies reported as engaged in the production of natural gas and petroleum. The par value of the capital stock and bonds issued by these companies amounted to $281,335,689, or 63.6 per cent of the total amount issued. The capitalization actually issued by companies paying either dividends or interest formed 87 per cent of their total authorized capitalization, and the dividends and interest paid by them represented a return of 6.1 per cent on capital stock and bonds actually issued.

Of the 248 companies there were 216 that reported the payment of dividends on either common or preferred stock. The par value of the authorized capital stock of these companies amounted to $225,767,930, or 41.8 per cent of the total authorized capital stock of all companies; and the par value of the stock issued amounted to $211,774,741, or 47.9 per cent of the total capital stock issued by all companies. The dividends that were paid on either or both of these classes of stock amounted to $15,715,970, or a return of 7.4 per cent on the stock issued by such companies.

Capitalization of incorporated companies, by states and territories.—As previously explained, the capital stock of incorporated companies represented their entire capitalization. In some cases the companies operated mines in different states and were engaged in the production of different minerals. For instance, a mining company engaged primarily in the production of iron ore may also operate a limestone quarry, and some of its enterprises may be located in different states. It was impracticable to segregate the capital stock so as to show the amount devoted to each industry in each state, therefore the total capitalization was assigned to the mineral or state representing the interest of greatest value. With the exception of buhrstones and millstones, lithium ore, tungsten, and uranium and vanadium, the production of all of the minerals for which separate statistics are shown was controlled to some extent by the corporate form of organization and incorporated companies were reported for every state and territory in which minerals were mined. Statistics concerning employees, wages, expenses, and production of incorporated companies are given in Table 23, page 68, but since in an unknown number of instances the capital stock represented interests other than mining and since the capitalization for some companies was not reported or, for the reasons explained above, was excluded from the statistics, a satisfactory comparison of capitalization and production is impracticable. The statistics for the capitalization for all minerals in each state and territory are presented in Table 35.

TABLE 35.—CAPITALIZATION OF INCORPORATED

	STATE OR TERRITORY.	Number of incorporated companies.	Number reporting.	AGGREGATE CAPITALIZATION. Authorized.	Issued.	Interest and dividends.	CAPITAL STOCK. Total. Authorized.	Issued.	Dividends.
1	United States	5,386	4,876	$3,801,264,332	$3,217,719,458	$86,020,837	$3,440,194,687	$2,902,835,541	$72,416,913
2	Alabama	111	105	92,613,200	78,146,800	2,080,030	70,689,700	58,723,300	979,588
3	Alaska	1	1	2,004,000	1,789,000	14,250	1,504,000	1,504,000	.....
4	Arizona	67	66	88,795,000	70,398,622	4,150,296	84,360,000	66,186,092	4,071,586
5	Arkansas	33	32	21,196,800	14,921,750	328,109	19,206,800	13,022,750	328,109
6	California	512	484	438,557,414	335,109,463	3,186,120	431,327,414	331,683,413	3,098,375
7	Colorado	484	457	567,847,417	496,634,683	6,298,171	538,099,917	468,130,033	5,069,742
8	Connecticut	19	18	4,467,000	3,851,900	92,195	3,797,000	3,181,900	64,695
9	Delaware	7	7	1,776,000	1,296,000	16,360	1,770,000	1,290,000	16,000
10	Florida	28	24	6,594,800	6,217,800	179,890	5,318,000	5,197,000	121,380
11	Georgia	61	53	45,623,500	31,002,500	207,920	43,983,500	29,556,400	156,270
12	Hawaii	1	.....	.....	.....	.....	.....	.....	.....
13	Idaho	77	72	83,788,400	67,712,257	925,771	82,954,200	66,878,357	881,771
14	Illinois	251	244	43,437,400	40,137,600	1,081,745	37,787,400	35,126,600	799,619
15	Indian Territory	27	27	10,139,000	6,056,500	1,650	9,339,000	5,471,500	1,650
16	Indiana	480	370	68,551,760	61,339,145	3,726,801	53,646,093	50,178,178	2,980,151
17	Iowa	101	98	9,024,500	7,630,310	184,767	8,136,500	6,987,310	167,187
18	Kansas	102	75	19,001,915	16,131,027	321,791	17,449,215	14,578,327	272,951
19	Kentucky	176	166	47,895,000	37,327,446	529,623	45,570,800	35,362,984	448,752
20	Louisiana	3	3	960,000	520,000	.....	960,000	520,000	.....
21	Maine	32	28	9,339,500	8,506,100	169,422	6,212,000	5,158,100	31,177
22	Maryland	50	48	27,456,800	24,072,750	800,335	22,821,800	19,593,750	570,995
23	Massachusetts	37	37	13,876,000	9,801,450	263,383	10,790,000	8,137,950	202,400
24	Michigan	114	100	182,704,000	163,075,845	6,831,177	168,939,000	158,311,045	6,763,801
25	Minnesota	41	36	65,340,000	57,194,300	1,738,009	65,315,000	57,169,300	1,738,009
26	Missouri	231	224	69,431,600	43,075,110	1,037,526	65,283,600	41,598,840	966,546
27	Montana	94	92	392,474,060	329,892,980	7,066,269	388,781,000	327,223,980	6,891,969
28	Nebraska	3	3	65,000	65,000	2,250	65,000	65,000	2,250
29	Nevada	47	45	55,752,400	49,860,796	80,002	55,752,400	49,860,796	80,002
30	New Hampshire	13	13	769,500	668,450	1,100	769,500	668,450	1,100
31	New Jersey	49	42	33,724,100	25,680,750	2,138,434	22,886,600	20,843,250	1,965,934
32	New Mexico	62	57	64,617,000	41,103,491	189,410	62,932,000	39,193,491	111,110
33	New York	119	104	42,704,400	39,942,550	886,767	36,106,900	34,177,550	722,411
34	North Carolina	30	24	19,208,425	13,552,625	6,000	18,098,425	12,513,625	.....
35	North Dakota	9	8	2,375,000	2,085,000	.....	2,375,000	2,085,000	.....
36	Ohio	321	278	117,090,500	109,767,280	7,090,582	101,989,500	97,476,780	6,597,163
37	Oklahoma	4	4	760,000	660,000	2,400	760,000	660,000	2,400
38	Oregon	58	51	44,516,800	29,437,421	65,269	44,516,800	29,437,421	65,269
39	Pennsylvania	596	518	490,581,392	461,959,660	21,689,856	344,742,703	329,600,638	15,629,867
40	Rhode Island	3	3	600,000	568,400	.....	600,000	568,400	.....
41	South Carolina	22	19	3,437,000	2,916,500	21,740	3,129,000	2,608,500	2,500
42	South Dakota	29	29	68,455,500	57,096,144	271,443	68,455,500	57,096,144	271,443
43	Tennessee	100	95	28,995,480	26,759,749	611,965	24,473,820	22,872,089	433,068
44	Texas	183	174	113,494,400	87,969,608	1,025,024	107,440,400	82,932,911	806,090
45	Utah	96	93	116,384,400	112,299,074	4,482,497	114,315,000	110,260,671	4,403,803
46	Vermont	27	26	12,443,100	10,090,300	274,554	9,393,100	8,741,800	239,584
47	Virginia	63	51	17,265,200	15,148,200	268,280	15,790,200	13,706,200	209,280
48	Washington	50	46	93,005,029	73,808,603	1,202,212	76,723,200	58,676,774	642,112
49	West Virginia	274	250	130,969,700	114,835,344	3,924,022	114,404,700	100,105,844	3,225,197
50	Wisconsin	67	59	14,588,000	13,862,575	401,020	13,933,000	13,307,575	375,270
51	Wyoming	21	17	16,567,000	12,800,600	154,400	16,467,000	12,700,600	149,000

COMPANIES, BY STATES AND TERRITORIES: 1902.

CAPITAL STOCK—continued.						BONDS.			
Common.			Preferred.						
Authorized.	Issued.	Dividends.	Authorized.	Issued.	Dividends.	Authorized.	Issued.	Interest.	
$3,224,237,630	$2,718,796,984	$63,610,969	$215,957,057	$184,038,560	$8,805,944	$361,069,645	$314,883,914	$13,603,924	1
55,927,200	48,139,600	317,413	14,762,500	10,583,700	662,175	21,923,500	19,423,500	1,100,442	2
1,500,000	1,500,000	.....	4,000	4,000	.....	500,000	285,000	14,250	3
82,340,000	64,186,092	4,071,586	2,020,000	2,000,000	.....	4,435,000	4,212,510	78,710	4
12,714,900	11,217,425	253,514	6,491,900	1,805,425	74,595	1,900,000	1,899,000	.....	5
418,827,294	319,856,252	2,691,707	12,500,120	11,827,161	316,668	7,230,000	3,426,050	177,745	6
526,307,217	458,516,833	4,578,349	11,792,700	9,913,200	431,393	29,747,500	28,204,650	1,288,429	7
2,747,000	2,520,400	48,900	1,050,000	661,500	15,795	670,000	670,000	27,500	8
1,370,000	890,000	16,000	400,000	400,000	.....	6,000	6,000	360	9
5,008,000	4,887,000	92,490	310,000	310,000	31,890	1,276,800	1,020,800	55,510	10
41,221,000	27,015,500	156,270	2,762,500	2,540,500	.....	1,640,000	1,440,500	51,650	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	12
79,454,200	65,029,857	881,771	3,500,000	1,848,500	.....	834,200	833,900	44,000	13
36,654,400	34,103,600	786,459	1,133,000	1,022,000	13,160	5,650,000	5,012,000	282,126	14
9,339,000	5,474,500	1,650	.....	.....	.....	800,000	582,000	.....	15
53,237,093	49,770,478	2,955,911	408,000	408,000	24,240	14,905,667	14,160,667	746,650	16
5,956,520	4,808,240	166,137	2,179,980	2,179,070	1,050	888,000	643,000	17,580	17
17,339,215	14,468,327	272,951	110,000	110,000	.....	1,552,700	1,552,700	48,840	18
45,530,800	35,322,984	447,532	40,000	40,000	1,200	2,324,200	1,964,462	80,891	19
760,000	520,000	.....	200,000	.....	.....	.....	.....	.....	20
5,135,000	4,551,100	26,177	1,107,000	907,000	5,000	3,097,500	3,048,000	138,245	21
20,686,800	17,645,770	439,045	2,135,000	1,948,000	131,950	4,635,000	4,479,000	229,340	22
10,290,000	7,931,950	191,600	530,000	206,000	10,860	3,086,000	1,663,500	60,923	23
138,749,000	132,269,045	5,297,818	30,190,000	26,042,000	1,465,983	13,765,000	4,764,800	67,376	24
40,275,000	36,277,300	313,026	25,040,000	20,892,000	1,424,983	25,000	25,000	.....	25
61,370,600	38,356,505	913,006	3,913,000	3,242,355	53,540	4,148,000	1,476,250	70,980	26
382,484,000	321,172,580	6,744,069	6,390,000	6,051,400	150,000	3,690,000	2,669,000	172,200	27
65,000	65,000	2,250	.....	.....	.....	.....	.....	.....	28
55,302,400	49,560,796	32,002	450,000	300,000	48,000	.....	.....	.....	29
769,500	668,450	1,100	.....	.....	.....	.....	.....	.....	30
20,056,600	18,040,650	1,886,210	2,830,000	2,802,600	79,724	10,837,500	4,837,500	172,500	31
62,232,000	38,793,491	74,410	700,000	700,000	40,000	1,685,000	1,610,000	75,000	32
29,626,900	28,245,050	645,111	6,480,000	5,932,500	77,300	6,597,500	5,765,000	161,356	33
17,993,425	12,408,625	.....	105,000	105,000	.....	1,110,000	1,039,000	6,000	34
2,375,000	2,085,000	.....	.....	.....	.....	.....	.....	.....	35
99,911,500	96,022,280	6,561,093	2,078,000	1,454,500	36,070	15,101,000	12,290,500	493,419	36
760,000	660,000	2,400	.....	.....	.....	.....	.....	.....	37
44,516,800	29,437,421	65,269	.....	.....	.....	.....	.....	.....	38
290,349,496	269,587,590	12,442,037	54,393,207	51,013,048	3,187,830	146,838,080	141,359,022	6,059,989	39
600,000	568,400	.....	.....	.....	.....	.....	.....	.....	40
2,861,000	2,373,500	2,500	265,000	235,000	.....	308,000	308,000	19,240	41
67,555,500	56,214,137	253,803	900,000	882,007	17,640	.....	.....	.....	42
22,046,660	20,599,485	319,215	2,427,160	2,272,604	114,453	4,521,660	3,887,660	178,297	43
105,090,400	81,903,914	781,895	2,350,000	1,029,000	24,195	6,054,000	5,036,691	218,934	44
114,265,500	110,260,674	4,403,800	48,500	.....	.....	2,069,400	1,978,400	78,697	45
7,366,600	6,730,300	139,584	2,026,500	2,014,500	100,000	3,050,000	1,345,500	34,970	46
14,515,200	12,531,200	200,280	1,275,000	1,175,000	.....	1,475,000	1,442,000	59,000	47
67,580,210	51,130,684	385,862	9,142,990	7,546,090	256,250	16,281,829	15,131,829	560,100	48
113,059,700	98,760,844	3,215,497	1,345,000	1,345,000	10,000	16,565,000	14,729,500	698,525	49
13,643,000	13,017,575	375,270	290,000	290,000	.....	655,000	555,000	25,750	50
16,467,000	12,700,600	149,000	.....	.....	.....	100,000	100,000	5,400	51

VIII.

EMPLOYEES AND WAGES.[1]

The schedules used at the Twelfth Census for collecting statistics of employees and wages contained several important inquiries not used at previous censuses. Thus in 1902 employees were segregated into general groups of occupations, to show the prevailing daily rates of pay for each occupation and the average number employed during each month of the year; the number engaged in mining or quarrying who received pay according to the quantity of work done (namely, the number of tons, cars, or yards mined) and the total amount paid for such work; the amount paid for contract work, such as tunneling, sinking of shafts, boring test holes, etc., when done by independent contractors, and the number of men employed in such work; and, finally, the total number of days that the mines or quarries were in operation during the year.

No provision was made in the schedule for a separate report of female employees, either wage-earners or those receiving salaries. There is no doubt that among the salaried employees there were some female clerks, but so few as to be a negligible quantity and of no statistical importance, and none of them was engaged in the actual mining or quarrying. On the other hand the number of females engaged in the different branches of manufacturing is comparatively large and, therefore, of vital economic and sociologic importance.

In the various tables in this report showing wage-earners and wages comparisons have been made with the statistics of earlier censuses whenever they were available; but because of the adoption of a radically different method of ascertaining the average number of wage-earners at this census any comparisons will be invalidated to a considerable degree. In the schedules for 1889 the inquiry as to the number of persons employed asked for the number of foremen or overseers separately, but the inquiry as to the amount of wages paid did not call for a separate statement as to the amount paid in wages to this class of employees. As a result, the statistics for labor and wages published in the Report on Mineral Industries at the Eleventh Census show separately the number of foremen and overseers, but not the amounts received by them, and in no case can the wages paid to this class of employees be separated. In the statistics for 1902, on the other hand, foremen and overseers, with their salaries, are included with superintendents, managers, surveyors, etc., and not with wage-earners.

Again, the schedule for 1889 called for a separate statement as to the amount paid for contract work, but not for the number of persons employed on such work, though such employees were probably included in the total average number of wage-earners.

In the schedule for 1889 the inquiry as to labor and wages is followed by this note: "In giving the number of men employed include those employed by contractors and subcontractors as well as by the company itself." In the corresponding inquiry of the schedule for 1902 the note of instruction reads as follows: "Amounts paid for contract work not done by employees hired directly, and the number employed in such work, must not be included in this inquiry, but should be reported in answer to inquiry 6." In inquiry 6 of the schedule for 1902 the amount paid for tunneling, shaft sinking, boring test holes, etc., if not done by employees hired directly, and the average number of men employed on such work are asked for separately.

The greatest difference, however, between the statistics for the two censuses results from a radical change in the method of obtaining the average number of persons employed. In editing the schedules for 1902 the figures for the average number of employees were reduced to a 300-day basis whenever the schedule showed them to be the average number for a shorter period; when it was evident that the employees had worked more than 300 days, the average number for the longer period was allowed to stand. The figures for 1902, therefore, show the average number of employees that would be required at continuous employment throughout the year to perform the work done, while the figures for 1889 represent the average number employed during the actual time that the several establishments concerned were in operation and not an average number for the whole year.[2]

It is obvious that the method adopted in 1902 tends to produce a smaller average number than the method employed in 1889. This is illustrated in the statistics for several minerals as shown in this report. Thus, for example, the statistics for the production of marble, which show an increase in value of product between 1889 and 1902 of over $1,500,000, seem to show a decrease in the average number of wage-earners. Excluding the number of foremen and overseers for both years, the figures are as follows: 1889, 4,275; 1902, 4,070. But while the figures for 1902 represent the continuous employment of 4,070 men for 300 days, the average number of days worked by the 4,275 wage-earners in 1889, as the detailed statistics show, was only 255. Reduced to a 300-day basis, the average number of wage-earners for 1889 is found to be 3,648, thus showing that there has been a substantial increase during the decade.

[1] This section and the sections following, Contract Mining and Quarrying and Contract Work, were prepared by Mr. Joseph D. Lewis, chief of the division of manufactures.

[2] The difference between the two methods of computing the average is practically the same as in the statistics for manufactures of the Eleventh and Twelfth censuses and is fully explained in the Report on Manufactures for the Twelfth Census. (See Part I, pages cvi to cxi.) The instructions for verifying and correcting the number of wage-earners reported for 1902 are given in Appendix C.

It should be stated also that it is impracticable to make a comparison of the statistics of wage-earners and wages at the two censuses for the entire mining industry because the figures were not summarized for the earlier period.

Employees, by classes.—The following table summarizes the totals reported for 1902 in answer to that part of the inquiry which called for the average number of each class of salaried employees and wage-earners and the amounts paid them:

TABLE 36.—*Employees by classes: 1902.*

Salaried officials, clerks, etc.:	
Total number	38,128
Total salaries	$39,020,552
General officers—	
Number	4,591
Salaries	$8,218,541
Superintendents, managers, foremen above ground, surveyors, etc.—	
Number	15,538
Salaries	$16,666,416
Foremen below ground—	
Number	6,863
Salaries	$6,208,307
Clerks—	
Number	11,136
Salaries	$7,927,288
Wage-earners:	
Aggregate average number	581,728
Aggregate wages	$369,950,960
Above ground—	
Total average number	221,505
Total wages	$125,086,530
Engineers, firemen, machinists, blacksmiths, carpenters, and other mechanics—	
Average number	60,859
Wages	$44,478,246
Miners, quarrymen, and stonecutters—	
Average number	67,129
Wages	$33,971,290
Boys under 16 years—	
Average number	6,219
Wages	$1,339,478
All other wage-earners—	
Average number	87,298
Wages	$45,297,516
Below ground—	
Total average number	360,223
Total wages	$244,873,430
Miners—	
Average number	257,301
Wages	$184,674,193
Miners' helpers—	
Average number	18,736
Wages	$11,496,910
Boys under 16 years—	
Average number	5,638
Wages	$1,518,889
All other wage-earners—	
Average number	78,548
Wages	$47,153,438

Table 36 shows the number of all classes of employees reduced to the yearly average as above described, with the amount paid to each class in salaries and wages. Salaried officials, clerks, etc., usually receive annual or monthly salaries and, as a rule, are employed throughout the entire year; consequently, for this class, in a great majority of cases, it was unnecessary to make the reduction to the average for the year.

The employees shown in Table 36 may be arranged in two groups—first, the office force, which consisted of 15,727 general officers and clerks, receiving $16,145,829 as salaries, the number and salaries forming 2.5 and 3.9 per cent, respectively, of the totals for all employees; second, the employees engaged in supervising and in the actual work of the mines and quarries, which include the superintendents, managers, foremen, surveyors, etc., as well as the mechanics, the miners and their helpers, and all other wage-earners. This class numbered 604,129, and their salaries and wages amounted to $392,834,683, forming 97.5 and 96.1 per cent, respectively, of the totals. The superintendents, managers, foremen, and surveyors are classed as salaried officials though the distinction between foremen and miners is difficult to preserve, especially when there is very little, if any, difference in their wages.

Exclusive of the general officers and clerks, 237,043 employees, or 38.3 per cent of the total number were engaged in operations above ground, and the salaries and wages paid for such work amounted to $141,752,946, or 34.7 per cent of the total. The employees reported as engaged below ground numbered 367,086, or 59.2 per cent, and their salaries and wages amounted to $251,081,737, or 61.4 per cent of the total. The separation of employees so as to show the numbers working above and below ground can not be accepted as exact, because the same employees may, at different times, work in both places, and in some classes of mining the distinction between the two branches of work is not preserved uniformly. From Table 1, pages 348 to 361, it appears that employees working below ground were reported for the majority of the minerals; but of the total number of such employees 352,472, or all but 7,751, were employed in the mining of coal, iron, copper, gold and silver, and the salaries and wages they received amounted to $240,737,543, or all but $4,135,887 of the total salaries and wages paid for work below ground.

The miners, miners' helpers, quarrymen, and stonecutters, who may be accepted as the employees engaged in the actual work of removing the ore or mineral, and dressing the stone at the quarry, numbered 343,166, or 59 per cent of the total number of wage-earners, and their wages amounted to $230,142,393, or 62.2 per cent of the total wages.

Wage-earners, by occupations.—Table 37 shows the distribution of the several classes of wage-earners according to occupations, by minerals and groups of minerals.

TABLE 37.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO OCCUPATIONS, BY MINERALS AND GROUPS OF MINERALS: 1902.

MINERALS, BY GROUPS.	All wage-earners (number).	ENGINEERS.		FIREMEN.		MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.		MINERS, QUARRYMEN, AND STONE-CUTTERS.		MINERS' HELPERS.		TIMBERMEN AND TRACK LAYERS.		BOYS UNDER 16 YEARS.		ALL OTHER WAGE-EARNERS.	
		Number.	Per cent of all wage-earners.	Number.	Per cent of all wage-earners.	Number.	Per cent of all wage-earners.	Number.	Per cent of all wage-earners.	Number.	Per cent of all wage-earners.	Number.	Per cent of all wage-earners.	Number.	Per cent of all wage-earners.	Number.	Per cent of all wage-earners.
Total	581,728	26,249	4.5	8,740	1.5	25,870	4.5	324,430	55.8	18,736	3.2	13,544	2.3	11,857	2.0	152,302	26.2
Metallic	110,404	3,763	3.4	2,027	1.9	6,643	6.0	55,124	49.9	7,730	7.0	3,558	3.2	699	0.6	30,850	28.0
Copper ore	26,007	552	2.1	487	1.9	1,819	7.0	12,821	49.3	1,257	4.8	863	3.3	103	0.4	8,105	31.2
Gold and silver	36,142	1,528	4.2	465	1.3	2,522	7.0	19,737	54.6	3,293	9.1	536	1.5	27	0.1	8,034	22.2
Iron ore	38,851	1,102	2.8	812	2.1	1,842	4.8	18,556	47.8	2,293	5.9	2,099	5.4	518	1.3	11,629	29.9
Lead and zinc ore	7,881	528	6.7	224	2.8	397	5.0	3,300	41.9	658	8.3	36	0.5	30	0.4	2,708	34.4
Manganese ore	194	15	7.7	7	3.6	4	2.1	96	49.5	3	1.5	.....	.....	13	6.7	56	28.9
Quicksilver	1,329	38	2.9	42	3.2	59	4.4	614	46.2	226	17.0	24	1.8	8	0.6	318	23.9
Fuels	372,559	19,148	5.2	5,134	1.4	14,183	3.8	207,040	55.6	10,558	2.8	9,820	2.6	10,194	2.7	96,482	25.9
Coal, anthracite	69,691	2,064	3.0	1,836	2.6	2,613	3.8	17,767	25.5	6,921	9.9	1,977	2.8	4,564	6.5	31,949	45.8
Coal, bituminous	280,638	3,781	1.4	3,112	1.1	6,739	2.4	189,273	67.4	3,637	1.3	7,843	2.8	5,628	2.0	60,625	21.6
Natural gas	4,678	352	7.5	121	2.6	1,074	23.0	.....	.....	.....	.....	.....	.....	2	(1)	3,129	66.9
Petroleum	17,552	12,951	73.8	65	0.4	3,757	21.4	.....	.....	.....	.....	.....	.....	.....	.....	779	4.4
Structural materials	86,295	2,909	3.4	1,287	1.5	4,419	5.1	54,476	63.1	237	0.3	22	(1)	872	1.0	22,073	25.6
Cement	13,041	337	2.6	338	2.6	1,417	10.9	3,031	23.2	220	1.7	20	0.2	111	0.8	7,567	58.0
Clay	2,433	53	2.2	19	0.8	34	1.4	1,649	67.8	17	0.7	2	0.1	30	1.2	629	25.8
Limestones and dolomites	31,547	940	3.0	358	1.1	935	3.0	22,036	69.8	.....	.....	.....	.....	258	0.8	7,020	22.3
Marble	4,070	113	2.8	80	2.0	324	8.0	2,513	61.7	.....	.....	.....	.....	22	0.5	1,018	25.0
Sandstones and quartzites	10,448	529	5.1	241	2.3	478	4.6	7,117	68.1	.....	.....	.....	.....	76	0.7	2,007	19.2
Siliceous crystalline rocks	18,836	658	3.5	164	0.9	1,094	5.8	14,474	76.8	.....	.....	.....	.....	206	1.1	2,240	11.9
Slate	5,920	279	4.7	87	1.5	137	2.3	3,656	61.8	.....	.....	.....	.....	169	2.8	1,592	26.9
Abrasive materials	610	40	6.5	15	2.5	20	3.3	402	65.9	10	1.6	.....	.....	3	0.5	120	19.7
Buhrstones and millstones	86	2	2.3	.....	.....	2	2.3	80	93.1	.....	.....	.....	.....	.....	.....	2	2.3
Corundum and emery	47	4	8.5	.....	.....	2	4.3	23	48.9	10	21.3	.....	.....	.....	.....	8	17.0
Crystalline quartz	29	1	3.4	.....	.....	.....	.....	26	89.7	.....	.....	.....	.....	.....	.....	2	6.9
Garnet	118	4	3.4	1	0.9	5	4.2	61	51.7	.....	.....	.....	.....	.....	.....	47	39.8
Grindstones and pulpstones	210	24	11.4	14	6.7	10	4.8	118	56.2	.....	.....	.....	.....	2	0.9	42	20.0
Infusorial earth, tripoli, and pumice	35	2	5.7	.....	.....	.....	.....	23	65.7	.....	.....	.....	.....	.....	.....	10	28.6
Oilstones, whetstones, and scythe-stones	85	3	3.5	.....	.....	1	1.2	71	83.5	.....	.....	.....	.....	1	1.2	9	10.6
Chemical materials	8,835	278	3.1	227	2.6	277	3.1	5,539	62.7	144	1.6	128	1.5	55	0.6	2,187	24.8
Borax	153	8	5.2	3	2.0	6	3.9	66	43.1	27	17.7	.....	.....	.....	.....	43	28.1
Fluorspar	269	16	6.0	4	1.5	5	1.9	176	65.4	9	3.3	.....	.....	2	0.7	57	21.2
Gypsum	1,472	52	3.5	29	2.0	20	1.4	614	41.7	.....	.....	.....	.....	3	0.2	754	51.2
Phosphate rock	5,971	173	2.9	169	2.8	171	2.9	4,382	73.4	.....	.....	111	1.9	37	0.6	928	15.5
Sulphur and pyrite	970	29	3.0	22	2.3	75	7.7	301	31.0	108	11.1	17	1.8	13	1.3	405	41.8
Pigments	592	19	3.2	6	1.0	12	2.0	411	69.4	20	3.4	12	2.0	2	0.4	110	18.6
Barytes	336	2	0.6	2	0.6	.....	.....	321	95.5	1	0.3	.....	.....	2	0.6	8	2.4
Mineral pigments, crude	256	17	6.6	4	1.6	12	4.7	90	35.2	19	7.4	12	4.7	.....	.....	102	39.8
Miscellaneous	2,433	92	3.8	34	1.4	316	13.0	1,438	59.1	37	1.5	4	0.2	32	1.3	480	19.7
Asbestos	23	1	4.3	2	8.7	2	8.7	17	74.0	.....	.....	.....	.....	.....	.....	1	4.3
Asphaltum and bituminous rock	156	6	3.8	4	2.6	7	4.5	116	74.4	1	0.6	1	0.6	.....	.....	21	13.5
Bauxite	150	9	6.0	3	2.0	5	3.4	77	51.3	.....	.....	.....	.....	3	2.0	53	35.3
Feldspar	252	11	4.4	1	0.4	6	2.4	183	72.6	.....	.....	.....	.....	3	1.2	48	19.0
Flint	119	5	4.2	2	1.7	4	3.4	65	54.6	.....	.....	.....	.....	.....	.....	43	36.1
Fuller's earth	114	4	3.5	5	4.4	3	2.6	54	47.3	.....	.....	.....	.....	24	21.1	24	21.1
Graphite	164	8	4.9	1	0.6	18	11.0	87	53.0	6	3.7	3	1.8	1	0.6	40	24.4
Lithium ore	6	.....	.....	.....	.....	.....	.....	6	100.0	.....	.....	.....	.....	.....	.....	.....	.....
Marl	13	1	7.7	1	7.7	.....	.....	10	76.9	.....	.....	.....	.....	1	7.7	.....	.....
Mica	98	5	5.1	1	1.0	6	6.1	70	71.4	3	3.1	.....	.....	.....	.....	13	13.3
Monazite	88	.....	.....	.....	.....	.....	.....	86	97.7	.....	.....	.....	.....	.....	.....	2	2.3
Precious stones	108	.....	.....	.....	.....	4	3.7	79	73.2	5	4.6	.....	.....	.....	.....	20	18.5
Silica sand	335	21	6.2	3	0.9	8	2.4	149	44.5	.....	.....	.....	.....	.....	.....	154	46.0
Talc and soapstone	771	21	2.7	10	1.3	251	32.6	411	53.3	17	2.2	.....	.....	.....	.....	61	7.9
Tungsten	2	.....	.....	.....	.....	.....	.....	2	100.0	.....	.....	.....	.....	.....	.....	.....	.....
Uranium and vanadium	19	.....	.....	.....	.....	2	10.5	17	89.5	.....	.....	.....	.....	.....	.....	.....	.....
All other minerals [3]	15	.....	.....	1	6.7	.....	.....	9	60.0	5	33.3	.....	.....	.....	.....	.....	.....

[1] Less than one-tenth of 1 per cent.
[2] Includes pumpmen.
[3] Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.

Table 37 shows the relative proportions of the several classes of wage-earners that were required in the different branches of the mineral industry. The schedule of inquiry, of course, could not be made in sufficient detail to show separately all classes of occupations, and consequently a large number of wage-earners that in a complete presentation would be given separately are included in the class of "all other wage-earners." A very large proportion of this class, however, were common workmen or unskilled laborers. For the industry as a whole the percentages which the numbers of the different classes of wage-earners were of the total number are as follows: Engineers, 4.5 per cent; firemen, 1.5; mechanics, 4.5; miners, quarrymen, and stone

cutters, 55.8; miners' helpers, 3.2; timbermen and track layers, 2.3; boys under 16 years, 2; all other wage-earners, 26.2.

So far as possible the minerals in Table 37 are arranged in groups according to their character or the uses to which they are put. For the reason that there is, as a rule, a similarity in the conditions of mining the minerals in the same groups, the statistics in each group are more comparable with each other than with those of different groups. A notable exception, however, is found in the group of fuels, in which the statistics for natural gas and petroleum are not at all analogous to those for coal, and are not in any sense comparable with them on account of the entirely different conditions governing production.

The conditions that chiefly affect the proportions of the several classes of wage-earners are the methods of mining, whether surface or underground, and whether the mineral is sold in the crude state or undergoes some process of manufacture at the mine before being marketed. If the mine workings are underground and are spread over a wide area, the proportion of miners is reduced and those of other classes are correspondingly increased. Conversely, in surface mining and quarrying, the proportion of those engaged in the work of getting out the mineral is, as a rule, larger than in the other branches. Any manufacturing process to which the product may be subjected at the mine or quarry before shipment necessarily increases the proportion of "all other wage-earners." This is plainly indicated in the statistics for cement, the finished cement being in every case manufactured in connection with quarrying the rock, and also to a slightly less degree in the case of gypsum, the work of manufacturing land plaster, wall or cement plaster, and plaster of Paris being done at the quarry. The proportions of "all other wage-earners" in these two industries were 58 and 51.2 per cent, respectively. The largest proportion in this miscellaneous group of employees, namely, 66.9 per cent, was for the natural gas industry, in which the principal work, after the equipment of the property is complete, is the distribution of the gas to the consumers; and the group of "all other wage-earners" was composed chiefly of the various classes of employees engaged in this part of the work. In this industry the mechanical force composed of machinists, blacksmiths, carpenters, and other mechanics, formed 23 per cent of the entire number of wage-earners. Upon comparing the statistics for petroleum with those for natural gas, it is found that the percentages for the mechanical force were almost identical in the two industries, but that in the petroleum industry the predominating class consisted of the engineers engaged in the work of pumping wells, these forming 73.8 per cent of the whole number. As shown by a comparison of anthracite and bituminous coal, the percentages for the mechanical force and for "all other wage-earners" were greater for the anthracite, while miners constituted a larger proportion in the case of bituminous. These are the natural results of the greater difficulty of anthracite mining and of the necessity of preparing the product for market after it is mined.

In addition to the foregoing and other facts that a critical analysis of Table 37 might disclose, it is shown that the mechanical force was especially large for cement, graphite, natural gas, petroleum, and talc and soapstone; that practically all the wage-earners employed were directly engaged in removing the mineral in the case of barytes, buhrstones and millstones, monazite, oilstones, whetstones, and scythestones; and that the proportion of employees included under "all other wage-earners" was considerably above the average in the case of cement, gypsum; mineral pigments, natural gas, and sulphur and pyrite.

Boys as wage-earners.—Provision was made in the schedule for reporting separately the men, and the boys under 16 years, employed as wage-earners. Table 38 shows for each mineral the number of men and boys employed, with the percentage that the number of each is of the total number of wage-earners.

TABLE 38.—*Wage-earners, men and boys, by minerals: 1902.*

MINERAL.	Total average number.	MEN.		BOYS UNDER 16 YEARS.	
		Average number.	Per cent of total.	Average number.	Per cent of total.
Total	581,728	569,871	98.0	11,857	2.0
Asbestos	23	23	100.0	.....	.....
Asphaltum and bituminous rock	156	156	100.0	.....	.....
Barytes	336	334	99.4	2	0.6
Bauxite	150	147	98.0	3	2.0
Borax	153	153	100.0	.....	.....
Buhrstones and millstones	86	86	100.0	.....	.....
Cement	13,041	12,930	99.1	111	0.9
Clay	2,433	2,403	98.8	30	1.2
Coal, anthracite	69,691	65,127	93.5	4,564	6.5
Coal, bituminous	280,638	275,010	98.0	5,628	2.0
Copper ore	26,007	25,904	99.6	103	0.4
Corundum and emery	47	47	100.0	.....	.....
Crystalline quartz	29	29	100.0	.....	.....
Feldspar	252	249	98.8	3	1.2
Flint	119	119	100.0	.....	.....
Fluorspar	269	267	99.3	2	0.7
Fuller's earth	114	90	78.9	24	21.1
Garnet	118	118	100.0	.....	.....
Gold and silver	36,142	36,115	99.9	27	0.1
Graphite	164	163	99.4	1	0.6
Grindstones and pulpstones	210	208	99.1	2	0.9
Gypsum	1,472	1,469	99.8	3	0.2
Infusorial earth, tripoli, and pumice	35	35	100.0	.....	.....
Iron ore	38,851	38,333	98.7	518	1.3
Lead and zinc ore	7,881	7,851	99.6	30	0.4
Limestones and dolomites	31,547	31,289	99.2	258	0.8
Lithium ore	6	6	100.0	.....	.....
Manganese ore	194	181	93.3	13	6.7
Marble	4,070	4,048	99.5	22	0.5
Marl	13	12	92.3	1	7.7
Mica	98	98	100.0	.....	.....
Mineral pigments, crude	256	256	100.0	.....	.....
Monazite	88	88	100.0	.....	.....
Natural gas	4,678	4,676	100.0	2	(1)
Oilstones, whetstones, and scythestones	85	84	98.8	1	1.2
Petroleum	17,552	17,552	100.0	.....	.....
Phosphate rock	5,971	5,934	99.4	37	0.6
Precious stones	108	108	100.0	.....	.....
Quicksilver	1,329	1,321	99.4	8	0.6
Sandstones and quartzites	10,448	10,372	99.3	76	0.7
Silica sand	335	335	100.0	.....	.....
Siliceous crystalline rocks	18,836	18,630	98.9	206	1.1
Slate	5,920	5,751	97.2	169	2.8
Sulphur and pyrite	970	957	98.7	13	1.3
Talc and soapstone	771	771	100.0	.....	.....
Tungsten	2	2	100.0	.....	.....
Uranium and vanadium	19	19	100.0	.....	.....
All other minerals[2]	15	15	100.0	.....	.....

[1] Less than one-tenth of 1 per cent.
[2] Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.

The average number of wage-earners employed in the mining industry in 1902 was 581,728, of whom only 11,857, or 2 per cent, were boys under 16 years, which may be considered a small proportion. The statistics of manufactures show that there were 168,583 children under 16 years out of a total of 5,308,406 wage-earners, a percentage of 3.2, employed in the manufacturing industries in 1900. The reason for the small proportion of boys employed in mines and quarries is undoubtedly the arduous nature of the work and the rigorous conditions under which it is performed in many branches of the industry. Aside from the physical strength and endurance required in much of the work, it frequently has to be performed under conditions extremely injurious to health and of great hazard to life and limb.

In many of the industries, as shown by the table, no boys were found, and in most of the others the proportion was very small. The industries for which no boys were reported are as follows: Asbestos; asphaltum and bituminous rock; borax; buhrstones and millstones; corundum and emery; crystalline quartz; flint; garnet; infusorial earth, tripoli, and pumice; lithium ore; mica; mineral pigments, crude; monazite; petroleum; precious stones; silica sand; talc and soapstone; tungsten; uranium and vanadium; chrome ore; magnesite; molybdenum; nickel and cobalt; and rutile.

It should be observed that for the mineral industries giving employment to but a small number of wage-earners in the aggregate the percentages given may be, and no doubt are, in some cases entirely misleading, as the large proportion of boys may be due to circumstances which are entirely fortuitous. The highest percentage shown is for the mining of fuller's earth, for which 24 boys, or 21.1 per cent of the total number of wage-earners, were reported. They were nearly all reported by one large establishment and were employed at the lighter work, such as driving carts and performing certain parts of the processes of drying and grinding the product. When the product, after being mined, requires some preparation before shipment, the proportion of boys is always larger than when the mineral is sold in a crude condition. This is clearly shown in coal mining, in which industry there were among the employees in both branches, anthracite and bituminous, 10,192 boys, or 86 per cent of the total for the United States in all branches of the mining and quarrying industries. In anthracite mines there were 4,564 boys employed, or 6.5 per cent of the total number of wage-earners in that industry, and in bituminous mines there were 5,628, or 2 per cent of the total. The occupations commonly followed by boys below ground are mule driving and door tending. In anthracite mines the number of boys below ground was 1.1 per cent of the total number of wage-earners, and in bituminous 1.7 per cent, showing that a somewhat larger proportion of boys was required in underground work in bituminous mining than in anthracite. As a rule bituminous coal requires no preparation after being mined; the "run of mine" is usually marketed in that condition. Anthracite, on the other hand, is always crushed, screened, picked or cleaned, and in many instances washed before being shipped, and many boys are employed in the various stages of the process. This is clearly indicated by the statistics. In bituminous mining only three-tenths of 1 per cent of the total number of wage-earners were boys working above ground, while in anthracite mining such employees formed 5.5 per cent of the entire number.

It is especially noteworthy that for gold and silver mining, in which on an average 36,142 wage-earners were employed, only 27 boys, or one-tenth of 1 per cent of the total, were reported, and of this number only 6 worked underground. The number of boys reported in copper and in lead and zinc mining was also noticeably small.

Wage-earners employed during each month.—The statistics for the average number of wage-earners employed each month are summarized in the following table:

TABLE 39.—*Average number of wage-earners employed during each month: 1902.*

	Total.	Men 16 years and over.	Boys under 16 years.
Yearly average	581,728	569,871	11,857
January	605,802	590,362	15,440
February	602,635	587,181	15,454
March	611,026	595,413	15,613
April	620,166	604,359	15,807
May	566,870	556,464	10,406
June	525,464	518,197	7,267
July	516,870	509,596	7,274
August	528,532	521,089	7,443
September	537,433	529,932	7,501
October	575,796	566,591	9,205
November	646,922	631,639	15,283
December	643,220	627,629	15,591

The greatest number, 646,922, were employed in November. Exclusive of the coal mines, the greatest activity in the mining industries was during the summer months, the largest number being employed in August. The largest number were employed in the coal mines during December, but the strike in the anthracite coal region continued from May to October and greatly reduced the number employed during that period. The number employed each month in the production of the different minerals, shown in Table 40, indicates that in some branches of mining the operations were comparatively constant during the year, while in others the activity of the industry varied widely.

There is a natural division of mining operations into two main classes, surface and deep mining. Activity in the former is affected, as it is in outdoor industries generally, by the weather and by seasonal changes; while operations in the latter class, as a rule, are governed more by the market conditions. No idea can be

obtained from Table 39 of the periods of activity and depression in particular branches of the mining industry, although it shows general conditions for the industry as a whole. It is not practicable to make a complete segregation of the statistics based on this division, as operations in some of the industries, iron ore for example, are conducted both on the surface and underground.

Reference to the detailed statistics in Table 1, page 348 of this report, will show for each branch of the mining industry the variations in the average number of wage-earners employed during each month. Table 40 shows the average number of wage-earners employed each month for the more important minerals—that is, those showing a yearly average of more than 2,000 wage-earners.

TABLE 40.—AVERAGE NUMBER OF WAGE-EARNERS EMPLOYED DURING EACH MONTH, BY MINERALS, IN THE MINING OF WHICH MORE THAN 2,000 WERE EMPLOYED: 1902.

MONTH.	All minerals.	Cement.	Clay.	Coal, anthracite.	Coal, bituminous.	Copper ore.	Gold and silver.	Iron ore.	Lead and zinc ore.	Limestones and dolomites.	Marble.	Natural gas.	Petroleum.	Phosphate rock.	Sandstones and quartzites.	Siliceous crystalline rocks.	Slate.	All other minerals.
Yearly average.	581,728	13,041	2,433	69,691	280,638	26,007	36,142	38,851	7,881	31,547	4,070	4,678	17,552	5,971	10,448	18,836	5,920	8,022
January	605,802	10,426	2,147	118,380	290,537	24,996	34,705	34,259	7,352	22,581	3,574	3,821	17,364	5,592	5,727	12,442	5,265	6,634
February	602,635	10,364	2,128	119,228	287,007	24,768	34,952	33,592	7,293	22,410	3,618	3,577	17,238	5,366	5,794	12,828	5,302	7,170
March	611,026	10,883	2,259	117,584	283,327	25,715	34,837	35,168	7,493	27,638	3,880	3,633	17,346	5,551	7,705	14,933	5,468	7,546
April	620,166	12,413	2,433	117,707	272,927	26,201	35,986	37,326	7,636	33,077	4,030	3,868	17,435	5,883	10,405	18,882	5,898	7,999
May	566,870	13,303	2,608	56,155	268,006	27,183	37,192	39,830	7,996	35,084	4,316	4,113	17,482	5,985	12,778	20,350	6,136	8,253
June	525,464	13,396	2,658	16,353	263,253	26,572	37,333	39,842	8,028	35,959	4,184	4,573	17,364	6,410	13,406	21,589	6,143	8,401
July	516,870	13,594	2,638	6,552	260,817	26,950	37,130	41,167	8,013	36,447	4,186	4,633	17,484	6,378	13,368	22,678	6,302	8,503
August	528,532	14,622	2,601	7,706	269,173	26,000	37,166	42,025	8,212	36,965	4,228	5,084	17,547	6,364	13,152	22,843	6,353	8,491
September	537,433	14,666	2,512	8,236	278,697	25,790	36,757	41,857	8,099	36,621	4,430	5,070	17,566	6,442	12,705	22,331	6,314	8,710
October	575,796	14,459	2,499	36,469	292,054	26,366	36,785	41,528	8,157	34,947	4,275	5,495	17,863	6,420	11,980	22,019	6,223	8,557
November	616,922	14,295	2,420	113,320	298,718	25,811	36,154	40,401	8,061	30,604	4,119	5,332	17,934	5,810	10,566	19,348	5,947	8,142
December	643,220	14,071	2,293	118,602	303,140	25,732	34,707	39,217	8,202	26,231	3,940	6,337	18,001	5,751	7,790	15,789	5,659	7,758

Of the minerals shown separately in Table 40, the production of clay appears to have been carried on with the greatest degree of regularity, the number employed varying only from 2,658 in June to 2,128 in February, while the number employed in the production of anthracite coal varied from 119,228 in February to 6,552 in July. This wide variation marked an abnormal condition—the great strike, which continued from May to October. While it seems that the strike affected all of the wage-earners in the coal industry, the operators were successful in most cases in securing the services of a sufficient number of men to protect their properties and to preserve them from deterioration and, in some instances, even to mine small quantities of coal.

In bituminous coal mining the largest number of wage-earners, 303,140, appears for December. The number fluctuates from month to month, reaching the lowest point, 260,817, in July.

Table 40 clearly indicates that in all kinds of mining and quarrying, where the work is done largely in the open air, the period of greatest activity is in summer, while the averages for the winter months denote a time of comparative depression. This condition is shown for clay, limestones and dolomites, marble, sandstones and quartzites, siliceous crystalline rocks, and slate, and also, although less pronounced, for cement, iron ore, and lead and zinc ore. Phosphate rock, being mined almost entirely in the South where the seasonal changes have less effect, shows a less marked reduction of the number of employees in the colder months than some of those just mentioned.

The variation in the average number of wage-earners in gold and silver mining was from 37,333 in June to 34,705 in January, and in copper mining from 27,183 in May to 24,768 in February.

Average earnings of wage-earners.—In considering the statistics of employees and wages included in this report it should be understood that it is not possible to draw from the figures any trustworthy conclusion regarding the average earnings of all those employed at stated wages, either by the day or piece. The division of the total amount paid in wages to the wage-earners of any industry or of any class by the number of wage-earners in the industry or class results in an unreal and deceptive amount, which is the quotient of the mathematical operation and nothing more. It does not represent the rate of wages of any one class of wage-earners.[1]

A part of the inquiry into employees and wages was framed for the purpose of bringing out the actual daily rates of pay received by the different classes of wage-earners, and this division of the general subject is treated on pages 96 to 101 of this report. While this class of wage statistics, i. e., actual wage rates, appears to receive the more general approval of statisticians, in preference to statistics purporting to represent average earnings, these rates, unless considered in connection with the duration of the period of employment, are liable to prove misleading. While a given rate represents the earnings of each wage-earner at that rate for a day's employment, it fails to furnish a true indication as to the annual earnings of the workman, and so falls short of being a correct index of his economic condition, which is better determined by the amount of wages paid to him annually. This is perhaps true more

[1] This question is fully discussed in the Report on Manufactures for the Twelfth Census. (See Part I, pages cxi to cxxv.)

especially of mining and quarrying than of other lines of industry, as operations are frequently very irregular and spasmodic by reason of a fluctuating demand for the products.

The statistics for anthracite coal may be taken as illustrating these points. Table 40 shows that for 1902 the least number of men, 6,552, was reported for July, and the greatest number, 119,228, for February. The strike of the anthracite coal miners lasted from May 12 to October 23, and the number employed in July may be said to represent the minimum, or the number required to preserve and protect the properties; while the number for February, giving due consideration to the fact that it is an average for the month, is the full quota finding employment in the industry. The amount paid in wages during the year was $38,716,113, and the division of this amount by the average number of wage-earners for the year, 69,691, results in a quotient of $555, which can be regarded only as an abstract quantity indicating the measure of the earnings of a theoretical average employee who worked full time during the year. This, in the light of the actual experience of those employed at anthracite mines in 1902, can only be considered as an ideal state of affairs.

Wage-earners at specified daily rates of pay.—The inquiry designed to elicit the daily rates of pay of the wage-earners called for a distribution of the several classes according to their rates by 25-cent groups from 50 cents to $4.24, those receiving less than 50 cents and those receiving $4.25 or over to be combined into single groups. The exact rate of pay was not asked for, and in most cases the distribution of the employees within the 25-cent groups is not definitely known. It may be stated as a general proposition, however, that the greater proportion of the wage-earners included in the various 25-cent rate groups received the lowest rate of those groups. In the case of coal and iron ore miners and other employees paid in accordance with the amount of work done, very little can be said regarding daily rates of pay. When wage-earners are paid by the hour there is the same difficulty, for the daily rates are then naturally dependent upon the hours of employment. However, with the exception of coal and iron ore miners and some quarrymen, the great majority of the wage-earners employed in the mineral industries of the United States are paid by the day; and when employees are paid by the day their rates are more likely to be in multiples of 25 cents than otherwise. For example, the returns show that 6,742 of the men employed in copper mines received between $3.50 and $3.74 per day, and it may be safely stated that most of these men received $3.50 a day. For some minerals the daily rates of the several occupations are fixed at figures which are not multiples of 25 cents. But it would be more nearly correct to take the lowest rate in most wage groups as the rate paid to the greater number of the employees included within that group than it would be, for example, to consider the rate halfway between the limits of the group as an average for the entire group.

The distribution of the wage-earners according to these rates is shown in the following table for each mineral in the production of which more than 1,000 wage-earners were employed on the average during 1902. The table gives also the per cent that the number at each rate is of the total number; and the cumulative percentage at each rate, which shows what proportion of the total number received a wage as great as, or greater than, the lowest wage of the given wage group.

TABLE 41.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY MINERALS: 1902.

[Each cumulative percentage shows the proportion of the total number receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	ALL MINERALS.			CEMENT.			CLAY.			COAL, ANTHRACITE.			COAL, BITUMINOUS.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total	581,728	100.0	.....	13,041	100.0	.....	2,433	100.0	.....	69,691	100.0	.....	280,638	100.0	.....
Less than 0.50	538	0.1	100.0	37	0.3	100.0	11	0.4	100.0	70	0.1	100.0	117	(1)	100.0
0.50 to 0.74	4,677	0.8	99.9	20	0.2	99.7	44	1.8	99.6	2,459	3.5	99.9	1,139	0.4	99.9
0.75 to 0.99	11,054	1.9	99.1	192	1.5	99.5	330	13.6	97.8	3,808	5.5	96.4	2,720	1.0	99.5
1.00 to 1.24	33,503	5.8	97.2	1,099	8.4	98.0	494	20.3	84.2	6,546	9.4	90.9	8,084	2.9	98.6
1.25 to 1.49	45,101	7.8	91.4	3,849	29.5	89.6	871	35.8	63.9	8,495	12.2	81.5	11,928	4.2	95.7
1.50 to 1.74	78,102	13.4	83.6	4,107	31.5	60.1	322	13.2	28.1	10,712	15.4	69.3	32,034	11.4	91.5
1.75 to 1.99	75,554	13.0	70.2	1,632	12.5	28.6	89	3.7	14.9	11,547	16.6	53.9	36,797	13.1	80.1
2.00 to 2.24	110,689	19.0	57.2	933	7.1	16.1	121	5.0	11.2	8,159	11.7	37.3	70,909	25.3	67.0
2.25 to 2.49	73,665	12.7	38.2	427	3.3	9.0	65	2.7	6.2	7,253	10.4	25.6	43,609	15.5	41.7
2.50 to 2.74	52,837	9.1	25.5	433	3.3	5.7	68	2.8	3.5	3,132	4.5	15.2	32,454	11.6	26.2
2.75 to 2.99	24,446	4.2	16.4	103	0.8	2.4	7	0.3	0.7	1,819	2.6	10.7	15,814	5.6	14.6
3.00 to 3.24	31,577	5.4	12.2	125	1.0	1.6	10	0.4	0.4	1,806	2.6	8.1	12,038	4.3	9.0
3.25 to 3.49	10,733	1.8	6.8	47	0.4	0.6	1	(1)	(1)	1,382	2.0	5.5	6,370	2.3	4.7
3.50 to 3.74	20,324	3.5	5.0	19	0.2	0.2	.....	.....	.....	1,317	1.9	3.5	4,402	1.6	2.4
3.75 to 3.99	2,397	0.4	1.5	7	(1)	.....	.....	.....	.....	517	0.7	1.6	1,324	0.5	0.8
4.00 to 4.24	4,214	0.7	1.1	7	(1)	.....	.....	.....	.....	167	0.2	0.9	495	0.2	0.3
4.25 and over	2,317	0.4	0.4	4	(1)	.....	.....	.....	.....	502	0.7	0.7	404	0.1	0.1

[1] Less than one-tenth of 1 per cent.

TABLE 41.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY MINERALS: 1902—Cont'd.

RATE PER DAY (DOLLARS).	COPPER.			GOLD AND SILVER.			GYPSUM.			IRON ORE.			LEAD AND ZINC ORE.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total	26,007	100.0	.....	36,142	100.0	.....	1,472	100.0	.....	38,851	100.0	.....	7,881	100.0	.....
Less than 0.50	.....	.....	.....	4	(1)	100.0	.....	.....	.....	141	0.4	100.0	5	0.1	100.0
0.50 to 0.74	29	0.1	100.0	54	0.1	99.9	3	0.2	100.0	270	0.7	99.6	14	0.2	99.9
0.75 to 0.99	49	0.2	99.9	234	0.6	99.9	1	0.1	99.8	853	2.2	98.9	7	0.1	99.7
1.00 to 1.24	201	0.8	99.7	369	1.0	99.3	33	2.2	99.7	4,618	11.9	96.7	165	2.1	99.6
1.25 to 1.49	368	1.4	98.9	218	0.6	98.3	82	5.6	97.5	2,874	7.4	84.8	1,371	17.4	97.5
1.50 to 1.74	1,847	7.1	97.5	283	0.8	97.7	754	51.2	91.9	5,468	14.1	77.4	2,053	26.0	80.1
1.75 to 1.99	3,354	12.9	90.4	580	1.6	96.9	339	23.0	40.7	7,344	18.9	63.3	683	8.7	54.1
2.00 to 2.24	6,277	24.1	77.5	1,180	3.3	95.3	150	10.2	17.7	8,535	22.0	44.4	2,301	29.2	45.4
2.25 to 2.49	2,066	8.0	53.4	783	2.2	92.1	49	3.3	7.5	4,862	12.5	22.4	788	10.0	16.2
2.50 to 2.74	2,285	8.8	45.4	5,527	15.3	89.8	37	2.5	4.2	2,511	6.4	9.9	309	3.9	6.2
2.75 to 2.99	661	2.5	36.6	2,884	8.0	74.5	.....	.....	1.7	630	1.6	3.5	26	0.3	2.3
3.00 to 3.24	961	3.7	34.1	12,166	33.7	66.5	20	1.4	1.7	451	1.2	1.9	143	1.8	2.0
3.25 to 3.49	131	0.5	30.4	1,614	4.5	32.8	.....	.....	0.3	77	0.2	0.7	10	0.1	0.2
3.50 to 3.74	6,742	25.9	29.9	6,873	19.0	28.3	.....	.....	0.3	125	0.3	0.5	4	0.1	0.1
3.75 to 3.99	54	0.2	4.0	345	0.9	9.3	.....	.....	0.3	7	(1)	0.2	1	(1)	(1)
4.00 to 4.24	605	2.3	3.8	2,554	7.1	8.4	3	0.2	0.3	30	0.1	0.2	1	(1)	(1)
4.25 and over	377	1.5	1.5	474	1.3	1.3	1	0.1	0.1	43	0.1	0.1	.....	.....	.....

RATE PER DAY (DOLLARS).	LIMESTONES AND DOLOMITES.			MARBLE.			NATURAL GAS.			PETROLEUM.			PHOSPHATE ROCK.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total	31,547	100.0	.....	4,070	100.0	.....	4,678	100.0	.....	17,552	100.0	.....	5,971	100.0	.....
Less than 0.50	16	0.1	100.0	6	0.1	100.0	.....	.....	.....	1	(1)	100.0	52	0.9	100.0
0.50 to 0.74	196	0.6	99.9	17	0.4	99.9	2	(1)	100.0	1	(1)	99.9	89	1.5	99.1
0.75 to 0.99	389	1.2	99.3	61	1.5	99.5	11	0.2	99.9	4	(1)	99.9	1,288	21.6	97.6
1.00 to 1.24	4,126	13.1	98.1	558	13.7	98.0	28	0.6	99.8	74	0.4	99.9	3,656	61.2	76.0
1.25 to 1.49	7,870	24.9	85.0	963	23.7	84.3	248	5.3	99.2	61	0.4	99.6	378	6.3	14.8
1.50 to 1.74	9,195	29.1	60.1	858	21.1	60.6	1,230	26.3	93.9	699	4.0	99.2	250	4.2	8.5
1.75 to 1.99	4,944	15.7	31.0	286	7.0	39.5	873	18.7	67.6	1,078	6.1	95.2	25	0.4	4.3
2.00 to 2.24	2,637	8.4	15.3	293	7.2	32.5	1,090	23.3	48.9	1,403	8.0	89.1	101	1.7	3.9
2.25 to 2.49	885	2.8	6.9	182	4.5	25.3	558	11.9	25.6	10,046	57.2	81.1	33	0.6	2.2
2.50 to 2.74	580	1.8	4.1	291	7.2	20.8	326	7.0	13.7	2,366	13.5	23.9	55	0.9	1.6
2.75 to 2.99	193	0.6	2.3	159	3.9	13.6	72	1.6	6.7	242	1.4	10.4	3	(1)	0.7
3.00 to 3.24	218	0.7	1.7	130	3.2	9.7	67	1.4	5.1	859	4.9	9.0	21	0.4	0.7
3.25 to 3.49	114	0.4	1.0	82	2.0	6.5	8	0.2	3.7	277	1.6	4.1	.....	.....	0.3
3.50 to 3.74	121	0.4	0.6	57	1.4	4.5	28	0.6	3.5	89	0.5	2.5	4	0.1	0.3
3.75 to 3.99	1	(1)	0.2	4	0.1	3.1	37	0.8	2.9	38	0.2	2.0	3	(1)	0.2
4.00 to 4.24	58	0.2	0.2	15	0.4	3.0	34	0.7	2.1	25	0.1	1.8	5	0.1	0.2
4.25 and over	4	(1)	(1)	105	2.6	2.6	66	1.4	1.4	289	1.7	1.7	8	0.1	0.1

RATE PER DAY (DOLLARS).	QUICKSILVER.			SANDSTONES AND QUARTZITES.			SILICEOUS CRYSTALLINE ROCKS.			SLATE.			ALL OTHER MINERALS.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total	1,329	100.0	.....	10,448	100.0	.....	18,836	100.0	.....	5,920	100.0	.....	5,221	100.0	.....
Less than 0.50	2	0.1	100.0	4	(1)	100.0	37	0.2	100.0	7	0.1	100.0	28	0.5	100.0
0.50 to 0.74	22	1.7	99.9	40	0.4	99.9	133	0.7	99.8	72	1.2	99.9	64	1.2	99.5
0.75 to 0.99	10	0.7	98.2	60	0.6	99.6	573	3.0	99.1	101	1.7	98.7	363	7.0	98.3
1.00 to 1.24	113	8.5	97.5	292	2.8	99.0	1,282	6.8	96.1	290	4.9	97.0	1,475	28.2	91.3
1.25 to 1.49	211	15.9	89.0	1,195	11.4	96.2	2,096	11.1	89.3	983	16.6	92.1	1,040	19.9	63.1
1.50 to 1.74	56	4.2	73.1	2,437	23.3	84.8	3,546	18.8	78.2	1,145	19.4	75.5	1,106	21.2	43.2
1.75 to 1.99	164	12.3	68.9	1,796	17.2	61.5	3,045	16.2	59.4	658	11.1	56.1	320	6.1	22.0
2.00 to 2.24	195	14.7	56.6	2,215	21.2	44.3	2,483	13.2	43.2	1,369	23.1	45.0	338	6.5	15.9
2.25 to 2.49	160	12.0	41.9	484	4.6	23.1	692	3.7	30.0	671	11.3	21.9	52	1.0	9.4
2.50 to 2.74	299	22.5	29.9	446	4.3	18.5	1,141	6.1	26.3	349	5.9	10.6	225	4.3	8.4
2.75 to 2.99	14	1.1	7.4	259	2.5	14.2	1,364	7.2	20.2	161	2.7	4.7	35	0.7	4.1
3.00 to 3.24	78	5.9	6.3	654	6.3	11.7	1,608	8.5	13.0	105	1.8	2.0	114	2.2	3.4
3.25 to 3.49	4	0.3	0.4	110	1.1	5.4	480	2.5	4.5	4	0.1	0.2	22	0.4	1.2
3.50 to 3.74	1	0.1	0.1	314	3.0	4.3	199	1.1	2.0	4	0.1	0.1	25	0.5	0.8
3.75 to 3.99	.....	.....	.....	26	0.2	1.3	23	0.1	0.9	.....	.....	(1)	10	0.2	0.3
4.00 to 4.24	.....	.....	.....	86	0.8	1.1	125	0.7	0.8	.....	.....	(1)	4	0.1	0.1
4.25 and over	.....	.....	.....	30	0.3	0.3	9	0.1	0.1	1	(1)	(1)	.....	.....	.....

[1] Less than one-tenth of 1 per cent.

The production of the minerals for which separate statistics are shown in Table 41 gave employment to 576,507 wage-earners, this number forming 99.1 per cent of the 581,728 wage-earners reported for all mines and quarries. The average number and per cent of the total number are shown in the table for each rate group. The percentages are also accumulated.

The cumulative percentage is obtained by combining the figures which represent the per cent of total. For example, in Table 41, under the head of "all minerals," four-tenths of 1 per cent of the wage-earners received $4.25 or over and seven-tenths of 1 per cent received between $4 and $4.24; adding the two percentages, it is found that 1.1 per cent received $4 per day or over.

This process is continued throughout the wage scale until all the wage-earners have been included, when the cumulative percentage naturally becomes 100 per cent. The cumulative percentage, as stated opposite any wage group, shows then the percentage of the total number formed by the sum of the number included in that wage group plus the number included in all the higher wage groups.

Two advantages are gained by the use of the cumulative percentage. In the first place, it is possible to determine at a glance the proportion of the total number receiving as much as, or more than, a given rate. For example, if the cumulative percentages were not given in the preceding table, and it were desired to obtain the proportion of the total number who received $1.50 per day or over, it would be necessary to add the nine numbers representing the percentages at each rate from $1.50 up. In the cumulative percentage column this addition is already made, and it is evident at a glance that 60.1 per cent of the cement workers received at least $1.50 per day.

The second advantage gained by the use of the cumulative percentage lies in the fact that it is possible to compare two given sets of returns much more readily than by either the numbers or the percentages in the respective groups. For example, in Table 41 the column headed "cumulative percentage" shows that for cement workers the proportion of the total number receiving $1 per day or more was 98 per cent, while for clayworkers it was 84.2 per cent. At $1.50 the respective proportions were 60.1 and 28.1 per cent, and at $2 they were 16.1 and 11.2 per cent. The cumulative percentages thus show that wages were higher in 1902 for cement workers than for workers in clay mining.

Of the various minerals for which statistics are shown separately in the above table the production of anthracite and bituminous coal gave employment to the greatest number of wage-earners. A very large proportion of the miners in the coal mines were paid according to the quantity of their product, and some of the principal coal companies were unable to classify these employees according to the specified daily rates of pay. When data of this character were not reported by the company estimates were made in the Bureau of the Census from the total number of such employees reported, the total amount of wages paid, and the number of days that the mine was in operation, the rate being determined by the average daily earnings for the time employed, and the average number for the entire year being computed as previously explained; therefore, in such cases all employees of a mine who were paid by the piece or quantity of work done as measured by their output were estimated as receiving a uniform daily rate of pay. There were 230,846 employees reported as the average number receiving wages according to the quantity of their production, and they were paid $155,578,988. Of this number, 211,710, or 91.7 per cent, were reported for anthracite and bituminous coal, and they received $144,628,436, or 93 per cent of the amount paid for such mining in all minerals.

When the figures for all minerals are combined, it is found that the range of wages for practically all of the wage-earners was from $1 to $3.74 per day, 556,531, or 95.7 per cent of the total number employed, being included between those rates. Less than 3 per cent of the total number received less than $1 per day, and only 1.5 per cent received $3.75 or over. The four rate groups that lead in the number of employees included are consecutive and constitute the range from $1.50 to $2.49 per day. Between those limits is included 58.1 per cent of the total number. It should be added, however, that the proportion at $2.50 or over is much greater than that at less than $1.50. Of the total number of wage-earners, 57.2 per cent were paid $2 per day or more. An attempt to find the median rate (that is, a rate such that half the number of wage-earners receives that rate or more and the other half receives that rate or less) discloses the fact that this rate lies somewhere in the group $2 to $2.24. It will also be noticed that the rate group that includes the median includes a greater number of wage-earners than any other group in the scale.

In regard to the various minerals, the figures shown in Table 41 may be briefly summarized as follows:

Cement: Of the total number of wage-earners, 73.5 per cent were paid from $1.25 to $1.99.

Clay: The range of wages for 82.9 per cent of the total number was from $0.75 to $1.74; 35.8 per cent were included in the single rate group $1.25 to $1.49.

Coal: For a large number of coal miners the figures given represent average earnings and not rates, as most of these employees are paid by the ton or other unit. As the figures stand, they show that for anthracite coal 75.7 per cent of the employees received between $1 and $2.49, and for bituminous coal 76.9 per cent received between $1.50 and $2.74.

Copper ore: A wide range is noticeable in the wages paid to employees engaged in copper mining. Of the total number 24.1 per cent received between $2 and $2.24, and 25.9 per cent were paid from $3.50 to $3.74; the remaining wage-earners were distributed in smaller groups throughout the scale from $0.50 to $4.25 and over.

Gold and silver: Employees engaged in the mining of gold and silver were largely concentrated in three groups as follows: 15.3 per cent from $2.50 to $2.74; 33.7 per cent from $3 to $3.24; and 19 per cent from $3.50 to $3.74.

Gypsum: The range of wages for 84.4 per cent of the wage-earners was from $1.50 to $2.24; 51.2 per cent received from $1.50 to $1.74.

Iron ore: Of the total number of wage-earners, 86.8 per cent received between $1 and $2.49; the greatest concentration was at $2; 40.9 per cent of the total number received between $1.75 and $2.24.

Lead and zinc ore: Almost all, 91.3 per cent, of the wage-earners received between $1.25 and $2.49 per day; 26 per cent receiving from $1.50 to $1.74; and 29.2 per cent from $2 to $2.24.

Limestones and dolomites: The range of wages for 91.2 per cent of the total number was from $1 to $2.24. Here again there was a marked concentration at two rate groups, 24.9 per cent receiving from $1.25 to $1.49, and 29.1 per cent from $1.50 to $1.74.

Marble: The returns for wage-earners engaged in quarrying marble show a less marked concentration than is observable in most other minerals. There were, however, 58.5 per cent of the total number between the rates $1 and $1.74.

Natural gas: For 92.5 per cent of the wage-earners the range was from $1.25 to $2.74. The two wage groups showing the greatest number are as follows: $1.50 to $1.74, 26.3 per cent; $2 to $2.24, 23.3 per cent.

Petroleum: For 70.7 per cent of the total number of wage-earners the range of wages was from $2.25 to $2.74 per day, 57.2 per cent being included in the single rate group $2.25 to $2.49.

Phosphate rock: Almost all the wage-earners received less than $1.25, 82.8 per cent getting between $0.75 and $1.24. In the wage group $1 to $1.24, there were 61.2 per cent of the total number.

Quicksilver: The range of wages for the bulk of the employees was from $1.25 to $2.74, 81.6 per cent being included within those rates.

Sandstones and quartzites: The range of wages for 73.1 per cent of the total number was from $1.25 to $2.24.

Siliceous crystalline rocks: The figures show less concentration than for most of the other minerals; more than half, 59.3 per cent, of the total number, however, received between $1.25 and $2.24 per day.

Slate: In the quarrying of slate the rates for 81.5 per cent of the total number of wage-earners ranged from $1.25 to $2.49. The greatest concentration was in the wage group $2 to $2.24, which showed 23.1 per cent of the total number.

An examination of the cumulative percentages shows that wages were far higher for employees in gold and silver mines than for any other mineral, 66.5 per cent of all the wage-earners receiving $3 or over. Employees in copper mines were next highest paid, 29.9 per cent receiving $3.50 or over, and 77.5 per cent getting at least $2. Of the men employed in connection with petroleum wells, almost 90 per cent received $2 or over, but only 9 per cent of these received as much as $3. After gold and silver, copper, and petroleum the minerals showing the highest rates of wages are bituminous coal, quicksilver, natural gas, sandstones and quartzites, and siliceous crystalline rocks, in the order named. Following these come a large class of minerals which show very little difference in daily rates of pay, when all the wage-earners are considered as one group without distinction as to geographic location or specified occupation. These minerals are anthracite coal, iron ore, lead and zinc ore, marble, and slate. As will be shown later, when these minerals are considered by states and the wage-earners separated into the several classes, considerable variation in the rates are found. The rates of pay for men employed in quarrying phosphate rock were lower than those for any other mineral, only 14.8 per cent getting as much as $1.25 a day. This industry was practically confined to Florida, South Carolina, and Tennessee.

The number of wage-earners employed in the different occupations is an important factor to be considered in connection with these statistics, and the following table summarizes the returns for all minerals so as to show the average number receiving stated daily rates of pay in each occupation and the percentage which the number at each rate forms of the total number in the class:

TABLE 42.—AVERAGE NUMBER OF WAGE-EARNERS, AND PER CENT OF TOTAL NUMBER, AT SPECIFIED DAILY RATES OF PAY, BY OCCUPATIONS: 1902.

RATE PER DAY (DOLLARS).	ALL WAGE-EARNERS.		ENGINEERS.[1]		FIREMEN.		MACHINISTS, BLACKSMITHS, CARPENTERS, AND OTHER MECHANICS.		MINERS, QUARRYMEN, AND STONECUTTERS.		MINERS' HELPERS.		TIMBERMEN AND TRACK LAYERS.		BOYS UNDER 16 YEARS.		ALL OTHER WAGE-EARNERS.	
	Average number.	Per cent.	Average number.	Per cent.	Average number.	Per cent.	Average number.	Per cent.	Average number.	Per cent.	Average number.	Per cent.	Average number.	Per cent.	Average number.	Per cent.	Average number.	Per cent.
Total	581,728	100.0	26,249	100.0	8,740	100.0	25,870	100.0	324,430	100.0	18,736	100.0	13,544	100.0	11,857	100.0	152,302	100.0
Less than 0.50	538	0.1	1	(2)	.....	.....	.....	.....	29	(2)	.....	.....	.....	.....	447	3.8	61	(2)
0.50 to 0.74	4,677	0.8	6	(2)	6	0.1	8	(2)	222	0.1	26	0.1	1	(2)	3,448	29.1	960	0.6
0.75 to 0.99	11,054	1.9	23	0.1	50	0.6	174	0.7	2,832	0.9	252	1.4	46	0.3	4,062	34.2	3,615	2.4
1.00 to 1.24	33,503	5.8	273	1.1	281	3.2	400	1.6	14,978	4.6	1,190	6.4	209	1.6	3,212	27.1	12,960	8.5
1.25 to 1.49	45,101	7.8	569	2.2	676	7.7	798	3.1	18,903	5.8	2,001	10.7	381	2.8	419	3.5	21,351	14.0
1.50 to 1.74	78,102	13.4	1,264	4.8	1,646	18.8	2,333	9.0	36,569	11.3	2,599	13.9	1,119	8.3	130	1.1	32,442	21.3
1.75 to 1.99	75,554	13.0	1,813	6.9	2,422	27.7	2,899	11.2	37,492	11.6	3,692	19.7	2,102	15.5	61	0.5	25,073	16.5
2.00 to 2.24	110,689	19.0	3,884	14.8	1,945	22.3	5,155	19.9	65,307	20.1	3,021	16.1	3,778	27.9	56	0.5	27,543	18.1
2.25 to 2.49	73,665	12.7	11,500	43.8	457	5.2	3,916	15.1	39,895	12.3	1,907	10.2	3,640	26.9	22	0.2	12,328	8.1
2.50 to 2.74	52,837	9.1	3,546	13.5	562	6.4	3,153	12.2	36,721	11.3	1,429	7.6	954	7.0	.....	.....	6,472	4.3
2.75 to 2.99	24,446	4.2	607	2.3	111	1.3	1,185	4.6	19,446	6.0	488	2.6	312	2.3	.....	.....	2,297	1.5
3.00 to 3.24	31,577	5.4	1,101	4.2	244	2.8	2,151	8.3	22,197	6.9	1,186	6.3	399	3.0	.....	.....	4,299	2.8
3.25 to 3.49	10,733	1.8	186	0.7	20	0.2	597	2.3	8,854	2.7	392	2.1	59	0.4	.....	.....	625	0.4
3.50 to 3.74	20,324	3.5	452	1.7	267	3.1	1,021	4.0	16,094	5.0	541	2.9	456	3.4	.....	.....	1,493	1.0
3.75 to 3.99	2,397	0.4	89	0.3	6	0.1	137	0.5	2,078	0.6	5	(2)	26	0.2	.....	.....	56	(2)
4.00 to 4.24	4,214	0.7	762	2.9	38	0.4	1,144	4.4	1,750	0.5	4	(2)	57	0.4	.....	.....	459	0.3
4.25 and over	2,317	0.4	173	0.7	9	0.1	799	3.1	1,063	0.3	.....	.....	5	(2)	.....	.....	268	0.2

[1] Includes pumpmen employed at petroleum and natural-gas wells.

[2] Less than one-tenth of 1 per cent.

Of the total number of wage-earners considered in the preceding tables, 11,857 were boys under 16 years of age, and nearly all of them received less than $1.25 per day. It will be noticed that the employees in the three lowest wage groups were very largely boys. For all occupations combined the range of wages for 58.1 per cent of the total number was from $1.50 to $2.49 per day. For 16.4 per cent the rates were less than $1.50, and the balance, 25.5 per cent, received $2.50 or over. Of the miners, quarrymen, and stonecutters, 66.6 per cent received between $1.50 and $2.74 per day, leaving 11.4 per cent who received less than $1.50 and 22 per cent who received $2.75 or more. The group of "all other wage-earners" is the next most important class in point of numbers. The figures for this class of employees show the following distribution: Less than $1.25, 11.5 per cent; between $1.25 and $2.24, 69.9 per cent; $2.25 or over, 18.6 per cent. There is a marked excess at the higher rates of pay for engineers, 70.1 per cent receiving $2.25 a day or over; a very large proportion of these were pumpmen employed at petroleum wells. The great majority of the timbermen and track layers were concentrated in the three groups between $1.75 and $2.49, 70.3 per cent being included between these rates. There was less concentration among the miners' helpers, the range of wages for 70.6 per cent of them being from $1.25 to $2.49.

The distribution of wage-earners according to daily rates of pay, by states and territories, is shown in the following table:

TABLE 43.—AVERAGE NUMBER OF WAGE-EARNERS AT SPECIFIED DAILY RATES OF PAY, BY STATES AND TERRITORIES: 1902.

STATE OR TERRITORY.	Total.	Less than $0.50.	$0.50 to $0.74.	$0.75 to $0.99.	$1.00 to $1.24.	$1.25 to $1.49.	$1.50 to $1.74.	$1.75 to $1.99.	$2.00 to $2.24.	$2.25 to $2.49.	$2.50 to $2.74.	$2.75 to $2.99.	$3.00 to $3.24.	$3.25 to $3.49.	$3.50 to $3.74.	$3.75 to $3.99.	$4.00 to $4.24.	$4.25 and over.
United States...	581,728	538	4,677	11,054	33,503	45,101	78,102	75,554	110,689	73,665	52,837	24,446	31,577	10,733	20,324	2,397	4,214	[illegible]
Alabama	19,132	43	154	639	2,689	2,455	3,193	2,692	2,333	970	2,980	657	291	80	5	.....	1	.....
Arizona	5,323	.....	.....	.....	20	26	58	685	525	625	283	242	746	202	1,520	51	280	[illegible]
Arkansas	2,944	3	8	41	134	161	393	303	347	561	368	380	195	.....	2	45	3	.....
California[1]	12,964	2	22	13	36	262	222	589	1,535	798	4,072	1,203	3,016	214	447	56	297	[illegible]
Colorado	20,519	.....	1	3	138	203	189	1,086	1,475	1,209	2,867	2,790	6,482	794	1,355	355	1,353	[illegible]
Connecticut	1,497	.....	1	8	35	174	618	295	127	27	24	91	63	18	16	.....	.....	.....
Delaware	504	.....	.....	1	27	233	186	28	9	9	6	1	.....	.....	1	3	.....	.....
Florida	3,146	6	8	447	2,063	211	234	20	76	30	24	4	7	.....	3	3	4	[illegible]
Georgia	2,820	48	77	492	1,147	431	231	51	63	44	17	26	114	40	31	.....	8	.....
Idaho	3,563	1	.....	3	22	10	8	11	27	10	52	64	918	597	1,551	11	241	[illegible]
Illinois	40,523	9	42	99	966	915	3,287	5,488	12,776	5,981	4,584	2,128	2,482	892	570	149	69	[illegible]
Indian Territory	4,814	.....	1	63	154	379	384	451	1,092	786	489	249	685	33	43	.....	.....	[illegible]
Indiana	16,473	2	25	49	369	1,366	2,042	1,451	2,559	5,064	1,529	809	464	257	375	24	51	[illegible]
Iowa	10,437	.....	7	17	186	164	1,101	1,299	3,744	1,497	1,552	278	350	31	176	34	1	.....
Kansas	8,726	2	3	27	177	304	1,356	1,112	1,061	1,465	1,093	1,040	197	173	72	20	6	[illegible]
Kentucky	10,654	13	212	314	1,430	1,751	2,086	1,714	1,888	710	319	73	43	42	5	8	32	[illegible]
Louisiana	61	.....	.....	.....	.....	.....	50	6	2	.....	2	.....	.....	.....	.....	.....	.....	[illegible]
Maine	3,084	.....	3	15	60	300	937	880	411	179	208	287	365	29	9	.....	1	.....
Maryland	6,826	8	77	66	398	735	893	772	670	1,125	475	859	319	95	52	269	1	[illegible]
Massachusetts	4,242	1	7	21	89	228	988	845	841	209	309	393	259	13	14	2	23	.....
Michigan	31,951	.....	4	21	258	429	4,462	7,010	10,363	4,883	3,304	477	547	89	21	8	19	[illegible]
Minnesota	9,760	2	4	2	17	32	281	2,219	3,820	1,436	973	396	191	221	96	20	21	[illegible]
Missouri	15,351	29	56	83	461	2,037	2,615	2,274	4,381	1,701	903	383	290	86	34	1	16	[illegible]
Montana	10,530	.....	.....	.....	14	4	5	4	29	170	210	301	886	159	7,572	67	689	[illegible]
Nebraska	178	.....	.....	1	2	1	8	151	8	5	.....	.....	2	.....	.....	.....	.....	.....
Nevada	1,132	.....	.....	1	.....	.....	72	14	33	3	23	75	443	12	96	2	204	[illegible]
New Hampshire	1,253	.....	1	3	39	37	214	383	106	40	40	185	163	27	5	1	6	[illegible]
New Jersey	5,645	.....	15	17	152	2,172	1,995	697	292	71	128	19	59	6	10	.....	8	[illegible]
New Mexico	2,275	.....	.....	3	42	157	416	180	141	103	329	131	576	39	67	52	22	[illegible]
New York	9,560	1	18	55	420	1,548	3,699	1,166	1,194	596	243	103	197	95	102	7	21	[illegible]
North Carolina	1,556	9	89	459	657	142	65	41	60	3	27	.....	4	.....	.....	.....	.....	.....
North Dakota	298	.....	1	1	1	7	63	18	69	53	66	8	10	.....	.....	1	.....	.....
Ohio	37,173	3	37	217	718	1,317	7,058	3,914	10,691	7,239	3,754	1,095	409	127	326	55	47	[illegible]
Oklahoma	128	.....	.....	1	6	5	83	8	14	1	6	.....	1	.....	3	.....	.....	.....
Oregon	1,166	.....	.....	1	12	4	28	14	289	45	170	95	301	40	114	3	40	[illegible]
Pennsylvania	190,935	113	2,721	4,897	10,472	18,865	27,250	27,763	35,484	27,950	14,164	6,084	4,651	5,375	3,468	826	294	[illegible]
Rhode Island	667	.....	1	22	7	49	107	73	94	20	44	109	121	10	3	2	4	[illegible]
South Carolina	2,694	51	152	1,199	785	171	66	11	31	1	53	.....	113	40	14	.....	2	[illegible]
South Dakota	3,131	.....	2	1	2	7	10	38	74	13	277	11	947	12	1,523	5	115	[illegible]
Tennessee	10,890	30	294	639	3,237	1,173	2,224	1,215	956	517	280	82	230	5	8	.....	.....	.....
Texas	3,853	8	69	187	280	800	448	420	841	73	294	32	264	32	47	7	22	[illegible]
Utah	5,712	1	2	1	28	8	37	60	343	797	1,448	1,436	1,004	138	301	33	56	[illegible]
Vermont	5,398	.....	14	43	141	791	1,057	983	1,030	335	304	349	255	71	4	1	10	[illegible]
Virginia	8,993	137	248	473	4,382	1,451	790	426	653	290	70	19	39	3	9	1	.....	[illegible]
Washington	4,567	1	6	8	24	34	107	126	330	691	466	574	1,814	147	129	14	92	[illegible]
West Virginia	30,002	12	287	390	1,176	3,362	5,339	5,127	5,544	4,337	2,549	657	701	392	54	12	42	[illegible]
Wisconsin	3,583	.....	8	10	60	169	1,063	1,150	745	167	78	43	53	25	8	1	3	.....
Wyoming	4,486	.....	.....	1	20	21	84	291	913	826	1,381	208	310	72	60	248	20	[illegible]

[1] Includes the employees of 2 operators in Alaska and of 1 operator in Hawaii.

Only the state totals are shown in the above table, the statistics for the various minerals in each state and for the several classes of employees being combined. The distribution of the various minerals throughout the United States differs so much that, while this table is of interest as showing the total number of wage-earners at the various rates of pay in the several states, a comparison of the rates paid in one state with those paid in

another is of little value unless the minerals in each state are kept in mind. Thus, according to the figures presented, rates were highest in Montana and lowest in Florida. But since the greater part of the wage-earners in Montana were employed in copper and gold and silver mines, while those in Florida were employed in quarrying phosphate rock, the difference in wages is hardly significant.

It will be observed that the states reporting a large number of employees at the low rates are Southern states, while those reporting the greatest proportion at high rates are Western states. The difference in wages, according to geographic location, is more clearly shown in the following table, in which the figures for the various states are combined in five groups. The percentage of the total number at each rate is given for each group, as are also the cumulative percentages.

TABLE 44.—DISTRIBUTION OF WAGE-EARNERS ACCORDING TO DAILY RATES OF PAY, BY GEOGRAPHIC DIVISIONS: 1902.

[Each cumulative percentage shows the proportion of the total number receiving a wage as great as, or greater than, the lowest wage of the given wage group.]

RATE PER DAY (DOLLARS).	UNITED STATES.			NORTH ATLANTIC DIVISION.			SOUTH ATLANTIC DIVISION.			NORTH CENTRAL DIVISION.			SOUTH CENTRAL DIVISION.			WESTERN DIVISION.		
	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.	Average number.	Per cent of total.	Cumulative percentage.
Total ...	581,728	100.0	.....	222,881	100.0	.....	56,541	100.0	.....	177,584	100.0	.....	52,476	100.0	.....	72,246	100.0	.....
Less than 0.50.	538	0.1	100.0	115	0.1	100.0	274	0.5	100.0	47	(1)	100.0	97	0.2	100.0	5	(1)	100.0
0.50 to 0.74....	4,677	0.8	99.9	2,781	1.2	99.9	938	1.7	99.5	189	0.1	99.9	738	1.4	99.8	31	0.1	99.9
0.75 to 0.99....	11,054	1.9	99.1	5,081	2.3	98.7	3,527	6.2	97.8	528	0.3	99.9	1,884	3.6	98.4	34	0.1	99.9
1.00 to 1.24....	33,503	5.8	97.2	11,415	5.1	96.4	10,635	18.8	91.6	3,217	1.8	99.6	7,880	15.0	94.8	356	0.5	99.8
1.25 to 1.49....	45,101	7.8	91.4	24,164	10.8	91.3	6,736	11.9	72.8	6,748	3.8	97.8	6,724	12.8	79.8	729	1.0	99.3
1.50 to 1.74....	78,102	13.4	83.6	36,865	16.5	80.5	7,894	13.8	60.9	23,346	13.1	94.0	8,861	16.9	67.0	1,226	1.7	98.3
1.75 to 1.99....	75,554	13.0	70.2	33,085	14.9	64.0	6,476	11.4	47.1	26,124	14.7	80.9	6,800	13.0	50.1	3,060	4.2	96.6
2.00 to 2.24....	110,689	19.0	57.2	39,579	17.8	49.1	7,106	12.6	35.7	50,891	28.7	66.2	7,473	14.2	37.1	5,640	7.8	92.4
2.25 to 2.49....	73,665	12.7	38.2	29,427	13.2	31.3	5,839	10.3	23.1	29,504	16.6	37.5	3,618	6.9	22.9	5,277	7.3	84.6
2.50 to 2.74....	52,837	9.1	25.5	15,461	6.9	18.1	3,221	5.7	12.8	18,113	10.2	20.9	4,738	9.0	16.0	11,301	15.6	77.3
2.75 to 2.99....	24,446	4.2	16.4	7,620	3.4	11.2	1,566	2.8	7.1	6,668	3.8	10.7	1,473	2.8	7.0	7,119	9.9	61.7
3.00 to 3.24....	31,577	5.4	12.2	6,133	2.8	7.8	1,297	2.3	4.3	5,912	3.3	6.9	1,709	3.3	4.2	16,496	22.8	51.8
3.25 to 3.49....	10,733	1.8	6.8	5,641	2.5	5.0	570	1.0	2.0	1,913	1.1	3.6	192	0.4	0.9	2,414	3.3	29.0
3.50 to 3.74....	20,324	3.5	5.0	3,631	1.6	2.5	164	0.3	1.0	3,201	1.8	2.5	113	0.2	0.5	13,215	18.3	25.7
3.75 to 3.99....	2,397	0.4	1.5	839	0.4	0.9	288	0.5	0.7	318	0.2	0.7	60	0.1	0.3	892	1.2	7.4
4.00 to 4.24....	4,214	0.7	1.1	367	0.2	0.5	57	0.1	0.2	348	0.2	0.5	58	0.1	0.2	3,384	4.7	6.2
4.25 and over.	2,317	0.4	0.4	671	0.3	0.3	43	0.1	0.1	487	0.3	0.3	49	0.1	0.1	1,067	1.5	1.5

[1] Less than one-tenth of 1 per cent.

As shown by the above table, rates were much higher in the Western division than in any of the others, 51.8 per cent of the wage-earners in that division receiving $3 per day or over. The three rate groups showing the greatest number of employees are as follows: $2.50 to $2.74, 15.6 per cent; $3 to $3.24, 22.8 per cent; and $3.50 to $3.74, 18.3 per cent. In this group of states are included almost all of the gold and silver and copper mines of the country.

The wages in the North Central division were considerably lower than those in the Western division, but higher than those in either of the three other divisions. The range of wages for the majority of the employees, 83.3 per cent, was from $1.50 to $2.74, the rate group showing the greatest number of wage-earners being that of $2 to $2.24, which includes 28.7 per cent of the total number. In this North Central division are included the iron mines of Michigan and Minnesota, the coal mines of Ohio, Indiana, and Illinois, and the oil wells of Ohio and Indiana.

The rates of pay in the North Atlantic division were only slightly lower than those in the North Central division. The bulk of the employees received between $1.25 and $2.49 per day, 73.2 per cent being included between those rates. Over 70 per cent of the wage-earners in this division were employed in the coal mines of Pennsylvania.

Wages were lowest in the South Atlantic and South Central divisions, there being very little difference between the two sections. In each section 78.8 per cent of the total number were included between the rates $1 and $2.49.

IX.

CONTRACT MINING AND QUARRYING.

By reference to the copy of that part of the schedule of inquiry which relates to employees and wages, shown in Appendix A, it will be seen that operators were required to report mining or quarrying which was paid for otherwise than by the day. The inquiry was made a part of the schedule in order to determine the conditions of employment of those engaged in the actual work of mining and the extent to which such work was done under other terms of payment than daily rates. To indicate the extent to which such work was done in the different kinds of mining, Tables 45 and 46 are shown. Table 45 gives the total average number of miners and miners' helpers, and quarrymen and stonecutters, with the amount paid in wages to this class of employees; also the average number of contract miners, with their wages and the percentage the number of contract miners forms of the total number of men engaged in mining and their wages form of the total wages, respectively.

TABLE 45.—*Comparison of contract miners with all miners, by minerals: 1902.*

MINERAL.	MINERS AND MINERS' HELPERS, AND QUARRYMEN AND STONECUTTERS.		CONTRACT MINERS AND QUARRYMEN.			
	Average number.	Wages.	Average number.	Per cent of all miners and quarrymen.	Wages.	Per cent of wages paid to all miners and quarrymen.
Total	343,166	$230,142,393	230,846	67.3	$155,578,988	67.6
Asbestos	17	5,703	.....	.....	.....	.....
Asphaltum and bituminous rock	117	60,721	13	11.1	5,550	9.1
Barytes	322	125,820	229	71.1	96,549	76.7
Bauxite	77	24,269	.....	.....	.....	.....
Borax	93	71,096	.....	.....	.....	.....
Buhrstones and millstones	80	36,734	9	11.3	4,390	12.0
Cement	3,251	1,440,029	449	13.8	215,796	15.0
Clay	1,666	661,202	177	10.6	90,896	13.7
Coal, anthracite	24,688	18,007,898	22,629	91.7	16,572,582	92.0
Coal, bituminous	192,910	130,364,990	189,081	98.0	128,055,854	98.2
Copper ore	14,078	12,375,203	2,206	15.7	1,601,091	12.9
Corundum and emery	33	20,146	.....	.....	.....	.....
Crystalline quartz	26	12,392	.....	.....	.....	.....
Feldspar	183	77,541	16	8.7	7,065	9.1
Flint	65	27,648	18	27.7	8,519	30.8
Fluorspar	185	74,947	.....	.....	.....	.....
Fuller's earth	54	17,140	.....	.....	.....	.....
Garnet	61	29,505	.....	.....	.....	.....
Gold and silver	23,030	22,755,625	357	1.6	381,796	1.7
Graphite	93	42,111	.....	.....	.....	.....
Grindstones and pulpstones	118	54,270	28	23.7	11,757	21.7
Gypsum	614	319,606	166	27.0	85,976	26.9
Infusorial earth, tripoli, and pumice	23	9,152	1	4.3	650	7.1
Iron ore	20,849	11,903,442	8,105	38.9	5,090,832	42.8
Lead and zinc ore	3,958	2,142,748	2	(1)	266	(1)
Limestones and dolomites	22,036	10,250,034	3,772	17.1	1,482,678	14.5
Lithium ore	6	3,744	.....	.....	.....	.....
Manganese ore	99	44,439	.....	.....	.....	.....
Marble	2,513	1,418,382	17	0.7	6,650	0.5
Marl	10	3,919	.....	.....	.....	.....
Mica	73	31,192	.....	.....	.....	.....
Mineral pigments, crude	109	42,222	52	47.7	28,907	68.5
Monazite	86	24,728	65	75.6	19,280	78.0
Oilstones, whetstones, and scythestones	71	31,097	1	1.4	209	0.7
Phosphate rock	4,382	1,335,979	1,160	26.5	328,003	24.6
Precious stones	84	69,828	.....	.....	.....	.....
Quicksilver	840	553,207	104	12.4	67,000	12.1
Sandstones and quartzites	7,117	4,420,075	822	11.5	585,905	13.3
Silica sand	149	66,074	24	16.1	9,229	14.0
Siliceous crystalline rocks	14,474	8,665,190	528	3.6	321,626	3.7
Slate	3,656	2,155,865	800	21.9	491,325	22.8
Sulphur and pyrite	409	192,836	7	1.7	5,803	3.0
Talc and soapstone	428	147,183	5	1.2	1,229	0.8
Tungsten	2	1,260	.....	.....	.....	.....
Uranium and vanadium	17	15,840	.....	.....	.....	.....
All other minerals[2]	14	9,411	3	21.4	1,575	16.7

[1] Less than one-tenth of 1 per cent.
[2] Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.

It should be understood that the contract miners and quarrymen reported in the above table were not employees additional to those shown under wage-earners by classes, but are included there and also in the tables showing wage-earners by specified daily rates of pay and the average number employed during each month.

Of the total number, 343,166, engaged in actual mining aside from the other supplemental but necessary work about mines, such as timbering, track laying, operating engines and pumps, etc., 230,846, or 67.3 per cent, were paid by the amount of work done. They received in wages $155,578,988, or 67.6 per cent of the total wage payment.

It will be observed that the statistics for petroleum and natural gas are not shown in the foregoing table. In these industries the regular employees are almost entirely engaged in the maintenance and operation of the wells, and there are no employees that could be classified as "miners and miners' helpers or quarrymen and stonecutters." The initial work of developing oil and gas properties—drilling wells and building rigs—is practically all done by outside contractors, and the cost of such work is given in Table 47.

The following industries are those for which no contract mining was reported and in which payment for mining, in all cases, was by the day: Bauxite, borax, corundum and emery, crystalline quartz, fluorspar, fuller's earth, garnet, graphite, lithium ore, manganese ore, marl, mica, precious stones, tungsten, uranium and vanadium, magnesite, molybdenum, nickel and cobalt, and rutile.

In the coal industry practically all the employees who are engaged in cutting the coal and loading it into cars in the mine are paid by the car, ton, or yard. In bituminous coal mining 189,081 miners and miners' helpers, or 98 per cent of the total number of this class of workmen, were paid by the piece; in anthracite mining 22,629, or 91.7 per cent of the total for the industry, received wages by the piece. The amounts paid in the two industries were $128,055,854, or 98.2 per cent, and $16,572,582, or 92 per cent, respectively.

A feature of wage payment which distinguishes coal mining from other branches of the mining industry is the custom of "allowance," which obtains to a greater or less degree in nearly all coal mining operations. There are so many complex influences affecting the amount of payment to miners working by the ton, car, yard, or otherwise than by the day, that it is sometimes considered expedient and equitable to make payment for yardage—the number of linear yards which the "chamber," "heading," or "breast" in which the miner works may have been driven during the time for which payment is made, in addition to the earnings which may have accrued from the regular rate by the car or otherwise; also to make additional allowances in consideration of difficult mining, narrow work, or for other causes. This is done in order to equalize the earnings of the miners; otherwise it might frequently be the case that the harder working and in other respects more deserving employee would receive less pay than one whose output was smaller and hours of work fewer. While it may be customary to make similar allowances in other mining industries, it certainly can not be so to the same extent, and therefore no provision was made in the general mining schedule or in any of the other schedules, except for coal, for a separate report of such payments. The following table shows, for coal by states, the total amount paid in wages to contract miners and, in an adjoining column, the amount of such wages which was paid for yardage or other allowances and the percentage

which the latter is of the total wages. The number of mines at which payment was reported by the ton, car, yard, or other unit is also given.

TABLE 46.—*Wages paid for contract coal mining, and amount paid in allowances, by states and territories: 1902.*

STATE OR TERRITORY.	Total wages paid for contract mining.	YARDAGE AND OTHER ALLOWANCES.		MINES REPORTING PAYMENT BY—			
		Amount paid.	Per cent of total wages for contract mining.	Ton.	Car.	Yard.	Other unit.
United States	$144,628,436	$10,970,567	7.6	4,044	571	27	6
Alabama	5,867,310	600,383	10.2	103	7	.....	.....
Arkansas	1,150,822	150,206	13.1	47	.....	.....	.....
California	18,003	.....	.....	2	.....	.....	.....
Colorado	3,602,429	413,925	11.5	81	9	3	.....
Illinois	17,930,485	1,233,139	6.9	640	6	8	.....
Indian Territory	1,941,863	307,557	15.8	54	.....	.....	.....
Indiana	5,225,804	450,158	8.6	259	7	.....	.....
Iowa	4,502,012	538,944	12.0	292	5	.....	.....
Kansas	3,488,067	540,345	15.5	146	.....	.....	.....
Kentucky	2,927,034	251,247	8.6	150	1	3	.....
Maryland	2,746,268	30,215	11.0	44	.....	.....	.....
Michigan	853,896	182,940	21.4	31	.....	.....	.....
Missouri	2,896,873	268,511	9.3	240	.....	.....	.....
Montana	1,071,586	71,445	6.7	29	1	.....	.....
New Mexico	680,552	73,928	10.9	20	2	.....	.....
North Dakota	120,443	9,841	8.2	25	2	.....	.....
Ohio	12,026,317	830,409	6.9	554	33	2	1
Oregon	80,228	2,700	3.4	4	.....	1	.....
Pennsylvania, bituminous	44,284,880	2,010,075	4.5	921	50	1	4
Pennsylvania, anthracite	16,572,582	1,930,015	11.6	26	254	7	.....
Tennessee	2,221,477	258,657	11.6	63	7	1	.....
Texas	788,777	38,898	4.9	21	2	.....	.....
Utah	838,148	84,326	10.1	15	.....	.....	.....
Virginia	856,999	23,866	2.8	3	14	.....	.....
Washington	1,415,687	42,530	3.0	3	7	1	.....
West Virginia	8,623,329	430,936	5.0	247	161	.....	1
Wyoming	1,882,869	194,888	10.4	22	3	.....	.....
All other states[1]	13,696	483	3.7	2	.....	.....	.....

[1] Includes Idaho and North Carolina.

Table 46 shows that the amount paid for yardage or other allowances in coal mining, both anthracite and bituminous, was $10,970,567, which was 7.6 per cent of $144,628,436, the total amount paid for contract coal mining. The prevailing method of payment for contract coal mining in bituminous mines was by the ton, as there were 4,018 mines for which this method was reported, compared with 317 by the car, 20 by the yard, and 6 by other methods. The total number of mines reporting some method of contract mining was 4,648. The difference between this number and the total number of coal mines reported for the United States is 1,338, and is accounted for by the number of mines in which a daily rate of pay was the rule, and by the small "local coal banks" at which no wage-earners were employed. In several instances more than one of these methods was reported for the same mine. In anthracite coal mining, the prevailing method of payment was by the car, 254 mines reporting that method, as compared with 26 by the ton and 7 by the yard.

It should be stated that when payment by the yard is in the form of allowance only, it has not been included in Table 46 as a method of payment.

The subject of allowances in addition to the regular schedule of rates for coal mining receives the careful consideration of both the operators and the miners. The fact that 7.6 per cent of the wages paid for contract work was in the form of allowances indicates the prime importance of this feature of wage payment in the economical administration of the properties. Without this system no equitable and uniform scale of wages could be arranged.

These allowances are nearly always fixed by the foreman in charge of the mine, and usually result from a conference as to the equities of the case between him and the miner interested. It will be observed that according to Table 46 allowances were made in every state and territory separately shown, the amount ranging from $3,940,090 for both anthracite and bituminous in Pennsylvania to $2,700 in Oregon, and the percentage that the allowance is of the total wages paid for contract mining from 21.4 per cent in Michigan to 2.8 per cent in Virginia.

The schedule called for the rate of payment by the ton, car, yard, or otherwise, and a mass of information was received bearing upon this point. However, the very wide range of the rates and the complexities of the subject generally have defeated any statistical presentation of the data reported.

The amount paid for contract mining in the iron ore industry was $5,090,832, which was 42.8 per cent of the total amount paid to miners in that industry. The number of wage-earners so employed was 8,105, or 38.9 per cent of the total number of miners. Payment for contract mining in this industry was principally by the ton and by the tram, and occasionally by the yard, with a wide range of rates.

The number of contract wage-earners engaged in quarrying limestones and dolomites was 3,772, or 17.1 per cent of the total number of contract quarrymen and stonecutters, and the amount of wages paid was $1,482,678, or 14.5 per cent of the total for such work. The unit upon which payment was based was very irregular, as payment was reported by the tram, ton, foot, yard, perch, and bushel.

In gold and silver and lead and zinc mining the proportion of contract mining was very small and indicates that most of the work was done by the day. In lead and zinc mining contract mining was exceptional, as the amount reported was only $266. In those mines, however, where the landowner or first lessee was also the buyer of all ore mined by the sublessees, the latter were virtually wage-earners paid by the ton. The total number of such sublessees reported was 638 and the total amount paid to them was $244,661; out of this amount they were required to furnish their own supplies. In the tabulation of the statistics these sublessees in lead and zinc were regarded as proprietors and are not included in Table 46.

Contract mining was reported for only a small number of copper mines, and these were all in Michigan, no work of that kind being reported for the argentiferous copper mines of the Rocky mountain region. The average number of contract miners was 2,206, or 15.7 per cent of the total number, and the amount paid was $1,601,091, or 12.9 per cent of the total wages paid for mining copper ore. Drifting, as reported, was paid for by the foot, the rate ranging from $5.75 to $7.71. Stoping was paid for at an average of about $8 per cubic fathom.

In barytes mining 71.1 per cent of the miners worked by the piece system, and according to the reports, received payment by the ton, the rates ranging from $2 to $3.50.

Only a comparatively small percentage of cement-rock mining was done by contract. Payment in such cases was by the ton and there was a wide range of rates.

Contract clay mining was paid for by the ton, the rate ranging from 13½ to 75 cents per ton.

The rate paid for mining gypsum on contract ranged from 20 to 65 cents per ton, with most of the operators reporting a rate between 40 and 50 cents.

Thirteen and three-tenths per cent of the wages paid for quarrying sandstones and quartzites was for contract quarrying. The unit upon which payment was based in this industry was the same as in the quarrying of limestone and dolomites and siliceous crystalline rocks, very irregular, as payment was reported by the tram, ton, foot, yard, perch, and bushel, and the rates varied more widely.

A large proportion, 68.5 per cent, of the mining of crude mineral pigments was by the ton; the lowest rate reported was 40 cents and the highest $5 per ton.

Most of those engaged in monazite mining, while working independently of any proprietors, were reported as wage-earners on contract, as elsewhere described. The crude monazite obtained from the placers was sold by the miners at the rate of 4 cents per pound, and this was treated in the statistics as the rate received by them for contract mining.

Approximately one-fourth of the mining for phosphate rock was by contract. In a few instances payment was made by the car and yard, but in most cases it was by the ton. The rates ranged from 25 cents to $5 per ton. The latter amount was paid by an establishment in New Mexico, where the product was a bat deposit found in a cave and difficult and expensive to mine on account of its location.

Contract slate quarrying was by the square, and the lowest rate reported was 70 cents and the highest $2.25.

As shown by Table 45, there were several other industries for which small proportions of contract mining were reported, but the amount and percentage of the figures are comparatively unimportant.

X.

CONTRACT WORK.

In nearly all branches of the mining and quarrying industry occasions arise which demand considerable outlays for work that is different from the regular production of the ore or mineral—work such as tunneling, shaft sinking, boring test holes, and removing top earth where open-cut mining is intended—and this is frequently let to contractors who make a specialty of the work in question, usually to the lowest bidders. Table 47 shows for each mineral the value of the product, the amount paid for contract work and the number of employees engaged in it, and the per cent that the amount paid for this work is of the value of product.

TABLE 47.—*Comparison of contract work with value of product, by minerals: 1902.*

MINERAL.	Value of product.	CONTRACT WORK.		Per cent amount paid for contract work forms of value of product.
		Amount paid.	Number of employees.	
Total	$796,826,417	$20,677,938	21,183	2.6
Asbestos	46,200			
Asphaltum and bituminous rock	236,728	10,060	60	4.2
Barytes	203,154	1,000	10	0.5
Bauxite	128,206	500	10	0.4
Borax	2,383,614			
Buhrstones and millstones	59,808			
Cement	24,268,338	10,627	34	(1)
Clay	2,061,072	13,241	36	0.6
Coal, anthracite	76,173,586	406,421	1,731	0.5
Coal, bituminous	290,858,483	1,244,114	5,040	0.4
Copper ore	51,178,036	188,768	195	0.4
Corundum and emery	104,605			
Crystalline quartz	43,085			
Feldspar	250,424			
Flint	144,209			
Fluorspar	275,682	300	3	0.1
Fuller's earth	98,144	4,021	8	4.1
Garnet	132,820			
Gold and silver	82,482,052	626,090	980	0.8
Graphite	227,508	900	2	0.4
Grindstones and pulpstones	667,431			
Gypsum	2,089,341	406	7	(1)
Infusorial earth, tripoli, and pumice	56,994			
Iron ore	65,465,321	425,292	1,079	0.6
Lead and zinc ore	14,600,177	108,607	223	0.7
Limestones and dolomites	30,441,801	36,381	137	0.1
Lithium ore	25,750			
Manganese ore	177,911			
Marble	5,044,182			
Marl	12,741			
Mica	118,849			
Mineral pigments, crude	360,885			
Monazite	64,160			
Natural gas	30,867,863	4,459,001	3,268	14.4
Oilstones, whetstones, and scythestones	113,968			
Petroleum	71,397,739	12,956,631	7,949	18.1
Phosphate rock	4,922,943	157,402	306	3.2
Precious stones	328,450			
Quicksilver	1,550,090	23,164	80	1.5
Sandstones and quartzites	10,601,171	500	1	(1)
Silica sand	421,289	100	2	(1)
Siliceous crystalline rocks	18,257,944			
Slate	5,696,051			
Sulphur and pyrite	947,089	3,587	15	0.4
Talc and soapstone	1,138,167			
Tungsten	5,975			
Uranium and vanadium	48,125			
All other minerals [2]	49,256	825	7	1.7

[1] Less than one-tenth of 1 per cent.
[2] Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.

When the schedule of inquiry was drawn up the difficulty of obtaining complete and correct information in regard to contract work, especially concerning the

number of men employed and the number of days required to complete the work, was fully appreciated by the officials of the Bureau of the Census and by experts who were consulted in the preparation of the schedule. It was believed that in most cases it would be impossible to locate the contractors. Generally no record is kept by the mine operators of any other data relating to contract work than the amount paid. The number of employees and the duration of the contract are matters of less concern to them. However, it was thought that the close attention they are obliged to pay to the work during its progress to insure strict compliance with the terms and specifications of the contract, would enable them, in the absence of records, to make a fair estimate of the data. This was realized in the course of the canvass, and the statistics are published with no pretentions that they can be regarded as strictly correct, but under the conviction that they are reasonably accurate considered as statistics which are in part estimated.

The employees reported under this inquiry are not included among the wage-earners and should not be considered as forming a part of the wage-earners reported by classes, and at specified daily rates of pay, nor of the average number reported for each month. No conclusions can be drawn from Table 47 as to the amount paid to contract employees, nor in regard to the average number for the entire year. As to the latter, indeed it is quite possible that some of the employees are duplicated in the figures.

The amount paid represents the entire cost of the contract work, including the wages paid, the cost of all supplies and materials used, other miscellaneous expenses, and the profits of the contractors. These expenses vary in their proportion to the whole cost according to the kind of work. In drilling wells for petroleum and natural gas, as a rule the cost of materials is greater in proportion than in any other description of contract work. The drilling carries with it the obligation to provide casing, tools, and all other supplies required to equip the wells; and in building the rig, all materials are generally furnished by the contractor. In shaft sinking, also, materials and supplies such as timber and explosives form a considerable proportion of the whole cost.

While no particular statistical value can be attached to a comparison of the cost of contract work with the value of product, yet always keeping in mind the fact that the figures are not fully representative of this class of work, a great deal of it being done by the regular employees of the mining companies, the table will serve to show the proportions of both with respect to the value involved.

Table 47 shows that the amounts paid for contract work and the percentages that these form of the value of the product are greater in the case of petroleum and natural gas than for any other mineral. In the crude-oil and natural-gas industry practically all of the development work, prospecting, and equipment of the properties are done by contract, which explains the large amount expended for such work. The regular employees of the producing companies are nearly all engaged in the maintenance and operation of the wells. The number of employees reported as employed on contract work in this industry approaches more nearly the true average number for the year than in any other.

As explained on page 20 of this report, the Standard Oil Company made reports covering the entire production of crude petroleum, with the exception of a few producers of heavy oil, in Pennsylvania, New York, Ohio, West Virginia, and Indiana, and combined reports of its own production for Kentucky and Kansas, without separating the production by counties, as was generally required by the Bureau of the Census. Also, for natural gas the company reported for its subsidiary or contributary companies the production in Pennsylvania, New York, Ohio, and West Virginia, making a single report for each state. In reporting contract work the amount paid was given, but it was stated that the number of men employed could not be given, and in lieu of exact information the average number of men required for each well and rig and the average time required to complete the work at each well were reported. From these data, using as a basis the number of wells drilled during the year and assuming that operations were continued throughout the whole year on full time, the average number of men employed was computed. While the figures, therefore, are pure estimates, if the information furnished by the company is accurate they may be accepted as fairly representing the statistics for this branch of the industry. Taking into consideration the fact that the amount paid for contract work in the petroleum and natural-gas industries, $17,415,632, is 84.2 per cent of the total paid in all mining and quarrying industries, $20,677,938, and that the number of employees in these industries, 11,217, is 53 per cent of the total, 21,183—with the additional consideration of the great preponderance of the Standard Oil Company's interests over those of all other oil producers—an idea is obtained of the extent to which the total number of employees engaged in contract work in all the industries is affected by the estimates which were made necessary.

The amount paid for contract work in coal mining was $1,650,535; in anthracite $406,421, and in bituminous $1,244,114; and the number of employees was 6,771—in the former 1,731, and in the latter 5,040. The information was generally reported by the coal operators very completely. No reduction of the number of employees reported to the average number for the year was made, and the number given in the table

may contain duplications, as there was nothing in the reports to show whether or not a force of employees engaged in a contract and so reported was not again reported for another contract, taken after the completion of the first for a different operator and both during the census year 1902. Unlike those engaged in deep mining for the precious metals—for copper, iron, etc.—coal miners, engaged as they are in mining a material more easily worked than the surrounding rock and which is always found in well-defined veins, are usually unsuited for what is termed "rock work." Therefore such work as tunneling, shaft sinking, boring test holes, etc., is in most cases done more economically under the contract system. The larger companies, however, frequently maintain a force of men especially for that purpose.

The amount reported as paid for contract work in gold and silver mining was $626,090, which was only eight-tenths of 1 per cent of the value of the product of the mines. The work was very similar to development work in other kinds of mining. In some cases, where considerable depth had been reached and pumping had to be done on an extensive scale, it was at times impossible for one mining company to pump the water from its mine without at the same time clearing all adjacent mines. This work was therefore most conveniently done by contracting firms or companies with whom the business had become a specialty.

The amount paid for contract work in iron ore mining was $425,292, and there were 1,079 men employed. The work was similar in character to that done in other branches of the mining industry, except that there may have been a larger proportion of stripping preparatory to open-cut mining.

It should be explained that in the data shown in Table 47, in addition to the amount paid for work other than mining which was done by contract, there is included the amount paid by private operators to state and municipal penal institutions for the lease or use of convicts in the operation of mines and quarries. A careful examination of the reports received shows that $530,341 was paid for this purpose. The laws of certain Southern states permit the lease of convicted prisoners to private persons or firms for work outside of the penitentiaries. Among the states by which this is done are Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, North Carolina, South Carolina, and Tennessee. This is entirely apart from the work of convicts in mines or quarries owned by the state. The only states in which the convicts were reported to have been leased to work in mines and quarries, and to which the amount above reported, $530,341, was paid, are the following: Alabama, coal; Florida, phosphate rock; Georgia, coal and iron ore; North Carolina, limestone.

In addition to the contract work shown in Table 47, a large amount of such work was done at mines and quarries which did not produce any mineral in 1902, but at which development work of some kind was done. The amount paid and the number of employees engaged in contract work at idle mines or those in process of development are shown, by minerals, in the following table:

TABLE 48.—*Contract work at nonproducing mines, by minerals: 1902.*

MINERAL.	Amount paid.	Number of employees.
Total	$2,664,526	7,049
Borax	500	3
Coal, bituminous	33,767	135
Copper ore	200	1
Gold and silver	1,542,771	5,649
Iron ore	216,168	286
Lead and zinc ore	8,149	17
Manganese ore	158	1
Natural gas	104,250	173
Petroleum	758,433	783
Quicksilver	150	1

Adding the amount paid and the number of employees given in the above table to the corresponding data shown in Table 47 makes a total for the United States of $23,342,464 paid for contract work in 1902 at all classes of mines and 28,202 employees. Contract work was reported in greatest amounts from petroleum and natural-gas wells among productive properties; the largest amount of contract work at mines for which no production was reported was in the development and improvement of gold and silver mines. Petroleum and natural gas, iron ore, and bituminous coal follow in the order named.

XI.

PRODUCTION WITHOUT EMPLOYEES.

Speaking broadly, it required the services of 619,856 wage-earners and salaried employees, to whom was paid $408,980,512 to produce in 1902 the mineral product of the United States, which was valued at $796,826,417.

The conditions of mining and quarrying were such as to call for the employment of at least one person at a very large proportion of the plants, and in some branches of the industry the investment of capital in buildings and mechanical and other equipment and the organization of the working force were equal to those features of industrial organization in the largest and most important manufacturing establishments. On the other hand, in certain branches of the industry operations were conducted at many mines and quarries under conditions of the greatest simplicity with no hired labor and no mechanical equipment, with the exception of a few tools. Table 49 presents for each mineral the number of mines or quarries at which there were no employees, the proprietor doing all the work; also the value of the output of such establishments, and in adjoining columns, for purposes of comparison, the total number of mines and quarries and the value of their product with the percentage that the product of the class reporting no employees forms of the total.

TABLE 49.—*Production without employees, by minerals: 1902.*

MINERAL.	Total number of mines, quarries, and wells.	Number of mines, quarries, and wells without employees.	PRODUCT.		
			Total value for all mines, quarries, and wells.	Value for mines, quarries, and wells without employees.	Per cent of total value.
Total	151,516	4,368	$796,826,417	$1,816,650	0.2
Asbestos	4	1	46,200	200	0.4
Asphaltum and bituminous rock	24	4	236,728	23,000	9.7
Barytes	49	1	203,154	20	(1)
Bauxite	38	1	128,206	75	0.1
Borax	6	.....	2,383,614	.....	.....
Buhrstones and millstones	29	3	59,808	862	1.4
Cement	101	.....	24,268,338	.....	.....
Clay	205	31	2,061,072	13,866	0.7
Coal, anthracite	334	.....	76,173,586	.....	.....
Coal, bituminous	5,652	290	290,858,483	70,280	(1)
Copper ore	144	1	51,178,036	3,075	(1)
Corundum and emery	5	.....	104,605	.....	.....
Crystalline quartz	6	.....	43,085	.....	.....
Feldspar	27	.....	250,424	.....	.....
Flint	19	.....	144,209	.....	.....
Fluorspar	22	.....	275,682	.....	.....
Fuller's earth	4	.....	98,144	.....	.....
Garnet	7	.....	132,820	.....	.....
Gold and silver	2,992	599	82,482,052	482,611	0.6
Graphite	28	.....	227,508	.....	.....
Grindstones and pulpstones	3	.....	667,431	.....	.....
Gypsum	62	1	2,089,341	75	(1)
Infusorial earth, tripoli, and pumice	11	1	55,994	5,720	10.2
Iron ore	525	27	65,465,321	13,572	(1)
Lead and zinc ore	559	.....	14,600,177	.....	.....
Limestones and dolomites	3,246	975	30,441,801	237,294	0.8
Lithium ore	3	.....	25,750	.....	.....
Manganese ore	19	9	177,911	4,795	2.7
Marble	83	1	5,044,182	300	(1)
Marl	11	.....	12,741	.....	.....
Mica	49	18	118,849	18,438	15.5
Mineral pigments, crude	35	2	360,885	2,450	0.7
Monazite	23	14	64,160	1,776	2.8
Natural gas	15,806	1,755	30,867,863	615,251	2.0
Oilstones, whetstones, and scythestones	15	.....	113,968	.....	.....
Petroleum	118,671	266	71,397,739	148,397	0.2
Phosphate rock	115	1	4,922,943	400	(1)
Precious stones	46	[2]2	328,450	71,510	21.8
Quicksilver	41	3	1,550,090	1,871	0.1
Sandstones and quartzites	1,304	286	10,601,171	65,871	0.6
Silica sand	26	.....	421,289	.....	.....
Siliceous crystalline rocks	906	68	18,257,944	28,186	0.2
Slate	199	4	5,696,051	1,316	(1)
Sulphur and pyrite	23	1	947,089	80	(1)
Talc and soapstone	20	.....	1,138,167	.....	.....
Tungsten	4	1	5,975	234	3.9
Uranium and vanadium	3	2	48,125	5,125	10.6
All other minerals[3]	6	.....	49,256	.....	.....

[1] Less than one-tenth of 1 per cent.
[2] Includes value of product of 436 operators for whom no mines were reported.
[3] Includes mines as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

The practice of operating mines by the owner or lessee without the employment of labor is more prevalent in some mining industries than in others, and necessarily affects the relative proportion which the number of employees bears to the quantity of product for the industry considered as a whole and in its several branches. Of the total number of mines, quarries, and wells (151,516) there were only 4,368, or 2.9 per cent, at which all the work was done by the proprietors, and the value of the products of such mines, quarries, and wells was only $1,816,650, or 0.2 per cent of $796,826,417, the total for the United States for all mining industries. At the census of manufactures, of the total number of manufacturing establishments (512,254) there were 110,510, or 21.6 per cent, in which the work was done by the proprietors without hired assistance.

The industries in which there was one employee or more reported at every plant are as follows: Borax, cement, coal, anthracite; corundum and emery, crystalline quartz, feldspar, flint, fluorspar, fuller's earth, garnet, graphite, grindstones and pulpstones, lead and zinc ore, lithium ore, marl; oilstones, whetstones, and scythestones; silica sand, sulphur and pyrite, talc and soapstone, chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.

Precious stones show the highest percentage for the value of the product obtained without employees, 21.8 per cent; this is accounted for by the fact that a value amounting to $69,550 was, as elsewhere explained, the result of accidental discoveries by individuals and not of systematic and regular mining. The other high percentages were for mica, 15.5; for uranium and vanadium, 10.6; for infusorial earth, tripoli, and pumice, 10.2; and 9.7 for asphaltum and bituminous rock. Less than one-tenth of 1 per cent of the product of bituminous coal mines was from mines without employees.

The statistics for petroleum and natural-gas wells are misleading and are not in the least representative of conditions as to the employment of wage-earners at the well. The percentage of the product of wells without employees as it appears in the table was 2 for both petroleum and natural gas. It is unquestionable that a much larger number of wells were operated and a larger output produced under conditions requiring no employees than the table indicates. The circumstances surrounding the reports of the Standard Oil Company, as previously explained, are accountable for the evident inaccuracy of the figures. Separate reports were not furnished by this company for the different groups of wells under its ownership or control, or for the wells in different counties, but the reports were made by states, the report for a state including all oil or gas operations in that state; it was, therefore, obviously impossible to determine from the reports whether or not particular wells or groups of wells required hired labor for their operation.

XII.

IRREGULAR PRODUCERS.

A large proportion of the mining and quarrying done in this country is of a regular and stable character, and there was no great difficulty encountered in securing complete Census reports from most of the operators of this class. There are, however, in some branches of mining and quarrying irregular producers who operate independently, working at such times as they feel inclined or only enough to obtain a product sufficient to satisfy the local demand. Some of these small operators work the same digging from time to time, while others, such as the placer gold and monazite miners, work in different localities, selected with reference to the richness of the deposits. It was found to be impossible to

secure Census reports from all operators of this class, but the necessary information was sometimes obtained from merchants who purchased the products, or from others.

This condition was exemplified in the monazite industry of North Carolina. The industry is one of placer mining, and is carried on in many instances irregularly by men whose expenses are sometimes advanced by the operators of a concentrating plant, who purchase their production, and from whom—as it was found impossible to obtain reports from the miners themselves—the report was obtained covering the operations of all. The men thus irregularly engaged in monazite mining are not employees or wage-earners, strictly speaking, but it was considered that they should be so treated in the statistics. Several hundred were reported as so employed, but by the method of reduction to the average for the entire year this number was very greatly reduced. The amount paid for the crude monazite at the concentrator was treated as the wages of these miners.

Somewhat similar conditions existed in the manner in which the operations were conducted in placer mining for gold. The mines were quite generally found in localities remote from settled communities and difficult to reach on that account, and partly for this reason the special agents engaged in making the canvass were instructed not to secure reports from placer mines at which less than two wage-earners were employed. This has resulted in the omission from the statistics of about one-fourth of the placer mines. Unlike the method followed in the treatment of statistics of monazite, no cognizance has been taken in the statistics, either by estimate or otherwise, of the operations thus omitted.

Again, in 1902, a large proportion of the output of precious stones was the result of work that was not open to statistical treatment as to capital, employees and wages, expenses, etc. The entire value of this product for the United States was $328,450, of which $69,550, or 21.2 per cent, was the value of different varieties of precious stones that were yielded not by systematic mining operations, but by accidental discovery here and there in the search for other minerals. For this part of the production, therefore, statistics for value of product alone are presented.

In bituminous coal mining there was a large number of mines which are classed as "local" mines or "farmers' coal banks," which were operated only to supply the needs of the neighborhood in which they were located. The number of such mines as reported at the Eleventh Census was 9,969, as compared with 826 reported at the census of 1902. The difference in the numbers reported at the two censuses is due largely, if not entirely, to the failure to reach all of these unimportant mines in 1902. According to the returns received from such mines, wage-earners were employed to but a limited extent and only for short periods, and when the total number was reduced to an average for the year, the result was a very insignificant number as compared with the total number of wage-earners employed in the industry.

XIII.

TIME IN OPERATION.

Table 50 shows the number of mines, quarries, and wells classified according to time in operation by periods of thirty days, by the number of shifts per day, and by the number of hours in a shift, from six to twelve. The number of mines for which the information was not reported also appears.

TABLE 50.—TIME IN OPERATION: 1902.

MINERAL.	NUMBER OF MINES, QUARRIES, AND WELLS CLASSIFIED ACCORDING TO DAYS IN OPERATION.													
	Total.	30 and less.	31 to 60.	61 to 90.	91 to 120.	121 to 150.	151 to 180.	181 to 210.	211 to 240.	241 to 270.	271 to 300.	301 to 330.	331 to 365.	Not reported.
Total	151,516	1,298	1,362	1,110	1,464	1,464	1,336	1,913	1,764	1,835	3,794	117,308	15,090	1,778
Asbestos	4	1		2							1			
Asphaltum and bituminous rock	24	2	2	2	1	1	1	1	3		5		1	5
Barytes	49	4	2	3	7	2		16	2	5	6			2
Bauxite	38					5	1	1			30			1
Borax	6							2			4			
Buhrstones and millstones	29	2	5	4	2		1	3	3	3	4	2		
Cement	101	3	3	3	5	3	3	9	7	18	28	13	6	
Clay	205	10	11	9	11	10	20	15	14	24	54	10		17
Coal, anthracite	334	7	13	19	54	111	89	25	9	2	2	1		2
Coal, bituminous	5,652	337	356	304	427	439	408	801	841	755	736	136	17	35
Copper ore	144	3	4	9	4	9	11	11	3	5	11	40	31	3
Corundum and emery	5		1			1					2		1	
Crystalline quartz	6					2	1				3			
Feldspar	27	4		2	2	5	1	2		2	8	1		
Flint	19		3	4	1		2	1	1	2	4	1		
Fluorspar	22		1		4	2		1	4	4	6			
Fuller's earth	4				1						2	1		
Garnet	7		1	1				1	1		2			1
Gold and silver	2,992	100	219	221	255	203	199	171	132	129	301	178	462	422
Graphite	28		3	11		2	1	3	1	4	2	1		
Grindstones and pulpstones	9				1	2		2	1		2		1	
Gypsum	62	2	4	4	4	2	4	3	3	6	25	3	2	
Infusorial earth, tripoli, and pumice	11	1			1	3		1			3			2
Iron ore	525	19	23	22	18	28	21	40	50	39	120	103	26	16
Lead and zinc ore	559	26	44	40	58	44	32	55	50	59	105	35	7	4
Limestones and dolomites	3,246	569	344	200	257	215	203	251	221	217	353	65	33	318
Lithium ore	3		1	1	1									
Manganese ore	19	3	1	1	2		1	1			2		1	7
Marble	83		4	4	1	4	4	8	7	5	33	11	1	1
Marl	11	3	3	1	2			1		1				
Mica	49	2	6	5	3	5	3	11	4		3			7
Mineral pigments, crude	35		4	1	5	5	2	1		4	7	4		2
Monazite	23	6	6	2	1	1	1	3	1		2			
Natural gas	15,806	19	33	39	79	108	44	72	31	198	1,118	1,858	11,898	312
Oilstones, whetstones, and scythestones	15	3		1	2	1		1		2	4	1		
Petroleum	118,671	57	115	74	93	101	74	122	90	58	446	114,753	2,581	107
Phosphate rock	115	1	8	5	4	5	1	7	13	15	46	8		2
Precious stones	46	1	1	1	8			2	19	10			3	1
Quicksilver	41				5		1		2	1	5	9	16	2
Sandstones and quartzites	1,304	77	85	56	88	76	62	119	84	72	98	19	2	466
Silica sand	26		1	2	1	3		2	4	3	7			3
Siliceous crystalline rocks	906	29	47	53	43	63	76	130	117	131	160	37	1	19
Slate	199	2	6	3	7	1	9	15	44	58	31	7		16
Sulphur and pyrite	23				1		2	2	1		6	7		4
Talc and soapstone	20	1			3	1	1	1	1	2	6	4		
Tungsten	4	1	2		1									
Uranium and vanadium	3	1			1					1				
All other minerals[1]	6	2		1		1					1			1

[1] Includes mines as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

TABLE 50.—TIME IN OPERATION: 1902—Continued.

MINERAL.	NUMBER OF MINES, QUARRIES, AND WELLS CLASSIFIED ACCORDING TO SHIFTS PER DAY.[1]				NUMBER OF MINES, QUARRIES, AND WELLS CLASSIFIED ACCORDING TO HOURS PER SHIFT.[2]							
	1.	2.	3.	Not reported.	6.	7.	8.	9.	10.	11.	12.	Not reported.
Total	20,873	128,406	212	2,025	84	86	4,628	2,685	13,604	210	128,185	2,034
Asbestos	4							1	3			
Asphaltum and bituminous rock	17		2	5			4		15			5
Barytes	47			2			11	13	23			2
Bauxite	36	1		1					36		1	1
Borax	4	1	1				1		5			
Buhrstones and millstones	29							3	26			
Cement	55	45	1				3	1	54	2	41	
Clay	185	3		17			32	21	130		5	17
Coal, anthracite	328	4		2		5	42	75	210			2
Coal, bituminous	5,527	90		35	12	39	2,729	872	1,951	5	9	35
Copper ore	54	66	19	5			66	20	50		3	5
Corundum and emery	5						1		4			
Crystalline quartz	6								6			
Feldspar	27							4	23			
Flint	19						1	2	16			
Fluorspar	21	1							22			
Fuller's earth	3	1							4			
Garnet	5	1		1					5		1	1
Gold and silver	1,778	638	158	418	4	9	945	363	1,099	9	136	427
Graphite	26	2					1	6	20		1	
Grindstones and pulpstones	9								9			
Gypsum	57	5					2	4	53	1	2	
Infusorial earth, tripoli, and pumice	8	1		2					8		1	2
Iron ore	356	140	12	17	1	1	28	9	451	14	4	17
Lead and zinc ore	480	70	5	4			143	326	76		10	4
Limestones and dolomites	2,898	28	2	318	1	2	115	142	2,624	15	29	318
Lithium ore	3						1	1	1			
Manganese ore	11	1		7			1		11			7
Marble	81	1		1			3	4	75			1
Marl	11								11			
Mica	41	1		7			4	12	26			7
Mineral pigments, crude	31	2		2				2	30		1	2
Monazite	23							2	21			
Natural gas	3,939	11,308		559	12	2	32	169	3,555		11,477	559
Oilstones, whetstones, and scythestones	15							2	13			
Petroleum	2,595	115,962	6	108	51	27	221	53	1,627	130	116,451	108
Phosphate rock	108	5		2				2	81	24	6	2
Precious stones	44	1		1			2	33	10			1
Quicksilver	25	11	5	2			6	6	27			2
Sandstones and quartzites	836	2		466	3	1	39	133	661	1		466
Silica sand	23			3					23			3
Siliceous crystalline rocks	887			19			186	355	341	5		19
Slate	182	1		16				42	139	2		16
Sulphur and pyrite	11	7	1	4			2	2	14		1	4
Talc and soapstone	14	6						2	14	2	2	
Tungsten	4						3	1				
Uranium and vanadium	3						3					
All others minerals[3]	4	1		1			1	2	1		1	1

[1] Duplication of 33 mines which reported more than one class of shifts per day, distributed as follows: Colorado, 13; California, 11; Idaho, 3; Oregon, 3; South Dakota, 1; Texas, 1; Utah, 1.

[2] Duplication of 34 mines which reported more than one number of "hours per shift," distributed as follows: Colorado, 4; California, 20; Idaho, 3; Montana, 1; Nevada, 1; Oregon, 4; Texas, 1.

[3] Includes mines as follows: Chrome ore, 1; magnesite, 1; molybdenum, 1; nickel and cobalt, 2; rutile, 1.

At many of the mines and quarries work was extremely irregular on account of fluctuating demands and the interruption of operations by seasonal changes.

From the totals for all minerals it appears that a large majority of the mines, quarries, and wells in the United States worked full time throughout the year, or from 301 to 365 days, with two shifts of 12 hours each per day; but this is caused by the fact that nearly all of the natural-gas and petroleum wells were in constant operation both day and night for periods exceeding 300 days. If the statistics for these wells are omitted, it will be seen that one shift of 10 hours was the most general plan, with the 8-hour day next in importance.

When the figures for petroleum and natural-gas wells are deducted from the totals for all minerals a total of 17,039 mines and quarries is obtained; of this number 14,339 worked one shift, 1,136 worked two shifts, 206 were operated by three shifts, and for 1,391 the information was not reported. The shift was 10 hours in length at 8,422 mines, 8 hours at 4,375, 9 hours at 2,463, and 12 hours at 254, and for 1,367 the information was not reported.

The larger number of anthracite coal mines were in operation from 91 to 210 days. This comparatively short period of operation was, as elsewhere explained, due to a strike in that industry. Of the total number of mines, 328 were operated by only one shift per day, which appeared to be the rule; the length of the shift was quite generally 10 hours.

The bituminous coal mines seem to be quite evenly distributed as to the number of days in operation, a large number appearing in each group from 30 days and less in those which exceeded 300 days. The larger number, however (3,133), were reported as operating for periods from 181 days to 300 days. One shift of 8 hours appears to have been the general custom.

In copper mining the mines working two shifts were more numerous than those working one, and a considerable proportion of gold and silver and iron ore mines worked more than one shift per day.

The statistics show that a very large proportion of

natural-gas and petroleum wells were in operation from 301 to 365 days, working two shifts of 12 hours each per day.

The stone quarries, including marble, limestones and dolomites, sandstones and quartzites, siliceous crystalline rocks, and slate, according to the table, with comparatively few exceptions, worked but one shift per day. The larger proportion were reported as working 10 hours per shift, although a considerable number reported 8 and 9 hour shifts.

XIV.

MISCELLANEOUS EXPENSES.

An inquiry concerning miscellaneous expenses was first included in the schedules at the census of 1890, when the "total of all other expenditures in the mines or works (including amounts paid for rent, taxes, insurance, interest, etc.)" was reported as a separate item. The same inquiry at the census of 1902 required separate amounts to be reported for (1) royalties and rent of mine and mining plant, and (2) amount paid for rent of office, taxes, insurance, interest, advertising, office supplies, law expenses, injuries and damages, telegraph and telephone service, gas, and all other sundries not reported elsewhere. In the special schedule for gold, silver, lead, and copper mines, these amounts were further itemized as follows: (1) Amount expended in development work; (2) rent and royalties of mine and mineral land; (3) rent of mining plant and improvements; (4) rent or royalty for tunnel privileges; (5) water rent; (6) other rent or royalties; (7) amount paid for taxes, insurance, interest, advertising, office supplies, law expenses, injuries and damages, telegraph and telephone service, gas, and all other sundries not reported elsewhere.

Of the total amount paid as miscellaneous expenses, $47,805,681, or 66.6 per cent, was reported by mine operators engaged in the production of fuels, and $17,168,321, or 23.9 per cent, for the metallic group, leaving only $6,797,711, or 9.5 per cent, for all other minerals.

The amounts reported in answer to the several inquiries are shown in detail in the reports for the different minerals. The miscellaneous expenses reported for all minerals amounted to $71,771,713, of which sum $34,530,713, or 48.1 per cent, was paid as royalties and rent of mines and mining plants. Royalties and rent form the most important single item included in the group of miscellaneous expenses, and, with the exception of salaries, wages, and supplies and materials, is the most important item of expenditure reported for mining operations. Of the total ($625,245,130) reported as expenses—salaries and wages amounted to $408,980,512, or 65.4 per cent; supplies and materials to $123,814,967, or 19.8 per cent; miscellaneous expenses to $71,771,713, or 11.5 per cent; and contract work to $20,677,938, or 3.3 per cent. Table 51 shows the amount of miscellaneous expenses reported for the different groups of minerals and the percentage that the totals for each group are of the total for all minerals.

TABLE 51.—*Miscellaneous expenses, by groups of minerals and percentage each group is of total: 1902.*

GROUP.	TOTAL.		ROYALTIES AND RENT OF MINE AND MINING PLANT.		RENT OF OFFICES, TAXES, INSURANCE, ETC.	
	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.
All minerals	$71,771,713	100.0	$34,530,713	100.0	$37,241,000	100.0
Metallic	17,168,321	23.9	9,591,964	27.8	7,576,357	20.3
Fuels	47,805,681	66.6	23,264,926	67.4	24,540,755	65.9
Structural materials	5,750,482	8.0	1,260,673	3.6	4,489,809	12.1
Abrasive materials	42,410	0.1	8,421	(1)	33,989	0.1
Chemical materials	741,570	1.0	296,410	0.9	445,160	1.2
Pigments	60,448	0.1	40,626	0.1	19,822	(1)
Miscellaneous	202,801	0.3	67,693	0.2	135,108	0.4

[1] Less than one-tenth of 1 per cent.

No analysis is possible of the amounts paid for rent of offices, taxes, insurance, etc., although these expenditures form the larger proportion of the miscellaneous expenses reported for a number of the minerals.

Royalties and rent.—Payments for the use of mineral lands are either in the form of a rental of a fixed amount or are made as percentages of the quantity of mineral extracted or of the value of the metal recovered. The importance of royalties and rent is indicated by the fact that in the total for all minerals it forms 4.3 per cent of the value of the products; in the metallic group, 4.5 per cent; in the fuels, 5 per cent; and in the other groups of minerals from seven-tenths of 1 per cent to 7.2 per cent of the value of the products. The largest amounts are paid as royalties and rent in the production of fuels, the expenditure forming an important item of the total cost. In the production of coal the royalty is usually specified in the contracts with the landowners and is generally a certain rate per ton of coal raised. The variation in the amount of royalty paid per ton in the production of anthracite coal is shown in the following table, which gives the number of operators paying each rate:

TABLE 52.—*Coal, anthracite—number of operators at various rates of royalty: 1902.*

RATE PER TON (CENTS).	Number of operators paying each rate.	RATE PER TON (CENTS).	Number of operators paying each rate.	RATE PER TON (CENTS).	Number of operators paying each rate.
0.3	1	15.0	9	30.6	1
0.6	1	15.9	1	31.0	1
0.7	1	16.0	2	32.0	4
1.0	1	16.7	1	32.1	1
1.1	1	16.8	1	32.3	1
2.0	2	17.7	1	32.8	1
2.7	1	17.8	1	33.0	3
3.0	1	18.0	4	33.1	1
3.1	1	18.7	1	33.2	1
4.0	2	20.0	12	33.3	1
4.5	1	20.3	1	35.0	18
5.0	14	21.0	1	36.0	4
5.5	1	22.0	2	37.0	2
6.0	3	22.4	1	37.5	1
6.2	2	22.5	1	38.0	2
6.3	2	23.0	3	39.7	1
7.0	2	23.5	1	40.0	10
7.1	1	24.0	2	41.0	1
7.3	1	25.0	20	44.0	1
8.0	3	26.0	4	45.0	1
8.8	1	26.5	1	46.0	2
9.0	2	26.8	1	46.6	1
10.0	16	27.0	2	47.0	1
10.3	1	27.2	1	47.5	1
11.0	1	27.3	1	49.0	2
12.0	1	28.0	3	50.0	5
12.2	1	28.3	1	53.0	1
12.5	3	28.4	1	60.0	1
13.0	1	29.0	2		
14.9	1	30.0	13		

Of the 119 operators reporting for the production of anthracite coal, 84 reported the payment of royalties varying from three-tenths of 1 cent to 60 cents per ton. The most common rates of royalty were 5 cents per ton and multiples of that amount; 14 operators reported royalty payments of 5 cents per ton; 16, of 10 cents; 9, of 15 cents; 12, of 20 cents; 20, of 25 cents; 13, of 30 cents; 18, of 35 cents; and 10, of 40 cents.

A number of mine operators reported different rates of royalty, each depending upon the terms of the contract with the individual owning the land. As large quantities of coal are mined from land owned by the operators, the amount of royalty paid has no relation to the value of the product reported for all mines.

The following table shows the number of bituminous coal operators reporting royalties at the rates specified:

TABLE 53.—COAL, BITUMINOUS—NUMBER OF OPERATORS IN EACH STATE AT VARIOUS RATES OF ROYALTY: 1902.

RATE PER TON (CENTS).	United States.	Colorado.	Illinois.	Indiana.	Iowa.	Kansas.	Kentucky.	Missouri.	Ohio.	Pennsylvania.	West Virginia.	All other states.[1]
0.8	2							1		1		
1.0	3									1	1	1
1.3	3		2							1		
1.5	7		6				1					
1.6	1			1								
1.8	1		1									
2.0	16		5	8					2	1		
2.3	3		2	1								
2.4	1										1	
2.5	25		9	8			1	2		4		1
2.6	1			1								
2.7	1		1									
3.0	79		26	21	1		4	3	5	16	1	2
3.1	19		10	3	1		4	1				
3.3	1		1									
3.5	22		8	7	1				4	2		
3.6	1			1								
3.7	2			1				1				
3.8	4		1	2						1		
4.0	69		15	7	4		3	13	16	6	3	2
4.1	1										1	
4.2	4		3		1							
4.3	2						2					
4.4	1						1					
4.5	9		1	1			2		3		1	1
4.7	5		3	1	1							
4.8	2			1					1			
4.9	2		2									
5.0	244		25	21	24	3	4	11	33	69	28	26
5.3	4				1		1		1		1	
5.4	1										1	
5.5	12		2	3			1	1	2	2	1	
5.8	3						2		1			
6.0	143	3	9	6	4	8	5	6	36	32	24	10
6.2	1					1						
6.3	144		37	4	42	11	8	25	8	4	1	4
6.5	24		4	2	2	1	1	2	4	5	3	
6.7	1									1		
6.8	3			1	1				1			
7.0	122	3	8	5	7	4	2		14	32	15	32
7.3	2									2		
7.5	39	2	6		2		2	5	12	5	1	4
7.6	1											1
8.0	208	4		5	4	16	1	8	37	68	23	42
8.1	1										1	
8.3	20	2	11	1	3		1	1			1	
8.4	1									1		
8.5	7				1		1			2	2	1
8.6	1			1								
8.7	1									1		
8.8	2				1					1		
9.0	33		5	2	1	2			1	3	13	3
9.4	1							1				
9.5	2		1								1	
10.0	403	9	26	18	22	18	12	6	49	87	98	58
10.1	1										1	
10.5	1				1							
10.6	1			1								
11.0	8		1		1					4	1	1
11.1	1		1									
11.3	4		1	1						2		
11.5	1		1									
11.8	1											1
12.0	46		12	3	1	6			13	7	1	3
12.3	1							1				
12.5	254	8	73	15	47	9	3	32	26	4	13	24
12.6	1								1			
13.0	12	1			3	2			2	3	1	
13.5	5		1							4		
14.0	4		1		1					2		
14.2	2		1		1							
15.0	83	4	17		10	1		2	20	11	6	12
15.3	1				1							
15.6	1										1	
16.0	8			1		1		2	1	1		2
16.5	1		1									
17.0	4				1	1				1	1	
17.5	2									1		1
18.0	9		4						1			4
18.5	1		1									
18.8	10		3	3	2	1			1			
19.0	2		1							1		
20.0	28	2	4	1	1	2	1		8	3	2	4
23.0	1								1			
25.0	77	8	15	5	16	4	2	7	4	3	1	12
26.3	1									1		
27.0	1								1			
30.0	7	1			1	1			1			3
31.3	1				1							
33.5	1									1		
35.0	1	1										
37.5	1				1							
38.0	1									1		
40.0	1								1			
50.0	4	1			1							2
57.0	1											1
150.0	1											1

[1] Includes operators distributed as follows: Alabama, 49; Arkansas, 25; California, 1; Indian Territory, 31; Maryland, 17; Michigan, 28; Montana, 4; New Mexico, 7; North Dakota, 6; Oregon, 4; Tennessee, 38; Texas, 9; Utah, 3; Virginia, 17; Washington, 10; Wyoming, 9.

Of the 4,409 operators engaged in the production of bituminous coal, 2,130, or 48.3 per cent, reported the payment of royalties varying from eight-tenths of 1 cent to $1.50 per ton. The rates most commonly reported were from 5 to 15 cents per ton, there being 1,850 operators paying royalties coming within these amounts.

The amount paid as royalties and rent in the production of petroleum was reported as $8,929,891, being one-eighth of the value of the product. In the majority of instances the royalty was a percentage of the oil produced. This percentage ranged from a fraction of 1 per cent to 50 per cent, but the usual amount of petroleum paid to the landowners was one-eighth of the amount marketed or sold to the pipe line companies. In a few cases a fixed amount was paid for each barrel. In northern Pennsylvania and southeastern Ohio a comparatively small amount of superior petroleum was produced, for which the operators paid one-sixth. Part of the petroleum produced in Kansas and Texas, and practically all of that produced in California, paid one-tenth.

The manner in which the amount of royalty to be paid is determined and the method of payment is

described by Mr. F. H. Oliphant, in the United States Geological Survey monograph, "The Production of Petroleum," 1902, pages 41 and 42.[1]

In the production of natural gas $2,533,895 was reported as rent and royalties. The usual rent paid for a gas well was from $100 to $300 per year.[2]

[1] The pipe line company, upon application from the producer, sends an agent, generally known as a "gauger," to measure and inspect the petroleum in his tank and run it into its lines, the tanks throughout the field having been carefully measured and a card issued showing the number of barrels from top to bottom to each inch of liquid. From his blank book the gauger gives the operator a "run ticket," sending a duplicate to the nearest general office as well as reporting the amount by telegraph, keeping a third one himself. The pipe line company deducts the amount due the owner of the property according to the terms of an agreement on file at the office, known as the royalty, and the next day the producer can secure the cash for his petroleum at the market quotation for the day or hour of his sale, at the nearest home office of the company, from a purchaser for the refining companies; or, if the producer wishes, he can obtain a certificate when his production in the tanks of the pipe line company amounts to 1,000 barrels.

These certificates are made payable to bearer, and are therefore transferable. They are subject to a transportation charge in the district of 20 cents per barrel and a charge for storage at the rate of 25 cents per day per 1,000 barrels when the price is less than $1, 30 cents when over $1 and under $1.50, and 40 cents for all over $1.50 per barrel. They are to be returned for exchange to the pipe line company within six months after issue, or be subject to a charge of one-twentieth of 1 per cent daily thereafter until exchanged. To cover losses by fire or lightning certificates are subject to an assessment pro rata on all oil in the custody of the pipe line. None of these charges are included in the prices of petroleum as quoted, and therefore the prices given are the prices at or near the wells. This system, by which the operator can always find a market for his production at a common price known to all, has done much to develop the oil resources of the United States. Other countries have suffered where there were no organized lines of transportation and storage to enable the producer to dispose of his products regularly.

[2] The form of lease for petroleum and gas wells is generally as follows:

Agreement made and entered into the —— day of ——, A. D. 190—, by and between ——, of ——, county of —— and state of ——, part—— of the first part, and —— part—— of the second part.

Witnesseth, That the said part—— of the first part, for and in consideration of the sum of one dollar to —— in hand well and truly paid by the said part—— of the second part, the receipt of which is hereby acknowledged, and of the covenants and agreements hereinafter contained on the part of the said party of the second part, to be paid, kept, and performed, ha—— granted, demised, leased, and let and by these presents do —— grant, demise, lease, and let unto the said part—— of the second part, —— heirs, executors, administrators, or assigns, for the sole and only purposes of mining and operating for oil and gas, and of laying pipe lines, and of building tanks, stations, and structures thereon to take care of the said products, all that certain tract of land, situate in —— township, —— county, and state of ——, on waters of ——, bounded substantially as follows: On the north by lands of ——; on the east by lands of ——; on the south by lands of ——; on the west by lands of ——; containing —— acres, more or less, and being same land conveyed to the first part—— by —— by deed, bearing date ——, 18—, reserving, however, therefrom —— feet around the buildings on which no well shall be drilled by either party except by mutual consent.

It is agreed that this lease shall remain in force for the term of ten years from this date, and as long thereafter as oil or gas or either of them is produced therefrom by the party of the second part, —— heirs, executors, administrators, or assigns.

In consideration of the premises the said part—— of the second part covenants and agrees: First. To deliver to the credit of the first part——, —— heirs or assigns, free of cost, in the pipe line to which it may connect its wells, the equal one-eighth part of all oil produced and saved from the leased premises; and, second, to pay 100 to 300 dollars per year for the gas from each and every gas well drilled on said premises, the product from which is marketed and used off the premises, said payment to be made on each well within sixty days after commencing to use the gas therefrom, as aforesaid, and to be paid yearly thereafter while the gas from said well is so used.

Second part—— covenant—and agree—to locate all wells so as to interfere as little as possible with the cultivated portions of the farm. And further, to commence a well on said premises within —— from the date hereof, or pay at the rate of —— dollars quarterly, in advance, for each additional three months such commencement is delayed from the time above mentioned for the commencement of such well until a well is commenced; and it is agreed that the commencement of such well shall be and operate as a full liquidation of all rental under this provision during the remainder of the term of this lease. Such payments may be made direct to the lessor—or deposited to —— credit in ——.

It is agreed that the second party is to have the privilege of using sufficient water from the premises to run all necessary machinery, and at any time to remove all machinery and fixtures placed on said premises; and, further, upon the payment of —— dollars at any time by the party of the second part, —— heirs, executors, administrators, or assigns to the part—— of the first part, —— heirs, executors, administrators, or assigns, said party of the second part, —— heirs, executors, administrators, or assigns shall have the right to surrender this lease for cancellation, after which all payments and liabilities thereafter to accrue under and by virtue of its terms shall cease and determine, and this lease become absolutely null and void.

In witness whereof the parties to this agreement have hereunto set their hands and seals the day and year first above written.

The following statement shows the amount of royalties and rent paid in the production of natural gas and petroleum in each state and the percentages the amounts so paid bear to the value of the product for the states and for the United States:

STATE.	NATURAL GAS.		PETROLEUM.	
	Amount paid for royalties and rent of mine and mining plant.	Per cent of value of product.	Amount paid for royalties and rent of mine and mining plant.	Per cent of value of product.
United States	$2,533,895	8.2	$8,929,891	12.5
California			214,261	4.4
Colorado			18,597	3.8
Indiana	539,844	7.6	1,034,070	15.8
Kansas	21,038	2.6	28,255	9.7
Kentucky	8,725	2.4	53,613	31.0
New York	32,439	9.4	194,717	12.7
Ohio	198,671	8.4	3,046,994	14.7
Pennsylvania	1,223,278	8.5	1,016,987	12.6
Texas	2,032	13.6	264,150	6.3
West Virginia	507,868	9.4	2,132,243	12.5
All other states and territories[1]			29,004	10.4

[1] Includes Illinois (no royalties paid), Indian Territory, Louisiana, Michigan, Missouri, Oklahoma, Tennessee, and Wyoming.

In the group of metallic ores the largest amount was paid in royalties in the production of iron ore, the total, $6,503,908, paid in this branch of mining forming 67.8 per cent of the $9,591,964 reported for the entire metallic group.

The following statement shows the amounts paid as royalties and rent in the iron mines in the different states and the percentage that total is of the total for the United States:

STATE.	Amount paid for royalties and rent of mine and mining plant.	Per cent of total.
United States	$6,503,908	100.0
Alabama	37,938	0.6
Colorado	87,094	1.3
Georgia	8,951	0.1
Maryland	2,271	(1)
Michigan	2,254,864	34.7
Minnesota	3,648,750	56.1
Missouri	2,538	(1)
New Jersey	7,915	0.1
New York	12,385	0.2
Ohio	1,503	(1)
Pennsylvania	26,343	0.4
Tennessee	93,672	1.5
Virginia	93,429	1.5
Wisconsin	181,243	2.8
All other states and territories	45,612	0.7

[1] Less than one-tenth of 1 per cent.

The operators in the states of Michigan and Minnesota paid $5,903,614 in royalties and rent, or 90.8 per cent of the total amount paid in the United States. Of the 72 operators reported for these states, 61 paid either rent or royalty. The state of Minnesota has adopted a system of leasing its iron lands for a term of years to prospectors and miners, and a royalty of 25 cents per ton is imposed on all iron ore mined and shipped from state lands. The state has received $332,119.02 in royalties on iron ore actually shipped up to the end of the fiscal year, July 31, 1902, and by annual payments on mining contracts, payment for prospecting leases, and

as royalty on a minimum output of 5,000 tons per year, the further sum of $212,515.75 has been turned into the state treasury, making a total of $544,634.77.[1]

Zinc mining lands are seldom sold, but are usually worked on royalties. Lands which have never been prospected are leased on a percentage royalty. The lessee prospects the land and lots are then subleased to mine operators at a larger percentage royalty than is paid by the first lessee. The first lessee usually contracts to put in pumping plants and keep the tract drained. The ore is sold in the bins and payment is made to the landowner or first lessee, who deducts his royalty and pays over the balance to the operator. Very frequently the sublessee further leases small plots to miners, usually neighboring farmers, who undertake to work the land on a royalty. The larger land companies buy all ore produced by these miners at a stipulated price, deducting from it the royalty. In such cases the terms resemble contract mining as practiced in other branches of the mining industry. The total amount of royalties reported for zinc mines at the Twelfth Census was $1,525,368. The royalty is computed on the price paid by the purchaser for ore in the bins; if the ore sells at $30 per ton and the royalty is 20 per cent, the landowner deducts $6 per ton for his royalty and draws his check for $24 to the operator.

Mining on royalties is of little importance in the copper mining industry. The total amount of royalties and rents paid in 1902 was $130,215, of which only $33,184 represented royalties. This was about 25 per cent of the gross value of the ore upon which the royalties were paid. Considering that the total production of copper ore was valued at $51,178,036 at the mine, it is apparent that royalties can not be considered a factor in copper mining.

In gold and silver mines the royalty is usually stipulated at a certain percentage of the net value realized for the ore, after deducting treatment charges and freight; the rate increases with the grade of the ore. Thus if the ore is worth $20 per ton, the cost of treatment and freight is $10, and the rate of royalty is 25 per cent; then the landowner is paid $2.50 per ton, which leaves $7.50 for the operator. Sometimes, though seldom, the rate is stipulated upon the gross value—say 10 per cent of the assay value of the ore; taking the same figures as in the preceding example, the royalty would amount to $2, which would leave for the operator $18, from which $10 would be deducted for treatment and freight, leaving a net balance of $8 for the operator.

In Colorado, where the mines are often leased in "blocks" to miners who perform the labor personally, the ore is marketed by the owner or shipped in his name, and he deducts his royalty and pays the balance to the lessee. When the ore is sold to a "sampler" (ore buyer), he frequently withholds the royalty for the owner and pays the balance to the lessee.

XV.

COST OF SUPPLIES AND MATERIALS.

The cost of supplies and materials of all kinds used in the mining industries during the year, including freight on the same when paid by the mine operator, amounted to $123,814,967. This includes lumber and timber used for repairs, mine supports, track ties, cars, and other purposes; iron and steel for blacksmithing, rails, frogs, sleepers, etc., for tracks; miscellaneous materials, parts of machinery, and tools used for renewals and repairs; and also explosives, water for boilers and other purposes, fuel, illuminating and lubricating oils, machinery, supplies, etc. Supplies may have been purchased with the intention of taking advantage of low prices, but only the cost of those used during the year was reported. The "material" operated upon in a mine is the mineral in place, and its cost is included in the cost of the land or in the amounts paid for royalty and rent. All the items here enumerated come under the definition of "supplies," and the total cost may be accepted as representing the purchase of supplies, with the exception of the purchase of lime rock by quarry companies engaged in the manufacture of cement. The totals are summarized in Table 54 and placed in comparison with the value of product for each mineral and group of minerals.

[1] Report of the auditor of the state of Minnesota for the fiscal year ending July 31, 1902.

TABLE 54.—COST OF SUPPLIES AND MATERIALS, AND PERCENTAGE THIS IS OF VALUE OF PRODUCT, BY MINERALS AND GROUPS OF MINERALS: 1902.

MINERALS, BY GROUPS.	Cost of supplies and materials.	Value of product.	Percentage that cost of supplies and materials is of value of product.
Total	$123,814,967	$796,826,417	15.5
Metallic	39,639,703	215,453,587	18.4
Copper ore	11,083,175	51,178,036	21.7
Gold and silver	16,699,768	82,482,052	20.2
Iron ore	9,005,608	65,465,321	13.8
Lead and zinc ore	2,511,657	14,600,177	17.2
Manganese ore	17,228	177,911	9.7
Quicksilver	322,267	1,550,090	20.8
Fuels	61,928,469	469,297,671	13.2
Coal, anthracite	12,740,780	76,173,586	16.7
Coal, bituminous	24,708,922	290,858,483	8.5
Natural gas	6,607,255	30,867,863	21.4
Petroleum	17,781,512	71,397,739	24.9
Structural materials	20,072,399	96,370,559	20.8
Cement	9,098,226	24,268,338	37.5
Clay	272,823	2,064,072	13.2
Limestones and dolomites	5,403,912	30,441,801	17.8
Marble	825,822	5,044,182	16.4
Sandstones and quartzites	1,298,190	10,691,171	12.2
Siliceous crystalline rocks	2,493,065	18,257,944	13.7
Slate	680,361	5,696,054	11.9
Abrasive materials	80,309	1,177,714	6.8
Buhrstones and millstones	1,809	59,808	3.0
Corundum and emery	26,114	104,605	25.0
Crystalline quartz	950	43,085	2.2
Garnet	10,128	132,820	7.6
Grindstones and pulpstones	31,349	667,431	4.7
Infusorial earth, tripoli, and pumice	2,297	55,904	4.1
Oilstones, whetstones, and scythestones	7,662	113,968	6.7
Chemical materials	$1,603,348	$10,618,669	15.1
Borax	213,538	2,383,614	9.0
Fluorspar	31,374	275,682	11.4
Gypsum	311,760	2,089,311	16.4
Phosphate rock	799,414	4,922,943	16.2
Sulphur and pyrite	217,262	947,089	22.9
Pigments	65,845	561,039	11.7
Barytes	7,772	203,154	3.8
Mineral pigments, crude	58,073	360,885	16.1
Miscellaneous	424,894	3,344,181	12.7
Asbestos	8,233	46,200	17.8
Asphaltum and bituminous rock	21,928	236,728	9.3
Bauxite	40,019	128,206	31.2
Feldspar	50,278	250,421	20.1
Flint	18,612	144,209	12.9
Fuller's earth	28,966	98,144	29.5
Graphite	51,840	227,508	22.8
Lithium ore	1,265	25,750	4.9
Marl	2,755	12,741	21.6
Mica	11,961	118,849	10.1
Monazite	253	61,160	0.4
Precious stones	17,781	328,450	5.4
Silica sand	38,386	421,289	9.1
Talc and soapstone	125,932	1,138,167	11.1
Tungsten	210	5,975	3.5
Uranium and vanadium	3,010	48,125	6.3
All other minerals	3,432	49,256	7.0

The various conditions under which mining operations are carried on destroy the possibility of a fixed ratio between the cost of supplies and the value of product for any mineral or group of minerals; therefore the percentages given in the above table should not be accepted as indicating such a ratio. They show only the relative importance of this item of expense for all mines, irrespective of the conditions under which they were operated. The total amount paid for supplies and materials for the entire mining industry was 15.5 per cent of the total value of product. The percentages that cost of supplies and materials formed of the value of the product ranged from 0.4 per cent for monazite to 37.5 per cent for cement. The high proportional cost in the latter was due in part to the fact that some crude cement rock was purchased from quarries that were not equipped for manufacturing cement, and large amounts were paid for cooperage stock, barrels, and other packages in which the product was packed for shipment.

XVI.

POWER AND MACHINERY.

The use of power is becoming more general in all branches of productive industry. In the mining industries power is employed for a variety of purposes, the chief of which are the operation of hoisting, draining, ventilating, conveying, drilling, and cutting machinery, derricks, steam shovels, and locomotives and hauling engines. It is also employed extensively in the operation of machinery used in crushing, screening, cleaning, or otherwise treating the crude material. Motive power is now generally used in all mining operations of any magnitude.

Table 55 shows the number of operators reporting the use of power and the value of their products in comparison with the total number and value of products for all operators for each classification and group of minerals.

TABLE 55.—NUMBER OF OPERATORS REPORTING USE OF POWER AND THE VALUE OF THEIR PRODUCTS COMPARED WITH TOTALS FOR ALL OPERATORS, BY MINERALS AND GROUPS OF MINERALS: 1902.

MINERALS, BY GROUPS.	NUMBER OF OPERATORS.			VALUE OF PRODUCT.		
	Total.	Reporting use of power.	Per cent which number reporting use of power forms of total number.	Total.	For operators reporting use of power.	Per cent which value of product for operators reporting use of power forms of total value.
All minerals	46,858	35,943	76.7	$796,826,417	$732,324,376	91.9
Metallic	4,081	2,058	50.4	215,453,587	204,828,082	95.1
Copper ore	144	102	70.8	51,178,036	50,837,067	99.3
Gold and silver	2,992	1,297	43.3	82,482,052	77,331,374	93.8
Iron ore	332	237	71.4	65,465,321	63,378,314	96.8
Lead and zinc ore	557	389	69.8	14,600,177	11,735,157	80.4
Manganese ore	19	5	26.3	177,911	37,806	21.2
Quicksilver	37	28	75.7	1,550,090	1,508,364	97.3
Fuels	36,017	[1]31,562	87.6	469,297,671	431,437,498	91.9
Coal, anthracite	119	119	100.0	76,173,586	76,173,586	100.0
Coal, bituminous	4,409	1,819	41.3	290,858,483	263,062,394	90.4
Natural gas	1,967	175	8.9	30,867,863	21,076,371	68.3
Petroleum	29,522	[1]29,449	99.8	71,397,739	71,125,147	99.6
Structural materials	5,746	2,041	35.5	96,370,559	83,103,040	86.2
Cement	93	89	95.7	24,268,338	24,137,396	99.5
Clay	203	68	33.5	2,061,072	1,337,230	64.9
Limestones and dolomites	3,137	862	27.5	30,441,801	23,662,513	77.7
Marble	75	55	73.3	5,044,182	4,906,303	97.3
Sandstones and quartzites	1,211	294	24.3	10,601,171	8,077,970	76.2
Siliceous crystalline rocks	853	519	60.8	18,257,944	15,416,935	84.4
Slate	174	154	88.5	5,696,051	5,564,693	97.7
Abrasive materials	75	29	38.7	1,177,711	565,697	48.0
Buhrstones and millstones	29	1	3.4	59,808	5,400	9.0
Corundum and emery	5	3	60.0	104,605	94,785	90.6
Crystalline quartz	5	1	20.0	43,085	12,000	27.9
Garnet	7	5	71.4	132,820	91,760	69.1
Grindstones and pulpstones	9	5	55.6	667,431	252,069	37.8
Infusorial earth, tripoli, and pumice	10	6	60.0	55,994	49,783	88.9
Oilstones, whetstones, and scythestones	10	8	80.0	113,968	59,900	52.6
Chemical materials	174	128	73.6	10,618,669	9,685,554	91.2
Borax	6	6	100.0	2,383,614	2,383,614	100.0
Fluorspar	18	12	66.7	275,682	261,210	94.8
Gypsum	45	41	91.1	2,089,341	2,044,188	97.8
Phosphate rock	87	56	64.4	4,922,943	4,293,434	87.2
Sulphur and pyrite	18	13	72.2	947,089	703,108	74.2
Pigments	77	23	29.9	564,039	281,120	49.8
Barytes	42	2	4.8	203,154	23,500	11.6
Mineral pigments, crude	35	21	60.0	360,885	257,620	71.4
Miscellaneous	688	102	14.8	3,344,181	2,423,385	72.5
Asbestos	4	2	50.0	46,200	36,000	77.9
Asphaltum and bituminous rock	24	8	33.3	236,728	51,869	21.9
Bauxite	7	6	85.7	128,206	128,131	99.9
Feldspar	26	12	46.2	250,424	138,645	55.4
Flint	17	8	47.1	144,209	112,251	77.8
Fuller's earth	4	4	100.0	98,144	98,144	100.0
Graphite	19	11	57.9	227,508	204,218	89.8
Lithium ore	3	.....	.....	25,750	.....	.....
Marl	11	1	9.1	12,741	4,267	33.5
Mica	38	7	18.4	118,849	31,865	26.8
Monazite	22	1	4.5	64,160	5	(2)
Precious stones	460	3	0.7	328,460	110,500	33.6
Silica sand	20	19	95.0	421,289	354,242	84.1
Talc and soapstone	20	16	80.0	1,138,197	1,127,625	99.1
Tungsten	4	2	50.0	5,975	4,734	79.2
Uranium and vanadium	3	.....	.....	48,125	.....	.....
All other minerals[3]	6	2	33.3	49,256	20,889	42.4

[1] Includes 28,925 operators reported by the Standard Oil Company, for which statistics of power were reported collectively.
[2] Less than one-tenth of 1 per cent.
[3] Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.

Of the 46,858 operators reported for all classes of minerals, 35,943, or 76.7 per cent, reported the use of power. The value of the products reported by operators using power amounted to $732,324,376, or 91.9 per cent, of the total value of products for all operators. In other words, all but 8.1 per cent of the mineral products of the country were obtained by operators who reported the use of power to some extent.

The entire production of anthracite coal, borax, fuller's earth, magnesite, and rutile was obtained by operators using power. For ten of the different classifications of minerals enumerated in the above table the use of power was reported by operators producing more than 95, but less than 100 per cent of the value of product. Of the seven groups of minerals the metallic group shows the largest proportion, 95.1 per cent, for the products obtained by operators using power. The next largest proportion, 91.9 per cent, is shown for the group of fuels, while for the remaining groups the percentages of the products obtained by the use of power are as follows: 91.2 per cent for chemical materials, 86.2 per cent for structural materials, 72.5 per cent for miscellaneous materials, 49.8 per cent for pigments, and 48 per cent for abrasive materials. The table shows very conclusively that practically all of the large producers employed mechanical power in some form.

In compiling these statistics, steam, gas or gasoline, and water were considered as primary power, and rented power of all classes was included under the same head. Gas engines embrace all forms of internal combustion engines in which the propelling force is the explosion of gaseous or vaporous fluid in direct contact with a piston within a closed cylinder. The inquiry concerning mechanical power called for a full report of all power employed, either owned or rented, including the number and horsepower of all engines, motors, water wheels, etc., used for ventilating, pumping, hoisting, derricks, surface machinery, and all other purposes. The power reported in answer to this inquiry amounted to 2,867,562 horsepower for all branches of mining. Of this total, 2,432,963 horsepower, or 84.9 per cent, was steampower; 60,897 horsepower, or 2.1 per cent, was waterpower; and 373,702 horsepower, or 13 per cent, was obtained from other forms of mechanical power, including electricity, gas engines, air compressors, etc. The use of steampower largely predominated in mining operations, other forms of primary power in comparison having only a limited application. While inquiries concerning power were included in the schedules used at previous censuses, they do not appear to have been answered uniformly, and the comparisons can not be accepted as an accurate indication of the increase in the quantity of power employed. The following table, however, presents the total horsepower reported at the censuses from 1870 to 1902:

TABLE 56.—*Horsepower: 1870 to 1902.*

MINERAL.	TOTAL HORSEPOWER.			
	1902	1889 [1]	1880	1870
Asbestos	105	(2)	(2)	(2)
Asphaltum and bituminous rock	720	(2)	(2)	50
Barytes	110	(2)	(2)	(2)
Bauxite	624	(2)	(2)	(2)
Borax	338	(2)	(2)	(2)
Buhrstones and millstones	85	(2)	(2)	(2)
Cement	114,092	(2)	3,445	2,090
Clay	4,478	(2)	351	1,201
Coal, anthracite	434,220	160,983	105,807	49,280
Coal, bituminous	521,165	54,795	26,191	13,361
Copper ore	198,507	34,390	13,541	6,388
Corundum and emery	110	(2)	16	(2)
Crystalline quartz	20	(2)	(2)	(2)
Feldspar	1,204	(2)	28	(2)
Flint	740	(2)	(2)	(2)
Fluorspar	669	(2)	(2)	(2)
Fuller's earth	460	(2)	(2)	(2)
Garnet	430	(2)	(2)	(2)
Gold and silver	195,805	78,343	[3] 24,369	5,606
Graphite	769	505	320	(2)
Grindstones and pulpstones	1,247	(2)	(2)	(2)
Gypsum	7,319	2,045	(2)	(2)
Infusorial earth, tripoli, and pumice	410	(2)	(2)	(2)
Iron ore	119,558	57,976	24,838	8,927
Lead and zinc ore	41,901	[4] 1,133	[5] 6,739	984
Limestones and dolomites	64,500	22,362	195	[6] 1,737
Magnesite	15	(2)	(2)	(2)
Manganese ore	354	(2)	87	(2)
Marble	14,286	11,392	(7)	636
Marl	50	(2)	(2)	(2)
Mica	185	(2)	(2)	(2)
Mineral pigments, crude	1,840	(2)	158	(2)
Monazite	30	(2)	(2)	(2)
Natural gas	104,107	(2)	(2)	(2)
Nickel and cobalt	(3)	140	155	130
Oilstones, whetstones, and scythestones	193	(2)	10	(2)
Petroleum	910,077	(2)	(2)	23,482
Phosphate rock	14,229	50	(2)	(2)
Precious stones	150	(2)	(2)	(2)
Quicksilver	1,808	2,441	(2)	147
Rutile	30	(2)	(2)	(2)
Sandstones and quartzites	25,652	15,516	(2)	(7)
Silica sand	2,000	(2)	286	(2)
Siliceous crystalline rocks	46,986	15,199	(2)	(7)
Slate	25,454	12,037	(2)	671
Sulphur and pyrite	6,305	(2)	(2)	(2)
Talc and soapstone	3,945	(2)	(2)	(2)
Tungsten	280	(2)	(2)	(2)

[1] Horsepower of boilers reported.
[2] Not reported.
[3] Exclusive of waterpower used at arrastra mills, and all power at stamp and amalgamating mills.
[4] Reported for eastern and southern zinc mines only.
[5] Reported for mines east of the one-hundredth meridian.
[6] Includes all stone except marble and slate.
[7] Included with limestones and dolomites.

Since statistics for power were not reported in a uniform manner at these censuses, the totals for the United States are not shown in Table 56. The figures can be accepted only as an indication of the more general use of power in mining operations and not as a basis for computing the actual increase in the horsepower employed in the industry. The inquiry for 1902 was confined to the operation of mines, quarries, or wells and such manufacturing processes as were carried on in immediate connection therewith. A number of minerals for which power was reported at the census of 1902 were not produced in commercial quantities at one or more of the three preceding censuses, or if they were so produced, power was not reported as employed in the mining operations.

The detailed statistics for the different varieties of

power reported for each mineral, each group of minerals, and for all minerals in each state are shown in Tables 1 and 2, pages 347 to 377. The following table shows the number of operators in each class of minerals and group of minerals reporting the use of the different varieties of power, and the total amount of horsepower employed:

TABLE 57.—NUMBER OF OPERATORS REPORTING THE USE OF THE DIFFERENT KINDS OF POWER, AND TOTAL HORSEPOWER: 1902.

MINERALS, BY GROUPS.	OPERATORS.		Total horsepower.	STEAM ENGINES.		GAS OR GASOLINE ENGINES.		WATER WHEELS.		ALL OTHER POWER.	
	Total number.	Number reporting power.		Number of operators reporting.	Horsepower.	Number of operators reporting.	Horsepower.	Number of operators reporting.	Horsepower.	Number of operators reporting.	Horsepower.
All minerals	46,858	[1] 35,943	2,867,562	35,060	2,432,963	29,530	259,695	471	60,897	753	114,007
Metallic	4,081	2,058	557,933	1,640	455,202	203	5,913	397	45,614	331	51,204
Copper ore	144	102	198,507	92	189,426	19	1,184	6	326	29	7,571
Gold and silver	2,992	1,297	195,805	922	122,354	142	4,060	381	43,936	207	25,455
Iron ore	332	237	119,558	233	102,878	9	86	5	1,010	64	15,584
Lead and zinc ore	557	389	41,901	365	38,616	24	431	2	320	30	2,534
Manganese ore	19	5	354	5	354	.....	.....	.....	.....	.....	.....
Quicksilver	37	28	1,808	23	1,574	9	152	3	22	1	60
Fuels	36,017	[1] 31,562	1,969,569	31,237	1,666,227	29,223	248,892	6	1,384	329	53,066
Coal, anthracite	119	119	434,220	119	415,827	3	185	.....	.....	20	18,208
Coal, bituminous	4,409	1,819	521,165	1,748	489,628	117	1,119	6	1,384	118	29,034
Natural gas	1,967	175	104,107	122	94,595	79	7,083	.....	.....	9	2,429
Petroleum	29,522	[1] 29,449	910,077	29,248	666,177	29,024	240,505	.....	.....	182	3,395
Structural materials	5,746	2,041	295,448	1,932	273,517	85	4,286	36	8,610	80	9,035
Cement	93	89	114,092	84	103,811	1	2,890	6	1,854	9	5,537
Clay	203	68	4,478	65	3,942	2	18	1	25	8	493
Limestones and dolomites	3,137	862	64,500	823	61,547	55	1,031	10	502	24	1,420
Marble	75	55	14,286	54	10,748	.....	.....	6	3,413	1	125
Sandstones and quartzites	1,211	294	25,652	275	24,631	7	72	3	885	8	64
Siliceous crystalline rocks	853	519	46,986	479	44,189	20	275	7	1,506	21	1,016
Slate	174	154	25,454	152	24,649	.....	.....	3	425	6	380
Abrasive materials	75	29	2,495	26	2,300	2	88	.....	.....	3	107
Buhrstones and millstones	29	1	85	.....	.....	.....	.....	.....	.....	1	85
Corundum and emery	5	3	110	2	30	1	80	.....	.....	.....	.....
Crystalline quartz	5	1	20	1	20	.....	.....	.....	.....	.....	.....
Garnet	7	5	430	5	420	.....	.....	.....	.....	1	10
Grindstones and pulpstones	9	5	1,247	5	1,235	.....	.....	.....	.....	1	12
Infusorial earth, tripoli, and pumice	10	6	410	6	410	.....	.....	.....	.....	.....	.....
Oilstones, whetstones, and scythestones	10	8	193	7	185	1	8	.....	.....	.....	.....
Chemical materials	174	128	28,860	116	27,009	9	302	12	1,094	5	455
Borax	6	6	338	4	205	3	123	1	10	.....	.....
Fluorspar	18	12	669	11	530	4	139	.....	.....	.....	.....
Gypsum	45	41	7,319	34	6,385	1	20	10	914	.....	.....
Phosphate rock	87	56	14,229	56	13,974	.....	.....	1	170	2	85
Sulphur and pyrite	18	13	6,305	11	5,915	1	20	.....	.....	3	370
Pigments	77	23	1,950	21	1,310	1	40	1	550	2	50
Barytes	42	2	110	2	110	.....	.....	.....	.....	.....	.....
Mineral pigments, crude	35	21	1,840	19	1,200	1	40	1	550	2	50
Miscellaneous	688	102	11,307	88	7,398	7	174	19	3,645	3	90
Asbestos	4	2	105	2	105	.....	.....	.....	.....	.....	.....
Asphaltum and bituminous rock	21	8	720	7	660	1	60	.....	.....	.....	.....
Bauxite	7	6	624	6	575	2	49	.....	.....	.....	.....
Feldspar	26	12	1,204	11	854	.....	.....	3	350	.....	.....
Flint	17	8	740	3	155	.....	.....	6	585	.....	.....
Fuller's earth	4	4	460	4	430	2	30	.....	.....	.....	.....
Graphite	19	11	769	11	749	.....	.....	1	10	1	10
Magnesite	1	1	15	1	15	.....	.....	.....	.....	.....	.....
Marl	11	1	50	1	50	.....	.....	.....	.....	.....	.....
Mica	38	7	185	6	160	1	25	.....	.....	.....	.....
Monazite	22	1	30	1	30	.....	.....	.....	.....	.....	.....
Precious stones	460	3	150	3	150	.....	.....	.....	.....	.....	.....
Rutile	1	1	30	1	30	.....	.....	.....	.....	.....	.....
Silica sand	20	19	2,000	21	1,980	.....	.....	.....	.....	1	20
Talc and soapstone	20	16	3,945	9	1,235	1	10	9	2,700	.....	.....
Tungsten	4	2	280	1	220	.....	.....	.....	.....	1	60
Uranium and vanadium	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
All other minerals[2]	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[1] Includes 28,925 operators reported by the Standard Oil Company for which statistics of power were reported collectively. A large number of operators, therefore, are duplicated in steampower and gas or gasoline power.
[2] Includes chrome ore, lithium ore, molybdenum, and nickel and cobalt.

All the operators reported for five of the minerals enumerated in the above table used mechanical power. The number of operators reported for the remaining minerals for which power was used includes all the operators of small mines and quarries, a number of whom work at irregular intervals, and the small lessees; therefore the comparison of the number of operators reporting the use of power, with the total number reported for each mineral, does not convey a correct impression of the importance of motive power in the

mining industries of the country. The following statement shows the proportion of each variety of power employed in the production of the different groups of minerals:

Per cent of each kind of power employed in the different groups of minerals: 1902.

GROUP.	OPERATORS.		Total horsepower.	POWER.							
	Total number.	Number reporting power.		Steam engines.		Gas or gasoline engines.		Water wheels.		All other power.	
				Number of operators.	Horsepower.	Number of operators.	Horsepower.	Number of operators.	Horsepower.	Number of operators.	Horsepower.
All minerals	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Metallic	8.7	5.7	19.4	4.7	18.7	0.7	2.3	84.3	74.9	43.9	44.9
Fuels	76.9	87.8	68.7	89.1	68.5	99.0	95.8	1.3	2.3	43.7	46.6
Structural materials	12.2	5.7	10.3	5.5	11.2	0.3	1.7	7.6	14.1	10.6	7.9
Abrasive materials	0.1	0.1	0.1	0.1	0.1	(1)	(1)	.....	.....	0.4	0.1
Chemical materials	0.4	0.3	1.0	0.3	1.1	(1)	0.1	2.6	1.8	0.7	0.4
Pigments	0.2	0.1	0.1	0.1	0.1	(1)	(1)	0.2	0.9	0.3	(1)
Miscellaneous	1.5	0.3	0.4	0.2	0.3	(1)	0.1	4.0	6.0	0.4	0.1

[1] Less than one-tenth of 1 per cent.

Of the total power for all minerals, including natural gas and petroleum, 1,969,569 horsepower, or 68.7 per cent, was reported by the operators engaged in the production of fuels. The universal use of power in anthracite coal mining, its very general application in the production of bituminous coal, and its use in the necessary pumping machinery at petroleum wells account for the large amount of power reported for the operators included in this group.

The metallic group, with 557,933 horsepower, or 19.4 per cent of the total, is the second in importance in the quantity of power used. While the operators in this group formed a comparatively small proportion, (5.7 per cent) of the total number of operators reporting the use of power, they produced a very large proportion of the total product. The fact that a large number of small operators reported for gold and silver and bituminous coal used no motive power is the principal reason for the small proportion using power.

While the use of power was an important factor in the production of practically all of the minerals, the horsepower reported for structural materials, abrasive materials, chemical materials, pigments, and miscellaneous minerals formed only 11.9 per cent of the total.

The following statement shows the proportion of steam, gas, water, and other power employed in the production of each group of minerals:

Per cent of operators reporting power, and per cent of these reporting steam, gas, water, or other power, by groups of minerals: 1902.

GROUP.	Per cent of operators reporting power.	POWER.			
		Steam, per cent of total.	Gas or gasoline, per cent of total.	Water, per cent of total.	All other, per cent of total.
All minerals	76.7	84.8	9.1	2.1	4.0
Metallic	50.6	81.6	1.0	8.2	9.2
Fuels	87.6	84.6	12.6	0.1	2.7
Structural materials	35.5	92.6	1.4	2.9	3.1
Abrasive materials	38.7	92.2	3.5	.....	4.3
Chemical materials	73.6	93.6	1.0	3.8	1.6
Pigments	29.9	67.2	2.0	28.2	2.6
Miscellaneous	14.8	65.4	1.6	32.2	0.8

There were 35,060 operators, including those for natural gas and petroleum, that reported the use of steampower. This class of power predominated in each of the general groups of minerals and formed 84.8 per cent of the power reported for all mining operations. The use of gas or gasoline engines was reported by 29,530 operators, the horsepower amounting to 259,695, or 9.1 per cent of the total. Engines of this variety predominated in the fuel industries as a result of the free use of natural gas and petroleum for motive power at the wells. The reports showed that 980 water wheels, with 60,897 horsepower, were used by 471 operators, and of this total 43,936 horsepower, or 72.1 per cent, was employed in the production of gold and silver.

The 84,546 horsepower reported for other kinds of power is composed very largely of the horsepower of air compressors.

A number of the mine operators reported that power was supplied by them to other mines or to operators engaged in other industries, there being 2,852 horsepower rented in this manner. A number also reported that they rented power from other operators or power companies, the rented power amounting to 29,461 horsepower, 23,556 of which was electric. The electric power generated by the mine operators amounted to 130,494 horsepower, which, with the electric power rented, makes a total of 154,050 electric horsepower used in the mining industry.

Under the present methods of operation mechanical power for hoisting, ventilating, and pumping is indispensable in mining operations of magnitude. Special inquiries were included in the schedules for gold, silver, and copper mines, concerning the character of power used in the operation of hoisting and pumping engines, and the following statement shows the number of engines employed for this purpose and operated by each class of power.

Number of hoisting and pumping engines employed in gold and silver and copper mining: 1902.

POWER.	GOLD AND SILVER.		COPPER.	
	Hoisting engines.	Pumping engines.	Hoisting engines.	Pumping engines.
Total	1,249	840	228	160
Steam	968	663	158	153
Gas or gasoline	84	21	16	2
Compressed air	91	84	51	2
Water	50	30	.....	2
Electric	56	42	3	1

In addition to the foregoing power the gold and silver and copper mines reported 3,399 power drills. Of these 302 were driven by steam, 3,060 by compressed air, 4 by water, and 33 by electric power. The gold and silver mines used also 32 steam shovels or derricks, and 44 dredges. Forty-nine locomotives also were reported for this industry.

While a perfect system of ventilation is of prime importance in all deep mines, the schedule for coal mines was the only one that contained inquiries on this subject. Of the 334 mines producing anthracite coal, reports for 271 showed the use of fan ventilators and 1 the use of exhaust steam. The remaining 62 reports either contained no answer to the inquiry or the statement was made that no mechanical arrangements were used. Of the reports for the 5,652 bituminous coal mines, 4,844 contained answers to these inquiries, showing that at 2,215, fan ventilators were used; at 1,355, furnaces; at 91, fire baskets; at 70, exhaust steam; while for 1,112 it was reported that ventilation was accomplished without the use of mechanical arrangements.

Mechanical systems of haulage were reported as in use in 201 anthracite mines. In 52 the tail rope was used; in 13, the endless rope; in 27, electric locomotives; and in 28, compressed air; while for 81 miscellaneous systems were reported. In the bituminous coal industry 502 mines used the tail rope; 105, the endless rope; 340, electric locomotives; 19, compressed air; and 65, other systems. In addition to other machinery, automatic slate pickers and coal cleaners were reported as in use at 258 anthracite coal mines.

A brief description is given in the following list of the most important mining machinery operated by motive power:

POWER DRIVEN MINING AND ORE DRESSING MACHINERY.

Air compressor: A machine for compressing air for use as a motive power in mines and quarries and for ventilation in shafts or mines. It may be direct steam driven, or driven from line shaft, electric motor, water wheel, or gas engine, by belt, rope, gearing, or silent chain.

Air drill: See Drill.

Amalgamating pan: A machine for grinding and amalgamating ore. It consists of a flat-bottomed iron pan, about 5 feet in diameter and from 2½ to 3½ feet deep, with an iron cone in the center, and sides nearly or quite vertical. In it a horizontal, annular disk, called a muller, is revolved.

Arrastra or drag-stone mill: A form of apparatus for comminuting gold and silver ores. The name is derived from the Spanish word meaning "to drag," and is indicative of the principle of the apparatus. It consists of a circular pavement from 6 to 20 feet in diameter, with a retaining wall from 2 to 4 feet high around it, made as nearly as possible impervious to water or quicksilver. In the center is a vertical rotating post, to whose radial arms are attached blocks of stone or mullers, which are dragged over the ore in the inclosure, thus crushing it.

Ball grinder: A pulverizer for minerals. It depends upon the attrition of spheres rolling inside a rotating cylinder, the periphery of which is provided with a cast steel ring, perforated with small holes. The heads of the cylinder are of heavy cast iron, lined with steel. It contains several steel balls from 2 to 5 inches in diameter. The steel ring is the crushing plate upon which the balls break up the material to a size varying from a powder to the size of the holes in the ring. In some cases a single large ball is used, moving in a grooved path.

Boring machine: See Drill; Hydraulic boring machine, etc.

Breaker: A machine for reducing ore as it comes from the mine to an approximately uniform size convenient for further working. In jaw crushers the ore is broken between a stationary and a movable jaw. Gyratory crushers, often called "coffee mill" crushers, are in part an application on a large scale of the principle of the ordinary household coffee mill. See also Coal breaker; Roll crusher; Ball grinder; Stamp mill, etc.

Buddle: One of that class of concentrating machines depending upon the principle of the settling of minerals in the order of their specific gravities. In round buddles the tables are convex-conical or concave-conical. In the stationary buddle the pulp is fed from slowly revolving feed pipes running from a main pipe in the center, and discharging at the circumference of the table, if an inward-flow buddle; or from a slowly revolving central feed, if an outward-flow buddle. In the revolving buddle the table revolves, while the feed is stationary. Distributing brushes spread the deposits evenly over the surface of the table.

Bumping table: A suspended table, capable of limited movement, which is subjected to a series of blows or shocks in the plane of its motion.

Chain cutter machine: Machine used to shear or undercut coal. It consists of a low metal bed frame, upon which is mounted a motor that rotates a chain, to which suitable cutting teeth are attached. It can be used only under certain conditions, viz: When the coal is comparatively free from balls of iron pyrites, or when the roof is good and props are not used close to the face of the coal. It can not be used to undercut coal having a squeeze upon it. Machines of the ordinary type perform their work by making a forward cut under the coal, then being withdrawn and moved over to reach fresh coal. This process is repeated across the face of the room. The Sullivan machine is fed under the coal but once, and then makes a continuous cut across the face, being withdrawn only at the farther side of the room.

Channeling machine: A machine for making channels in stone; that is, cutting the stone into blocks without the use of explosives. Its several forms are the track channeler, being a machine mounted on a truck running on a track, carrying a boiler furnishing steam to the machine; or the boiler may be omitted, the machine being driven by compressed air from mains; or the truck may carry a reheater for reheating the compressed air before it reaches the machine; the undercutting track channeler, similar to the above, but without boiler and cutting horizontally; the bar channeler, in which the cutting machine travels on a stationary bar. Any of these machines may be driven by either steam or compressed air.

Chilian mill: An apparatus in which the ore is crushed under vertical rollers running in a circular inclosure with a stone or iron base or die. The rollers rotate on a horizontal axis and also around a common vertical center.

Coal breaker: A machine for crushing lump coal as taken from the mine. It is also adapted for cleansing and sorting.

Coal conveyer: See Conveyer.

Coal cutter: See Pick machine.

Coal washer: A machine in which coal that has been broken and assorted is finally washed to deprive it of the dust and dirt adhering.

Compressor: See Air compressor.

Concentrator: General name applied to all machines for concentrating the mineral values of an ore to a smaller bulk in order to get rid of as much superfluous material as practicable.

Conveyer: An endless belt or chain device for transporting ore or coal.

Crossover dump: A contrivance for dumping cars on the mine tipple, which automatically dumps the car, restores it to its original position, and returns it to the mine.

Crusher: See Breaker.

Diamond drill: See Drill.

Dredge: A machine used in placer mining where streams can not be diverted from their course so as to expose the bed, or where bench placers do not have sufficient water for hydraulicking. A floating dredge is used for mining gravel under water; a traction dredge for "dry" or land mining. Dredges may be divided into two classes—those using a line of buckets on an endless chain, and those of the dipper type, which use a single bucket like a steam shovel.

Drill: A machine operated by steam, electricity, or compressed air, for boring. They are of two classes, percussive and rotary. A percussion drill consists of a cylinder in which works a piston carrying a long piston rod, and which is supported in such a manner that the drill, clamped to the end of the piston rod, alternately strikes and is withdrawn from the rock as the piston reciprocates back and forth in the cylinder. Means are provided by which the piston rod and drill turn slightly on their axis after each stroke. Rotary drills differ from percussive drills in the fact that the drill makes its way into the rock by a boring action produced by the axial rotation of the drill rod. Diamond drills are of the latter class, the drilling tool being a hollow cylinder armed with diamonds on its cutting end. See also Hydraulic boring machine; Gadder, etc.

Drill steel sharpener: A device driven by compressed air for sharpening steels for drills, channelers, etc.

Electric drill: See Drill.

Electric locomotive: See Mine locomotive.

Electric pump: A mine pump operated by electricity.

Elevator: A machine, consisting of series of buckets attached to an endless chain or belt, for lifting materials from one height to another.

Feeder: A machine for automatically delivering ore in proper quantities and at a definite rate to stamp batteries, roll grinders, etc.

Gadder: A machine by which holes are inserted into the side of the bench, for the insertion of plugs and feathers, by means of which the blocks are separated in the quarry. It may be driven by steam or compressed air.

Gravity stamp: See Stamp mill.

Grinder: See Breaker; Ball grinder; Stamp mill, etc.

Haulage engine: A stationary engine for hauling mine cars by means of tail rope or endless rope systems.

Header: A machine used principally for entry dividing, especially where it is not desired to make lump coal, and where the work must be pushed rapidly. The machine cuts a cylinder of coal about 4 feet in diameter and about 5 feet in length.

Hoisting engine: An engine for hoisting men or materials from a mine.

Hydraulic boring machine: A machine in which the rock drilling machine is actuated by the force of water under pressure, conducted by pipes to the breast of the tunnel.

Hydraulic coal miner: An apparatus for breaking down coal by means of an expanding plug worked by hydraulic pressure.

Jaw crusher: See Breaker.

Jig: A machine in which concentration is effected by giving a column of water a pulsating motion, or by giving the grating and screen, upon which a bed of ore lies, a short reciprocating motion, the resistance of the water lifting up the bed on the down stroke of the piston or grating and the particles assorting themselves as they settle back. The principle of the jig is the tendency of the particles of a bed of ore in water, when approximately of the same size, to arrange themselves in layers according to their specific gravity when the bed is kept sufficiently open to allow the particles to move freely among themselves.

Keeve: A round tub in which the separation is effected by means of stirring paddles, attached to and operated by a vertical shaft passing up through the center of the tub, and by hammers automatically striking the outside of the tub.

Long-wall mining machine: A machine especially designed for undercutting a long-wall face. It consists of an engine or motor mounted on a bed frame and a large cutter wheel in the periphery of which are placed the cutters or bits in a manner similar to that employed in setting the cutters in a chain cutter machine. The bed frame is mounted on wheels which run either on a single rail or an ordinary track laid parallel to the face of the coal. In machines of the Sullivan type the cutter consists of a bar of oblong shape, on which runs a chain carrying cutters or bits. This bar is similar to that used in the chain cutter machine. The machine travels along the bottom of the mine on a flat steel shoe, rails being unnecessary for its operation. The machine takes its motion along the face from a feed chain.

Mechanical conveyer: See Conveyer.

Mill: See Stamp mill.

Mine locomotive: Small, compactly built locomotive for use in mines. In the steam mine locomotive the water tank is set over the boiler, and the smokestack and top of the cab are on a level low enough to permit entrance into the mine passages. The compressed air locomotive requires a stationary air compressing plant and usually pipe lines to convey the compressed air to convenient points in the mine for charging purposes. The electric locomotive also requires a power generating station and is operated in a manner similar to an electric trolley car, using a conducting wire along the haulage road. A variation of the electric mine locomotives is the rack rail locomotive. This locomotive is propelled by sprocket wheels that mesh with the stationary rack laid parallel with the rail, the object being to obtain a great drawbar pull from a light locomotive of small outline dimensions. It is also able to climb steep grades. The electric current is carried to the locomotive in the rack and returned in the track rail.

Ore breaker: See Breaker.

Ore conveyer: See Conveyer.

Ore crusher: See Breaker.

Pick machine: A reciprocating percussive machine used to shear or undercut coal, etc. In undercutting the machine is mounted on small wheels; in shearing, these are removed and large wheels substituted.

Pneumatic drill: See Drill.

Pneumatic pump: A pump operated by compressed air.

Pneumatic stamp: See Stamp mill.

Pulsometer: A water raising device on the principle of the Savery engine. It will raise water by suction to a height of about 26 feet and, if necessary, force it to a height of about 100 feet. Its utility in mining operations lies in the fact that it will pump anything that can get past the valves, including mud, gravel, etc.

Pulverizer: See Roll crusher; Ball grinder; Stamp mill, etc.

Pump: See Steam pump; Sinking pump; Pulsometer, etc.

Riddle: A shaking screen with plane surface. They may be divided into four groups—shaking screens having an endwise or sidewise motion in the plane of the screen, or nearly so, with or without a bump; pulsating screens having an up-and-down motion perpendicular, or nearly so, to the plane of the screen; gyrating screens with a circular or elliptical motion in the plane of the

screen; gyrating screens with motion in a vertical plane parallel to their lengths.

Rock breaker: See Breaker.

Roll crusher: A machine for crushing ore to definite sizes. In roll crushers the ore is broken between two cylinders revolving in opposite directions on parallel horizontal axes.

Roller mill: A form of crushing machine in which the crushing is done by rollers moving around in a horizontal pan. They are of two general types, radial and centrifugal. In the radial roller mill the axis of the roller is a continuation of the radial arm. The rollers of the centrifugal mill revolve on independent axes and are free to swing outward in a radial direction, the rapid revolution of the central spindle causing the rollers to press against a hardened ring die in the side of the pan. See, also, Chilian mill.

Screen, revolving: A cylindrical rotating device consisting of perforated plate or woven wire for assorting material into different sizes. See, also, Trommel.

Screen, shaker: A device made of perforated plate, bars, or woven wire, to which is imparted a reciprocating motion for the purpose of separating material into different sizes. See, also, Riddle.

Shaft excavator: A system of apparatus for sinking shafts in coal mines.

Shearer: A machine for making vertical cuts in a stratum of coal. See, also, Pick machine.

Sinking pump: Portable pump used to drain water from the shaft bottom. It is especially adapted to the recovery of flooded mines. These pumps are suspended by a chain attached to eyebolts in the pump, and are provided with clamps for attaching them to the timbers in the shaft when it is desired to fix them in position temporarily. As the shaft gets deeper, the chain may be lengthened and an extra joint placed on the upper end of the delivery pipe. A single steam pipe down the shaft supplies both the sinking pump and the main pump. Electric sinking pumps are operated by electricity generated in a surface power plant.

Stamp mill: A mill for reducing ores to a comminuted state preparatory to extracting the precious metals by amalgamation. Stamps may be divided into three classes: Steam stamps, pneumatic and spring stamps, and gravity stamps. In the first-named class the pestles are raised and forced down by a steam piston. In pneumatic and spring stamps the power for lifting and forcing down the stamp is applied by a crank, while the shock to the machine and the variation of length of stroke are taken up by an air cushion or by a spring. The pestles of a gravity stamp are raised by power and fall by their own weight.

Steam drill: See Drill.

Steam pump: Force pump operated by steam acting upon the piston of a steam engine directly connected to the pump.

Steam stamp: See Stamp mill.

Trommel: A revolving screen, usually cylindrical in shape, in which ore is screened by causing it to slide by the revolution of the screen instead of a shaking movement. Tandem trommels have screens of two or more sizes on the same shaft, forming one continuous cylindrical or conical surface. Concentric trommels have two or more screens placed one outside of the other on the same shafts.

Undercutting machine: Machine for undercutting coal in the mine. See, also, Pick machine; Chain cutter machine, etc.

Vanner: A machine for separating heavy minerals from lighter by gently shaking or vanning, the mild agitation keeping the particles of the lighter mineral in suspension while the particles of the heavier mineral sink to the bottom.

Ventilating fan: A blower or ventilator for supplying air to mines.

XVII.

QUANTITY AND VALUE OF PRODUCTS.

Scope of the statistics.—For census purposes the productive industries of the country are divided into four broad groups—agriculture, manufactures, mining, and fisheries. It has been the endeavor since 1870 to preserve the distinction between these groups, but the trend of industrial development has been toward the consolidation of interests so as to bring under one management the production of both the raw material and the finished product. This tendency is especially noticeable in mining and manufacturing, and has caused these industries to overlap at many points, making a statistical separation impossible. The relationship between the two industries is discussed on page 9. It is evident that the difficulties attending a separation are increasing with the development of the resources of the country. If both industries were enumerated at the same time, it would be possible to so word the schedule as to obtain a consistent report covering the entire operations and at the same time make a practicable separation of the statistics. On the other hand, mines and quarries are a branch of the extractive industries, which include all those industries dealing in the natural products of the earth and are, in theory at least, allied to agriculture, but the statistics of agriculture for the Twelfth Census do not include any data relating to mines or quarries.[1]

The limitations of the statistics for manufactures are not so easily defined. Section 7 of the act of Congress of March 3, 1899, providing for the Twelfth and subsequent censuses, confined the inquiry to "manufacturing and mechanical establishments." If the law had not contained special provision for a mining census, this section would in all probability have been construed to cover mines and quarries, as was done in early censuses. In the absence of a direct provision of law, the limitation of the census of manufactures was not fixed arbitrarily, but was determined by the conditions and requirements of those industries which are on the border line between mining and manufacturing. This has resulted in some duplication in the statistics of production. For instance, an establishment engaged in the manufacture of cement that operated a quarry from which it obtained the raw material was reported as a manufactory, but it was also reported in the mining census as a quarry.

The two industries being thus interdependent, the duplication incident to the combination of their products can be eliminated only by ascertaining the quan-

[1] Twelfth Census, Report on Agriculture, Part I, pages xiii and xiv.

tity and value of the mining products consumed in manufacture. This was attempted at the Twelfth Census by obtaining from manufacturers the cost of materials purchased in a raw state.

Standard of measurement.—In statistics of manufactures the standard of measurement is limited to the dollar because of the great diversity of products and the impossibility of obtaining a uniform unit of quantity. For similar reasons the same unit of measurement is used in presenting the total for all mining products. The quantity is a more exact indication of the relative importance of a given product than is its value, and the quantity is shown for the majority of the minerals; but the impossibility of applying this standard is found when an attempt is made to reduce the different units to a uniform basis and give to each its true weight. For instance, there were 35,567,410 long tons of iron ore, 36,940,710 long tons of anthracite coal, 260,216,844 short tons of bituminous coal, 59,557,715 ounces of gold and silver, 34,291 flasks of quicksilver, and 89,275,302 barrels of petroleum reported as produced in the United States during the year 1902. These various units can not be reduced to a uniform basis, and the aggregate value is necessarily used in presenting the total. The value of the annual production of gold and silver was almost half as great as that of anthracite and bituminous coal, but there were nearly ten times as many wage-earners employed in the production of coal as in the production of the precious metals.

The changes in value per unit have resulted in a decrease in the total value of certain products, although the quantity has increased, while for others the percentage of increase in the total value has exceeded that of the total quantity. By the use of the quantity the uncertainties due to fluctuation in prices are eliminated. Table 58, which shows the production and commercial value of silver for selected years, as computed by the Director of the Mint, illustrates, for two periods, the increase in quantity accompanied by a decrease in value, and for three periods, the increase in quantity accompanied by a smaller increase in value.

TABLE 58.—*Production and commercial value of silver.*

YEAR.	FINE OUNCES.		COMMERCIAL VALUE.	
	Number.	Per cent of increase.	Amount.	Per cent of increase.
1880	30,320,000		$34,720,000	
1885	39,910,000		42,500,000	
Difference	9,590,000	31.6	7,780,000	22.4
1886	39,440,000		39,230,000	
1892	63,500,000		55,563,000	
Difference	24,060,000	61.0	16,333,000	41.6
1890	54,500,000		57,225,000	
1891	58,330,000		57,630,000	
Difference	3,830,000	7.0	405,000	0.7
1894	49,500,000		31,422,000	
1902	55,500,000		29,415,000	
Difference	6,000,000	12.1	[1] 2,007,000	[1] 6.4
1901	55,214,000		33,128,000	
1902	55,500,000		29,415,000	
Difference	286,000	0.5	[1] 3,713,000	[1] 11.2

[1] Decrease.

For three of the periods shown in the above table the percentage of increase in the quantity of silver produced exceeded the increase in commercial value, and for two there was an absolute decrease in value with a small rate of increase in quantity. The greatest difference is shown for the period from 1894 to 1902. The production for 1902 showed an increase of 6,000,000 ounces, or 12.1 per cent over the production of 1894, while the commercial value decreased by $2,007,000, or 6.4 per cent. There was also a decrease of $3,713,000, or 11.2 per cent, in the value reported for 1902 as compared with 1901, although the production increased by 286,000 fine ounces, or five-tenths of 1 per cent.

While in the case of silver the production has increased more rapidly than the value, the reverse is true for coal, the value having increased more rapidly than the production. This is shown by the following table, giving the quantity, value, and percentage of increase in the production of anthracite and bituminous coal:

TABLE 59.—PRODUCTION OF ANTHRACITE AND BITUMINOUS COAL.[1]

YEAR.	QUANTITY.		VALUE.		AVERAGE PRICE PER TON.		AVERAGE NUMBER OF EMPLOYEES.	
	Short tons.	Per cent of increase.	Amount.	Per cent of increase.	Amount.	Per cent of increase.	Number.	Per cent of increase.
1891	117,901,238		$117,188,400		$0.994		205,803	
1892	179,329,071		207,566,381		1.160		341,943	
Difference	61,427,833	52.1	90,377,981	77.1	0.166	16.7	136,140	66.2
1898	219,976,267		208,023,250		0.95		401,221	
1899	253,741,192		256,094,234		1.01		410,635	
Difference	33,764,925	15.3	48,070,984	23.1	0.06	6.3	9,414	2.3
1898	219,976,267		208,023,250		0.95		401,221	
1902	301,590,439		367,032,069		1.22		518,197	
Difference	81,614,172	37.1	159,008,819	76.4	0.27	28.4	116,976	29.2

[1] United States Geological Survey, "Mineral Resources of the United States," 1902.

The per cent of increase in the value of the production of coal for each of the periods covered by the above statement was greatly in excess of the percentage of increase in production and in the number of employees engaged in the industry. The production for 1902, as compared with 1898, increased by 81,614,172 short tons, or 37.1 per cent, while the value increased $159,008,819, or 76.4 per cent, the average value per ton increasing 27 cents, or 28.4 per cent, and the number of employees 116,976, or 29.2 per cent.

The increase in value does not convey a correct idea of the importance of the industry from the standpoint of employment, but there is a close affinity between the quantity of the product and the number of wage-earners. The production of a mine depends upon the thickness of the vein; the purity of the ore; the ease of working, as influenced, for example, by the necessity for drainage; the ability and energy of the superintendent and bosses; and the state of the labor market and the character of the laborers. All of these factors influence the cost of production, which also depends upon the price of supplies, the freight charges of transportation companies, and the character of the financial management.

Value of products for 1902.—The value of product reported at the census of 1902 was the value f. o. b. at the mine or quarry of all mineral or stone mined during the year. A similar value was given for the production of petroleum, but for natural gas the value reported was the price to the consumer as obtained from the books of the companies. The total value of products for all mines, quarries, and wells amounted to $796,826,417. As explained on pages 9 and 10, in some instances this value includes products that have been subjected to manufacturing processes carried on at the mine or quarry. It is the amount received by the operators of the mines or quarries and should not be confused with the value of the metallic contents of ores, such as refined gold and silver or fine lead, which are sometimes classed as a part of the value of the mineral products of the country. The total value of the commercial mineral production reported by the United States Geological Survey amounted to $1,260,637,415 for the year 1902. The difference between this value and the census value is explained on pages 129 to 131.

The value of the products reported at the census of 1902 is shown for each of the different classes of minerals, and these classes are also grouped in order to bring together the products of a similar character or of which similar uses are made. In all cases where the quantity of the product could be reported it is presented in connection with its value, and the statistics are discussed in detail in the separate reports for each mineral. The salaries, wages, and expenses reported for each mineral cover the development work carried on during the year at productive mines, and their sum for some mines necessarily exceeds the value of the products. In the natural gas industry the expenses incident to distribution are charged to the state in which they were incurred, while the value is reported for the state from which the product was obtained. For these and other reasons the expenses should not be considered as indicating the cost of the product, nor the difference between the total expenses and the value of the product as the profit of mining operations.

The statistics of production are discussed in detail in the separate reports for the different minerals and also in the presentation by states.

The following statement shows the value of the products for all minerals grouped according to their character or uses and the percentage that each group is of the total:

Value of products for groups of minerals and percentage each is of the total: 1902.

GROUP.	PRODUCTS.	
	Value.	Per cent of total.
Total	$796,826,417	100.0
Metallic	215,453,587	27.0
Fuel	469,297,671	58.9
Structural materials	96,370,559	12.1
Abrasive materials	1,177,711	0.2
Chemical materials	10,618,669	1.3
Pigments	564,039	0.1
Miscellaneous	3,344,181	0.4

Of the $796,826,417 reported as the value of products of mines, quarries, and wells, $469,297,671, or 58.9 per cent, is included in the group of "fuels," composed of coal, petroleum, and natural gas. The production for the "metallic" group, which includes copper ore, gold and silver, iron ore, lead and zinc ore, manganese ore, and quicksilver, was valued at $215,453,587, or 27 per cent. The structural materials, comprising stone, cement, clay, and slate, were valued at $96,370,559, or 12.1 per cent. All other substances obtained from mines and quarries were valued at $15,704,600, or 2 per cent of the total. It appears, therefore, that the mineral products of the country are composed very largely of fuels and metallic ores, these two groups forming 85.9 per cent of the total.

The proportions of the total value of the products obtained from the mines and quarries in different geographic divisions of the United States are shown by the following statement:

Value of products by geographic divisions: 1902.

DIVISION.	Value of products.	Per cent of total.
United States	[1] $796,826,417	100.0
North Atlantic	274,436,816	34.4
South Atlantic	71,571,074	9.0
North Central	251,874,635	31.6
South Central	50,044,483	6.3
Western	[1] 148,899,409	18.7

[1] Includes value of Alaskan coal and Hawaiian stone products.

The North Atlantic and the North Central states cover the principal mineral producing sections of the country. The value of the products of the two divisions amounted to $526,311,451, or 66 per cent of the total for the United States. Of the $274,436,816 reported as the value of products for the North Atlantic states, $236,871,417, or 86.3 per cent, was obtained from the mines, quarries, and wells of the state of Pennsylvania. The products of this state were composed very largely of coal, petroleum, and natural gas. Fuels were also the predominating minerals in the North Central division, their production amounting to $132,031,098, or 52.4 per cent of the total.

The value of the production of the Western states was only 18.7 per cent of the total for the United States. The chief products were gold and silver, copper ore, and lead and zinc ore, the production of these minerals amounting to $107,841,021 in value, or 72.4 per cent of the total for this division.

The value of the production of the South Atlantic and South Central states amounted to $121,615,557, or 15.3 per cent of the total for the United States.

Value per unit of measure.—The great variety of minerals included in the census reports and the wide variation in the value of products restricts the use of figures in ascertaining the average value per ton or other unit of production, there being comparatively few minerals for which the census statistics can be used for this purpose. This is illustrated by the following comparative table, presenting the quantity, value, and average value per unit of measure for selected minerals:

TABLE 60.—COMPARATIVE SUMMARY OF QUANTITY, VALUE, AND AVERAGE VALUE PER UNIT OF MEASURE OF PRODUCTS FOR SELECTED MINERALS: 1902 AND 1889.

MINERAL.	1902			1889		
	Quantity (short tons).	Value.	Average value per unit of measure.	Quantity (short tons).	Value.	Average value per unit of measure.
Asbestos	2,505	$46,200	$18.44	30	$1,800	$60.00
Asphaltum and bituminous rock	66,238	236,728	3.57	51,735	171,537	3.32
Barytes	61,668	203,151	3.29	21,460	106,313	4.95
Borax	19,142	2,383,614	124.52	[1] 4,000	[1] 500,000	125.00
Buhrstones and millstones	[2] 6,667	59,808	8.97	([3])	35,155	.....
Cement	[4] 24,655,360	24,268,338	0.98	[1,4] 7,000,000	[1] 5,000,000	0.71
Clay	1,455,357	2,061,072	1.42	[1] 329,665	[1] 635,578	1.93
Coal, anthracite	[5] 36,940,710	76,173,586	2.06	[5] 40,714,721	65,879,514	1.62
Coal, bituminous	260,216,844	290,858,483	1.12	95,620,026	94,343,809	0.99
Copper[6]	[7] 639,033,392	71,192,014	0.11	[7] 231,246,214	26,907,809	0.12
Corundum and emery	4,251	104,605	24.61	2,245	105,565	47.02
Crystalline quartz	15,104	43,085	2.85	([3])	([3])	.....
Feldspar	45,287	250,424	5.53	[1] 7,806	[1] 39,370	5.04
Flint	36,365	144,209	3.97	[1] 12,447	[1] 49,137	3.95
Fluorspar	48,818	275,682	5.65	9,500	45,835	4.82
Fuller's earth	11,492	98,144	8.54	([3])	([3])	.....
Garnet	3,926	132,820	33.83	([3])	([3])	.....
Gold, coining value[8]	[9] 3,242,039	67,018,899	20.67	[9] 1,590,860	32,886,744	20.67
Graphite	27,438	227,508	8.29	7,003	72,662	10.38
Grindstones and pulpstones	55,657	667,431	11.99	([3])	439,587	.....
Gypsum	[10] 681,633	2,089,341	3.07	[10] 267,760	764,118	2.85
Infusorial earth, tripoli, and pumice	6,415	55,994	8.73	3,466	23,372	6.74
Iron ore	[5] 35,567,410	65,465,321	1.84	[5] 14,518,041	33,351,978	2.30
Lead ore[11]	338,125	18,181,013	53.77	181,141	6,467,137	35.70
Lithium ore	1,245	25,750	20.68	([3])	([3])	.....
Manganese ore	[5] 16,477	177,911	10.80	[5] 24,197	240,559	9.94
Marl	12,439	12,741	1.02	156,265	63,956	0.41
Mica, sheet	[7] 373,266	83,843	0.22	[7] 49,500	[12] 52,450	.....
Mica, scrap and waste	1,400	35,000	25.00	196		
Mineral pigments, crude	35,479	360,885	10.17	[13] 38,184	[13] 483,766	12.67
Monazite	[7] 802,000	64,160	0.80	([3])	([4])	.....
Oilstones, whetstones, and scythestones	3,876	113,968	29.40	2,991	32,980	11.03
Petroleum	[4] 89,275,302	71,397,739	0.80	[4] 35,103,513	26,963,340	0.77
Phosphate rock	[5] 1,548,720	4,922,943	3.18	[5] 550,245	2,937,776	5.34
Platinum and iridium	[9] 94	1,814	19.30	[9] 500	2,000	4.00
Quicksilver, crude	11,727	82,242	7.01	2,750	([3])	.....
Quicksilver, refined	[14] 34,291	1,467,848	42.81	[14] 26,481	1,190,500	44.95
Silica sand	445,903	421,289	0.94	([3])	([3])	.....
Silver, coining value	[9] 54,198,344	70,074,625	1.29	[9] 51,354,851	66,396,988	1.29
Sulphur and pyrite	[5] 207,874	947,089	4.56	[5] 94,732	209,969	2.22
Talc and soapstone	97,563	1,138,167	11.67	36,461	475,878	13.05
Tungsten	184	5,975	32.47	([3])	([3])	.....
Uranium and vanadium	3,810	48,125	12.63	([3])	([3])	.....
Zinc ore[15]	527,121	9,006,361	17.09	234,503	3,049,799	13.01

[1] Not included as part of the census; no statistics other than production reported.
[2] Stones.
[3] Not reported.
[4] Barrels.
[5] Long tons.
[6] Copper contents of all ores mined.
[7] Pounds.
[8] Fine gold contents of auriferous ores and placer bullion.
[9] Troy ounces.
[10] Includes land plaster, calcined plaster, and crude gypsum.
[11] Nonargentiferous lead ore and lead contents of argentiferous and copper ores.
[12] Values not separable in 1889.
[13] Includes slate ground as a pigment, 2,000 long tons, value $20,000.
[14] Flasks.
[15] Zinc ore and zinc contents of auriferous and argentiferous ores.

While, with a few notable exceptions, the average values per unit for the minerals included in the above table indicate a general increase in 1902 as compared with 1889, the averages should not be accepted as reflecting the actual conditions. As explained on pages 8 and 9, the products were not reported at the two censuses on a uniform basis. The theory of both censuses was evidently to report, as a rule, the crude products, but in a number of cases refined or partially refined products were necessarily included. It is impossible to determine the exact extent to which the partially manufactured product has been included in the totals for either census. The quantities and value of coal, iron ore, petroleum, and other minerals for which a crude product is necessarily reported, or of buhrstones, millstones, oilstones, cement, and other substances reported in a manufactured or partially manufactured state may be accepted as a basis for computing the average value, although these values are in every instance the value f. o. b. at the mine and include different grades of a general class or group. For instance, different varieties of cement and different grades of the same variety are included in the totals for both censuses; therefore an average price obtained from such a combination has little significance. Where practicable the average value per unit is given in the reports on the separate minerals.

By-products.—In adopting the classification of minerals used by the United States Geological Survey it was necessary to assign to certain classes products obtained from mines or quarries reported under other classifications. The class of products included in the totals for each mineral are described in the separate reports and also in the discussion of "classification," pages 24 to 35. This method of assigning the products found the widest application in the group of "abrasive materials." Of the total value—$1,177,711, reported for this group of minerals—$444,539, or 37.7 per cent, represents products obtained from quarries included in other classifications and under which the statistics for employees and wages and expenses are shown.

In four of the classes of materials included under abrasives a portion of the products was obtained from quarries included under other classes of minerals. Of the $667,431 reported as the value of grindstones and pulpstones, $403,066, or 60.4 per cent, was obtained from quarries included under the classification of "sandstones and quartzites." This value, $403,066, should therefore be added to the classification of sandstones and quartzites in order to obtain a value consistent with the salaries, wages, and other expenses.

The following statement shows the quantity and value of each class of products included under abrasive materials and also the quantity and value of each class obtained from other classifications:

Abrasive materials and the quantity and value of such materials obtained from quarries included under other classifications: 1902.

Abrasive materials.	Total abrasive materials.		Obtained from quarries classified as—							
			Sandstones and quartzites.		Siliceous crystalline rocks.		Talc and soapstone.		Grindstones and pulpstones.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (stones).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Total	.....	$1,177,711	35,683	$411,938	100	$1,425	175	$1,436	595	$29,740
Buhrstones and millstones	[1] 6,667	59,808	.....	.....	100	1,425	.....	.....	.....	.....
Corundum and emery	4,251	104,605	.....	.....	.....	.....	.....	.....	.....	.....
Crystalline quartz	15,104	43,085	.....	.....	.....	.....	.....	.....	.....	.....
Garnet	3,926	132,820	.....	.....	.....	.....	.....	.....	.....	.....
Grindstones and pulpstones	55,657	667,431	35,503	403,066	.....	.....	.....	.....	.....	.....
Infusorial earth, tripoli, and pumice	6,415	55,994	.....	.....	.....	.....	175	1,436	.....	.....
Oilstones, whetstones, and scythestones	3,876	113,968	180	8,872	.....	.....	.....	.....	595	29,740

[1] Stones.

XVIII.

MINING OPERATIONS OF GOVERNMENTAL INSTITUTIONS.

In addition to the statistics for mines and quarries operated by private enterprise, the mining census includes the statistics for 3 quarries operated by the United States Government, 41 quarries and 79 natural-gas wells operated by city or town governments; also 2 coal mines, 1 iron mine, 35 natural-gas wells, and 18 quarries operated by penal or eleemosynary institutions. In order to preserve the distinction between the mining operations controlled by governmental institutions and those conducted by private enterprise the statistics for the former work are presented separately, and Table 61 summarizes the totals for the mines, quarries, and wells controlled by each of the four classes of governmental institutions.

TABLE 61.—SUMMARY, MINING OPERATIONS OF GOVERNMENTAL INSTITUTIONS: 1902.

CHARACTER.	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			
Total	179	78	106	$67,661	484	$270,938	$29,184	38	$46,330	$200,909	$1,071,153
United States	3	3	9	6,155	73	39,699	.....	.....	1,060	16,530	80,353
Municipal	120	48	51	28,921	305	167,886	22,436	30	40,123	122,136	494,037
Penal	19	19	46	32,585	105	63,028	3,248	.....	4,547	61,323	470,069
Eleemosynary	37	8	.....	.....	1	325	3,500	8	600	920	26,694

The wage-earners shown in Table 61 do not include the convicts in penitentiaries or the value of the work of such convicts when employed on contract, lease, or otherwise, nor do they include the number of inmates of eleemosynary institutions thus employed. The salaried officials reported were not engaged exclusively in the supervision of the mines and quarries. It is probable that most of them had other duties to perform in and about the institutions, and miscellaneous duties are also required to some extent of the wage-earners. The number of employees reported, therefore, should not be accepted as the number engaged exclusively in mining operations.

Federal and municipal quarries and wells.—Of the 179 quarries and wells operated by governmental institutions, 123 were controlled by the United States and by city or town governments, and the statistics for such mining operations are presented in Table 62.

TABLE 62.—MINES, QUARRIES, AND NATURAL-GAS WELLS OPERATED BY THE UNITED STATES AND CITY OR TOWN GOVERNMENTS: 1902.

	Number of mines, quarries, and wells.	Number of operators.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		CONTRACT WORK.		Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			
Total	123	51	60	$35,076	378	$207,585	$22,436	30	$41,183	$138,666	$574,390
Limestones and dolomites	16	16	21	12,857	128	66,203	.....	.....	2,234	21,477	123,749
Illinois	4	4	7	3,800	49	27,406	.....	.....	806	12,512	70,037
Iowa	4	4	2	837	9	4,578	.....	.....	.....	285	8,441
Kentucky	2	2	4	2,470	8	3,150	.....	.....	.....	125	5,492
Maryland	1	1	1	540	3	900	.....	.....	24	80	919
Minnesota	2	2	4	3,625	35	18,540	.....	.....	480	7,000	14,676
New York	1	1	1	700	9	5,089	.....	.....	150	425	8,500
Tennessee	1	1	1	280	5	1,624	.....	.....	230	50	2,184
Wisconsin	1	1	1	605	10	4,916	.....	.....	544	1,000	7,500
Natural gas	79	11	9	5,900	12	7,404	22,436	30	35,201	67,574	205,262
Indiana	27	2	1	900	2	1,068	900	4	3,172	100	22,339
Kansas	21	5	2	2,000	2	936	4,593	13	908	9,014	46,358
Ohio	27	3	6	3,000	8	5,400	9,000	8	31,121	58,460	126,570
South Dakota	4	1	.....	.....	.....	.....	7,943	5	.....	.....	10,000
Sandstones and quartzites	4	4	8	3,664	45	26,080	.....	.....	873	5,335	49,094
Illinois	1	1	.....	.....	.....	.....	.....	.....	23	2	25
Kentucky	1	1	3	750	11	3,350	.....	.....	.....	500	5,000
Massachusetts	2	2	5	2,914	34	22,730	.....	.....	850	4,833	44,069
Siliceous crystalline rocks	24	20	22	12,655	193	107,898	.....	.....	2,875	44,280	196,285
Connecticut	2	2	4	2,425	68	37,828	.....	.....	1,300	12,262	53,815
Massachusetts	19	15	16	8,771	109	61,738	.....	.....	1,575	29,837	128,385
Minnesota	1	1	1	670	10	6,405	.....	.....	.....	1,703	10,285
North Carolina	1	1	1	780	4	1,250	.....	.....	.....	288	2,700
Pennsylvania	1	1	.....	.....	2	677	.....	.....	.....	190	1,100

The mining operations carried on by the United States and by municipal governments gave employment to 378 wage-earners, to whom $207,585 was paid in wages during the year. Of this number 366, receiving $200,181 in wages, were engaged in operating quarries, from which were obtained products used in the construction of public buildings and highways, dams, canals, etc. The products of these quarries were valued at $369,128. Of the 28 quarries operated by municipalities and engaged in quarrying siliceous crystalline

rocks and sandstones and quartzites, 21 were located in Massachusetts, and their products were valued at $172,454, or 70.3 per cent of the total for all quarries of these classes. The municipal quarries in Massachusetts were engaged exclusively in the preparation of road material. There were 79 natural-gas wells operated by 11 municipalities, the gas, valued at $205,262, being used in the operation of electric light and power plants. The gas was also used for the illumination of public buildings, streets, and grounds, and in some instances, was sold to private consumers.

Penal institutions.—The United States Bureau of Labor has made two reports on convict labor.[1] From the latter of these reports, which was published in July, 1896, it appears that the practice of employing convicts in mines and quarries and in the dressing and preparation of stone for building purposes, or for the construction of highways, prevailed in a number of state penitentiaries. The value of such work for the year 1895 was reported at $1,578,905. Work of this character was also done to a considerable extent by the inmates of penal institutions, where the regulations are less rigorous than in state penitentiaries. The majority of the convicts thus employed were not engaged directly by the state, but were worked under a contract, lease, or other system, and therefore the value of their work reported to the Bureau of the Census would be included in the returns of mines and quarries operated by private enterprise and reported under the head of "contract work." The statistics for the 19 mines and quarries operated by penal institutions are presented in the following table:

[1] Report of the United States Commissioner of Labor, 1886, and Bulletin of United States Department of Labor, July, 1896.

TABLE 63.—MINES AND QUARRIES OPERATED BY PENAL INSTITUTIONS: 1902.

	Number of mines, quarries, and wells.	Number of operators.	Salaried officials, clerks, etc.		Wage-earners.		Contract work, amount paid.	Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.				
Total	19	19	46	$32,585	105	$63,028	$3,248	$4,547	$61,323	$470,069
Coal, bituminous	2	2	25	18,786	64	41,236	.....	4,085	21,881	390,054
Kansas	1	1	20	15,120	2	1,900	.....	1,581	7,200	126,530
Tennessee	1	1	5	3,666	62	39,336	.....	2,504	14,681	263,524
Iron ore	1	1	5	3,423	.....	.....	3,248	.....	32,440	4,336
Texas	1	1	5	3,423	.....	.....	3,248	.....	32,440	4,336
Limestones and dolomites	11	11	11	6,272	26	12,552	.....	462	3,203	38,231
Illinois	3	3	3	1,640	7	4,152	.....	.....	1,886	11,871
Iowa	1	1	2	1,200	9	5,400	.....	.....	297	8,653
Kentucky	3	3	2	732	10	3,000	.....	212	720	7,046
Minnesota	1	1	3	1,800	.....	.....	.....	.....	100	2,943
New York	2	2	1	900	.....	.....	.....	250	.....	2,875
Ohio	1	1	.....	.....	.....	.....	.....	.....	200	4,843
Sandstones and quartzites	3	3	1	560	2	1,240	.....	.....	2,775	18,732
Colorado	1	1	.....	.....	.....	.....	.....	.....	50	5,000
Nevada	1	1	.....	.....	.....	.....	.....	.....	25	3,732
South Dakota	1	1	1	560	2	1,240	.....	.....	2,700	10,000
Siliceous crystalline rocks	2	2	4	3,544	13	8,000	.....	.....	1,024	18,716
Minnesota	1	1	3	2,644	13	8,000	.....	.....	705	13,464
Pennsylvania	1	1	1	900	.....	.....	.....	.....	319	5,252

The 105 wage-earners shown in Table 63 as engaged in the mines and quarries operated by penal institutions do not include the convicts thus employed. They represent only the number of guards or free labor necessarily employed in the supervision of the work or in the performance of duties that can not be intrusted to the inmates. The production of the quarries thus operated was utilized in the erection of new buildings, retaining walls or sidewalks, or was broken into riprap and macadam by the prisoners and used in the construction of highways. The 2 coal mines operated by penal institutions gave employment to more than half of the salaried officials and wage-earners engaged in operating the mines and quarries controlled by such institutions. The coal mined was valued at $390,054, or 83 per cent of the total value of the production of all mines and quarries of this class.

Eleemosynary institutions.—The statistics for the 2 stone quarries and 35 natural gas wells operated by eleemosynary institutions are presented in Table 64.

TABLE 64.—QUARRIES AND NATURAL-GAS WELLS OPERATED BY ELEEMOSYNARY INSTITUTIONS: 1902.

	Number of quarries or wells.	Number of operators.	Salaried officials, clerks, etc.		Wage-earners.		Contract work.		Miscellaneous expenses.	Cost of supplies and materials.	Value of product.
			Number.	Salaries.	Average number.	Wages.	Amount paid.	Number of employees.			
Total	37	8			1	$325	$3,500	8	$600	$920	$26,694
Limestones and dolomites	2	2								300	944
Ohio	1	1								100	324
Pennsylvania	1	1								200	620
Natural gas	35	6			1	325	3,500	8	600	620	25,750
California	2	1								120	5,500
Indiana	30	3			1	325	3,500	8	600	500	19,800
Ohio	3	2									450

XIX.

THE VERIFICATION OF THE MINING CENSUS.

Statistics of the mineral products of the country are collected by the Bureau of the Census, also by the United States Geological Survey and by the mine inspectors and geologists of different states. When the statistics compiled by these various offices relate to the same mineral and cover the same year as that covered by the Census reports there should be a certain degree of harmony in the results, but this is disturbed because various methods are followed in collecting and compiling the data, according to the object of the report. The statistics in some of the reports represent a year's production; in others they represent the product placed on the market during the year; in some they give the quantity and value of the crude material; and in others they show the quantity and value of the product partly manufactured or prepared for the market.

Comparison with Geological Survey.—The reports of the United States Geological Survey are published yearly and are harmonized with the reports for the preceding year, also with prior Census reports. An agreement between the statistics of the Survey and those of the Bureau of the Census was one of the objects of the cooperative work of the two offices in collecting the reports for the mining census of 1902. The quantity and value of the different minerals as compiled by the two offices are compared in the following table:

TABLE 65.—COMPARISON OF MINERALS AND MINERAL PRODUCTS REPORTED BY THE BUREAU OF THE CENSUS AND THE GEOLOGICAL SURVEY: 1902.

Mineral or mineral product.	Bureau of the Census.		Geological Survey.	
	Short tons.	Value.	Short tons.	Value.
Antimony	(1)	(1)	3,561	$634,506
Asbestos	2,505	$46,200	[2] 1,005	[3] 16,200
Asphaltum and bituminous rock	66,238	236,728	[4] 105,458	765,048
Barytes	61,668	203,154	61,668	203,154
Bauxite	[5] 29,222	128,206	[5] 29,222	128,206
Borax	19,142	2,383,614	[5] 20,004	2,538,614
Buhrstones and millstones	[7] 6,667	59,808	(8)	59,808
Cement	[9] 24,655,360	24,268,338	[10] 25,753,504	25,366,380
Clay	1,455,357	2,061,072	1,455,357	2,061,072
Coal, anthracite	[5] 36,940,710	76,173,586	[5] 36,940,710	76,173,586
Coal, bituminous	260,216,844	290,858,483	260,216,844	290,858,483
Copper	[11] 639,033,392	71,192,014	[12] 659,508,644	76,568,954
Corundum and emery	4,251	104,605	4,251	104,605
Crystalline quartz	15,104	43,085	15,104	[13] 84,335
Feldspar	45,287	250,424	45,287	250,424
Flint	36,365	144,209	36,365	144,209
Fluorspar	48,818	275,682	[2] 48,018	[3] 271,832
Fuller's earth	11,492	98,144	11,492	98,144
Garnet	3,926	132,820	3,926	132,820
Gold, coining value	[14] 3,242,039	67,018,890	[15] 3,870,000	80,000,000
Graphite, crystalline			[2,16] 3,936,824	
Graphite, amorphous	27,438	227,508	[2] 4,739	[3] 182,108
Grindstones and pulpstones	55,657	667,431	(8)	667,431
Gypsum	681,633	2,089,341	[17] 816,478	2,089,341
Infusorial earth, tripoli, and pumice	6,415	55,994	6,365	55,994
Iron ore	[5] 35,567,410	$65,465,321	[18] 35,554,135	[18] $65,412,950
Lead ore	[19] 338,125	18,181,018	[15] 270,000	22,140,000
Lithium ore	1,245	25,750	1,245	25,750
Manganese ore	[5] 16,477	177,911	[5] 16,477	177,911
Marl	12,430	12,741	12,430	12,741
Mica, sheet	[16] 373,266	83,843	[16] 373,266	83,843
Mica, scrap and waste	1,400	35,000	1,400	35,000
Mineral pigments, crude	35,479	360,885	[2] 78,049	[3] 944,382
Monazite	[16] 802,000	64,160	[16] 802,000	64,160
Natural gas	(8)	30,867,863	(8)	[3] 30,867,668
Oilstones, whetstones, and scythestones	3,876	113,968	(8)	[20] 221,762
Petroleum	[9] 80,275,302	71,897,739	[2,9] 88,766,916	[3] 71,178,910
Phosphate rock	[5] 1,548,720	4,922,943	[2] 1,490,314	[3] 4,693,444
Platinum and iridium	(21)	(21)	[22] 94	1,814
Precious stones	(8)	328,450	(8)	328,450
Quicksilver, crude	[23] 11,727	[23] 82,242	(24)	(24)
Quicksilver, refined	34,291	1,467,848	[25] 34,291	1,467,848
Silica sand	[26] 445,903	421,289	[26] 943,135	807,797
Silver, coining value	[27] 54,198,344	70,074,625	[15] 55,500,000	71,767,575
Stone	(8)	[28] $64,769,897	(8)	[29] $64,559,099
Sulphur and pyrite	207,874	947,089	207,874	947,089
Talc and soapstone	97,563	1,138,167	[30] 97,954	1,140,507
Tungsten	184	5,975	(24)	(24)
Uranium and vanadium	3,810	48,125	3,810	48,125
Zinc ore	[31] 527,121	9,006,361	[15] 156,927	14,625,596
All other minerals	[32] 3,636	[32] 49,256	[33] 3,823	[33] 35,344

1 Not reported by the Bureau of the Census.
2 Quantity marketed in 1902.
3 Value of product marketed in 1902.
4 Includes residual asphaltum product from petroleum refineries not reported by the Bureau of the Census.
5 Long tons.
6 Includes 862 short tons of boric acid, valued at $155,000, not reported by the Bureau of the Census.
7 Stones.
8 Not reported.
9 Barrels.
10 Includes all manufactured cement. Bureau of the Census reports only cement manufactured at quarries.
11 Pounds, copper contents of all ores mined.
12 Quantity of refined metal, value at New York city.
13 Survey reports value of product finished and marketed. Bureau of the Census reports value at quarry.
14 Troy ounces. Fine gold contents of auriferous ores, and placer bullion, exclusive of 403,730 ounces, valued at $8,345,800, estimated by the Director of the Mint as produced in Alaska.
15 Quantity of refined metal.
16 Pounds.
17 Estimated as crude.
18 Does not include 13,275 tons of manganiferous iron ore used in production of spiegeleisen.
19 Nonargentiferous lead ore and lead contents of argentiferous and copper ores.
20 Survey reports an added value of $107,794 for a product which was finished away from quarries.
21 Not reported; entire production obtained in the refining of auriferous ores.
22 Troy ounces. Quantity of refined metal. Value at San Francisco.
23 Cinnabar mined, but not reduced.
24 Not reported by the Geological Survey.
25 Flasks. Quantity of refined metal. Value at San Francisco.
26 Bureau of the Census statistics include only the sand produced in sandstone quarries by crushing the rock. The Geological Survey includes sand produced in sandstone quarries as well as glass sand obtained from banks.
27 Troy ounces. Fine silver contents of argentiferous ores, and placer bullion, exclusive of 92,000 ounces, valued at $118,950, mined in Alaska.
28 Includes value as follows: Limestones and dolomites (less value of iron flux), $25,170,549; marble, $5,044,182; sandstones and quartzites, $10,601,171; siliceous crystalline rocks, $18,257,944; slate, $5,696,051.
29 Does not include limestone quarried for cement valued at $210,798.
30 Includes 391 tons of soapstone, valued at $2,340, classified by the Bureau of the Census under mineral pigments, crude.
31 Zinc ore and zinc contents of auriferous and argentiferous ores.
32 Includes chrome ore, magnesite, molybdenum, nickel and cobalt, and rutile.
33 Includes chrome ore, magnesite, nickel (refined metal), cobalt oxide, and rutile. Does not include molybdenum.

As explained on page 24, in the reports for the Bureau of the Census, the different mines and quarries were classified according to their product of chief value. By this practice there was assigned to some classifications a production of ores which included several metals, and in order to compare the Census data with the reports of the Geological Survey, the total production of gold, silver, copper ore, and lead and zinc ore is given in the foregoing table, irrespective of the class of ore with which they were mined or from which they were obtained. The products, therefore, do not agree with the products shown elsewhere for the same class of minerals. For instance, the copper contents of all ores, as shown by Table 65, amounted to 639,033,392 pounds, valued at $71,192,014, but the products of the copper mines, classed as such by the Bureau of the Census, amounted to 11,780,064 short tons of ore, valued at $51,178,036. Notwithstanding the above arrangement the production of gold as reported by the Geological Survey exceeds that of the Census report by 627,961 ounces, valued at $12,981,110; and of silver by 1,301,656 ounces, valued at $1,682,950, both exclusive of Alaska; of copper by 20,475,252 pounds, valued at $5,376,940. This excess in the reports of the Geological Survey is due to the fact that the totals for the Bureau of the Census are based on the reports of the mine operators representing the production of the mines, while those for the Geological Survey are based on the reports of smelters and refineries, and show the amount of refined metal marketed during the year rather than the amount produced by the mines. The value of 1 ton of ore assaying 1 ounce of gold per ton may have been computed, in the settlement between the miner and the smelter, at the rate of $19 per ounce of fine gold contents, from which further deductions were made for treatment and freight, leaving to the miner perhaps not more than $10 net, whereas the value of 1 ounce of refined gold bullion would be reported by the United States Geological Survey as $20.67. The results of both offices are correct, one aiming to obtain the market value of the refined metal and the other the amount received by the miner for his operations during the year.

The production of lead and of zinc, as reported by the Bureau of the Census, exceeds that of the Geological Survey by 68,125 and 370,194 short tons, respectively, while the value of these metals as reported by the Geological Survey exceeds the value shown in the Census report by $3,958,987 and $5,619,235, respectively. This discrepancy is due also to the fact that the Geological Survey reports the quantity and value of the refined product, the crude product reported by the Bureau of the Census being of greater weight but less value.

That part of the difference which is due to the inclusion of manufactured products by the Survey, under the same or similar mining classifications as those of the Bureau of the Census, is illustrated by asphaltum and bituminous rock. The Bureau of the Census reports 39,220 short tons less than the Geological Survey; these are valued at $528,320, and are the residual asphaltum product of petroleum refineries, which the Bureau of the Census classifies as the result of manufacturing processes. The Bureau of the Census report for mineral pigments, crude, is another illustration. The Geological Survey reports instead mineral paints, which are a manufacture, and its statistics are for the manufactured product marketed, the excess over the Bureau of the Census report being 37,570 short tons, valued at $583,447.

Graphite affords an illustration of the difference due to reporting the production marketed instead of the production mined. The Bureau of the Census values, which are for the production mined, exceed those of the Geological Survey, which are for the production marketed, by $45,400.

All of the differences between the amounts and values reported by the two offices are explained in the footnotes to Table 65, but another illustration may be given. The Bureau of the Census shows no production of antimony, but the Geological Survey reports 3,561 short tons of this metal, valued at $634,506. There was no production of antimony from domestic antimonial ores during the year 1902, and the entire quantity reported by the Geological Survey was obtained from smelting foreign or domestic hard lead ores from regulus or metal or from antimonial ores imported. The production, therefore, has no direct connection with the operations at the mine and was omitted from the mining census.

In addition to the minerals enumerated in Table 65, the annual reports of the Geological Survey show the quantity and value of the following substances which are, for Census purposes, classed as manufactured products, and therefore omitted from the statistics of mining: Aluminum, bromine, coke, pig iron, salt, zinc white, and arsenious oxide. The Geological Survey also reports the production of brick clay, glass sand, and mineral waters. Brick clay is omitted from the mining census, as the manufacture of brick, with that of all other clay products, was reported in the census of manufactures. The value of the material was a constituent of the value of product, and this material was generally mined by the manufacturer. Glass sand is omitted because most of it is obtained from sand banks or from river beds, and such production was not considered as forming a part of the mining or quarrying operations of the country. Glass sand, when obtained from the crushing of sandstone incident to the quarrying of such stone, has been included in the Census report on stone under the classification of "silica sand." Mineral waters are omitted because it is impossible to make a complete enumeration of such waters, and there is very little, if any, labor incident to their

production, the operations consisting entirely in bottling and otherwise making the product ready for the market.

In order to cover the total production of minerals of all classes, the Geological Survey also includes an "estimated value of mineral products unspecified." Beginning with 1889 the value of these miscellaneous minerals has been placed annually at $1,000,000. An estimate of this character was not attempted for the census of 1902, the production being confined to the quantities and values reported by the mine operators. With the exceptions indicated, all of which are due to the difference in the objects of the reports of the two offices, there is an exact agreement in the production of the different minerals as compiled by the Geological Survey and the Bureau of the Census.

Comparison with state reports.—While the state mine inspectors and geologists in a number of the states collected miscellaneous information concerning different minerals, the only uniform compilation of the production relates to anthracite and bituminous coal. The quantities of coal as reported by the Bureau of the Census and by the state officials in several of the principal producing states are shown in the following table:

TABLE 66.—*Yearly production of coal as reported by United States Census and state offices.*

STATE OR TERRITORY.	Bureau of the Census (short tons).	STATE REPORTS.	
		Short tons.	Year ending—
Colorado	7,401,343	7,522,923	Dec. 31, 1902
Illinois	32,939,373	30,021,300	June 30, 1902
Indian Territory	2,820,666	3,243,692	June 30, 1903
Iowa	5,904,766	6,185,734	June 30, 1903
Kansas	5,266,065	5,230,433	Dec. 31, 1902
Kentucky	6,766,984	6,429,419	Dec. 31, 1902
Michigan	964,718	869,228	Dec. 31, 1902
Missouri	3,890,154	4,063,572	Dec. 31, 1902
New Mexico	1,048,763	1,359,530	June 30, 1903
Ohio	23,519,894	23,929,267	Nov. 15, 1902
Pennsylvania:			
Bituminous	98,574,367	98,946,203	Dec. 31, 1902
Anthracite	[1] 36,940,710	[1] 36,911,554	Dec. 31, 1902
Washington	2,681,214	2,690,789	Dec. 31, 1902
West Virginia	24,570,826	23,359,083	June 30, 1902

[1] Long tons.

The production of coal, as reported by the Bureau of the Census, agrees exactly with the production as reported by the Geological Survey; and from the above table it appears that when the reports of the Bureau of the Census and the state officials cover the same year there is a substantial agreement in the quantities reported, the greatest variation being shown for Pennsylvania, where the production of bituminous coal as reported by the state exceeds that shown by the Bureau of the Census by 371,836 tons. A number of the state reports, however, cover the fiscal year ending June 30, while in one instance, Ohio, the report covers the year ending November 15, and no satisfactory comparison can be made with the Bureau of the Census returns.

In addition to statistics of the production of coal the state of Missouri collects information concerning the production of lead and zinc. The production of these metals, as reported by the state office for the year 1902, amounted to 126,831 and 234,903 tons, respectively, as compared with 124,537 and 240,057 tons, respectively, reported by the Bureau of the Census. This is a striking agreement in the quantities compiled by two entirely independent offices. The state of Idaho also collects information concerning the production of lead. The production for 1902, as reported by the state office, amounted to 119,223,000 pounds, as compared with 208,093,202 pounds reported by the Bureau of the Census, the census report exceeding that of the state by 88,870,202 pounds. The production of lead in Idaho is obtained entirely from silver-bearing lead ores, and the total quantity can not be definitely ascertained until the ores have been subjected to smelting processes. The quantities, therefore, were estimated. This fact, in connection with the fact that the reports for the state do not necessarily apply to the quantities obtained from the ores mined during the census year, probably accounts for the marked difference. The quantity of iron ore produced in the state of New Jersey during 1902, as reported by the geological survey of the state, amounted to 443,728 tons, as compared with 441,879 tons reported by the Bureau of the Census.

XX.

MINING AND MANUFACTURING.

The combination of mining and manufacturing by the use of the same capital, wages, expenses, etc., has been accentuated by the consolidation of industrial enterprises, and it is impossible, in many instances, to segregate the statistics so as to show the true totals for each branch of industry. If the statistics for mining and manufacturing were to be taken together it would be easy to find a common term for this union, and comparatively simple to show the aggregate figures; but such a combination would not be a compliance with the act of Congress of March 6, 1902, which provides for mines, mining, quarries, and minerals as a distinct class of census work. Theoretically a perfect mining census should terminate with the delivery of the ore or crude rock at the mine or quarry, but in many cases the employees work indiscriminately in both branches of industry and no value is placed on the ore as it leaves the mine. Where the milling, separating, washing, burning, calcining, or other forms of reduction or manufacture were performed at the mine or quarry, the census of mines for 1902 includes, as a rule, the employees and the expenses involved in the entire work of the establishment. But the absence of uniformity in this respect at prior censuses makes it impossible to prepare satisfactory comparative statistics for a number of the important minerals.

The Twelfth Census of manufactures includes in a number of instances the mining and quarrying oper-

ations which are incident to such manufacturing as the smelting and refining of ores, the manufacture of monuments, tombstones, etc. The statistics for the two branches of industry are therefore to some extent duplicated. The totals, however, are presented in the following table:

TABLE 67.—*Mining and manufactures: 1902 and 1900.*

	Total.	Mining, 1902.	Manufactures, 1900.
Number of establishments	664,250	[1] 151,516	512,734
Salaried officials, clerks, etc.:			
Number	435,876	38,128	397,748
Salaries	$443,873,390	$39,020,552	$404,852,838
Wage-earners:			
Average number	5,903,117	581,728	5,321,389
Wages	$2,700,537,970	$369,959,960	$2,330,578,010
Miscellaneous expenses	$1,100,680,624	$71,771,713	$1,028,908,911
Cost of supplies and materials	$7,484,808,385	$123,814,967	$7,360,993,418
Value of product	$13,836,105,983	$796,826,417	$13,039,279,566

[1] Number of mines, quarries, and wells.

The cessation of work in the anthracite coal industry for a number of months during 1902 tends to reduce the value of the statistics for the mining census as representing conditions during a normal year, but with this exception the totals may be accepted as showing the aggregate importance of the two industries during a period of twelve months and the proportion which each contributes to this aggregate. The table indicates that the kindred industries of mining and manufacturing, which include the mechanical industries, gave employment, on an average during the year to 6,338,993 persons, and paid $3,144,411,360 in salaries and wages. Of this total the salaried officials numbered 435,876, or 6.9 per cent, and the wage-earners 5,903,117, or 93.1 per cent. The mining industries contributed 9.8 per cent of the number and 13 per cent of the wages and salaries, respectively, and the manufacturing and mechanical industries 90.2 and 87 per cent, respectively. Of the $13,836,105,983 reported as the gross value of products, mining contributed 5.8 per cent and manufactures 94.2 per cent.

In a few of the basic industries it is possible to follow the production of the mine to the initiatory stage of its manufacture and to ascertain the quantity and value of the product after it has passed through the first manufacturing process; but the comparison of this quantity and value with the quantity and value of the mineral is apt to be misleading. The mineral materials consumed in manufactures are necessarily the result of mining processes carried on at a previous date, and often the manufactured product is composed of different minerals and other substances, some of which are the result of manufactures. For instance, the production of iron ore for 1902 was 35,567,410 long tons and of pig iron 17,821,307 long tons, indicating that each ton of pig iron required about two tons of iron ore, but it is probable that a large proportion of the pig iron was manufactured from iron ore mined during the preceding year and that a considerable proportion of the production mined during 1902 was not used in manufactures until after the expiration of that year. The production of pig iron consumed not only all of the iron ore, but a large proportion of the 39,604,007 short tons of coal from which 25,401,730 short tons of coke were produced, practically all being employed in blast furnaces. The industry also consumed the 11,878,675 long tons of limestone used for fluxing purposes, and large quantities of coal as fuel.

The raw materials reported at the Twelfth Census as consumed in manufactures amounted to $2,389,140,942. Of this total, $1,940,727,048, or 81.2 per cent, were obtained from the farm; $118,803,115, or 5 per cent, from the forest; $319,975,108, or 13.4 per cent, from the mine; and $9,635,671, or four-tenths of 1 per cent, from the sea.[1] These amounts represent the materials consumed during the year ending May 31, 1900, while the products for the mines and quarries, which products were valued at $796,826,417, were for the calendar year ending December 31, 1902. The two amounts, therefore, are not comparable. This lack of comparability is due not only to the fact that the two reports cover different periods, but also to the fact that the value of the products of the mines and quarries includes in many instances the value of finished products ready for consumption. For instance, the amount for the product of mines and quarries includes cement to the value of $24,268,338; finished slate products to the value of $5,696,051; buhrstones and millstones and other finished abrasives to the value of $841,207. It also includes considerable proportions of the products of marble, sandstones and quartzites, siliceous crystalline rocks, anthracite coal, natural gas, and other minerals which were either sold at the quarry as finished products or consumed in other establishments than those engaged in manufactures. But the cost of the materials obtained from the mine and consumed in manufactures does not include the cost of coal, natural gas, or petroleum used as fuel in manufactures. According to the Twelfth Census, all kinds of fuel consumed in manufacturing establishments cost $205,320,632, and there was also paid $10,986,353 for the rent of power and heat. A large proportion of this cost represents the products of mines.

While all manufactures depend upon the production of mines either for raw materials or machinery, the production of metals is the most striking illustration of this interdependence. Of the various metals, iron is the most important, and it is possible to show its production in connection with the production of the minerals upon which it depends. A presentation of this

[1] Twelfth Census, Report on Manufactures, Part I, page cxxxv.

character is made in the following statement, which presents the total production for the United States:

	1902 (long tons).	1889 (long tons).	Per cent of increase.
Iron ore	35,567,410	14,518,041	145.0
Coke[1]	[2]25,401,730	[2]10,258,022	147.6
Limestone flux[1]	12,139,248	6,318,000	92.1
Pig iron[1]	17,821,307	7,603,642	134.4

[1] United States Geological Survey, "Mineral Resources of the United States," 1902.
[2] Short tons.

The ratio of increase in the production of iron ore and pig iron during the period covered by the above statement was 145 per cent and 134.4 per cent, respectively. The production of coke increased 147.6 per cent, and of limestone used as fluxing material 92.1 per cent. The production of iron and steel was valued at $430,954,348 at the census of 1890, and at $803,968,273 at the census of 1900, an increase of $373,013,925, or 86.6 per cent. These industries are dependent upon the production of iron ore, and an increase in its production would necessarily be followed by a corresponding increase in their manufactures.

When the ore and fuel both exist in the same locality the corresponding manufactures naturally develop locally; this is well illustrated by the growth of iron manufactures in Alabama during the last two decades. Whereas at the census of 1880 Alabama ranked fifth in coke and eighteenth in iron and steel, in 1900 the state was second in coke production and sixth in iron and steel manufactures. The rapid growth of manufacturing industries is due to the utilization of the state's rich mineral resources, which were neglected in the earlier years of the century. The state possesses within its borders all the requisites for iron manufacture—iron ore, coking coal, and limestone for flux. The same is true of Colorado, which has developed greatly in coal and iron and the attendant manufacturing industries during the last decade. The following table shows the interdependent growth of the coal and iron and the allied manufactures in these states:

TABLE 68.—INTERDEPENDENT GROWTH IN THE MINING AND MANUFACTURES OF COAL AND IRON IN ALABAMA AND COLORADO: 1902 AND 1889.

	ALABAMA.			COLORADO.		
	1902	1880	Per cent of increase.	1902	1889	Per cent of increase.
Mine products:						
Iron ore, long tons	3,574,474	1,570,319	127.6	306,572	109,336	180.9
Coal, bituminous, short tons	10,354,570	3,572,983	189.8	7,401,343	2,544,144	190.9
Coke, short tons[1]	2,552,246	1,030,510	147.7	[2]1,003,393	187,638	434.7
Limestone flux for furnaces, long tons	[1]1,001,884	221,215	352.9	[1]402,735	46,296	769.9
Manufactures:						
Coke, value[1]	$8,300,838	$2,372,417	249.9	[2]$2,754,941	$643,479	328.0
Iron and steel, value	[5]$17,392,483	[4]$12,544,227	38.6	[5]$6,108,295	(3)	.....
Foundry and machine-shop products, value	[5]$5,482,441	[4]$2,195,913	149.7	[5]$3,986,915	[4]$1,792,619	122.4

[1] United States Geological Survey, "Mineral Resources of the United States," 1902.
[2] Includes Utah.
[3] Not reported separately.
[4] For census year 1890.
[5] For census year 1900.

While a considerable portion of the bituminous coal was consumed in the manufacture of coke, large quantities were used as fuel in manufactures generally, and also in other industries; therefore, the increase in its production is not necessarily accompanied by a corresponding increase in the production of iron. It is also probable that a portion of the coal, coke, and limestone produced in these states was shipped out of the state for consumption in manufactures in other sections of the country. During the period of thirteen years covered by this table the quantity of iron ore, coal, coke, and fluxing material more than doubled in both states, and the value of iron and steel and foundry products indicates that there has been a very large increase in the metal industries, though the statistics for them cover a period of only ten years.

Economies of production in manufactures demand the proximity of raw material, and also of a market for the finished product, or convenient transportation facilities for either or both. In the endeavor to secure the benefits incident to the greatest number of these conditions, factories have been located in different sections of the country, according to the relative advantages to be obtained from proximity to materials, market, or transportation facilities. This localization of industries has been in some instances a gradual growth, as in the case of the manufactures in the New England states, and in others a rapid development, following the discovery of exceptional natural advantages, such as the coal and iron fields of western Pennsylvania and of Alabama. Considering the census of manufactures of 1900 and the mining census of 1902 as comparable, Table 69 shows the total value and the proportion of the products of the mines and manufactures in the different geographic divisions of the country.

TABLE 69.—VALUE OF MINE AND QUARRY PRODUCTS AND MANUFACTURES THEREOF, BY GEOGRAPHIC DIVISIONS.[1]

DIVISION.	MINE AND QUARRY PRODUCTS: 1902.						MANUFACTURES BASED ON MINE AND QUARRY PRODUCTS: 1900.			
	All products.[2]	Per cent.	Fuels.	Per cent.	Metallic.	Per cent.	All mine and quarry products.	Per cent.	Metallic.	Per cent.
Total	$796,800,681	100.0	$469,278,623	100.0	$215,453,587	100.0	$3,726,602,390	100.0	$2,840,044,465	100.0
North Atlantic	274,486,816	34.4	213,701,645	45.5	4,483,383	2.1	2,077,230,940	55.7	1,572,873,315	55.4
South Atlantic	71,571,074	9.0	55,926,138	11.9	2,726,820	1.3	193,646,726	5.2	123,186,606	4.3
Nortl Central	251,874,635	31.6	132,031,098	28.1	91,216,846	42.3	1,102,285,147	29.6	854,212,737	30.1
South Central	50,044,483	6.3	37,727,941	8.1	6,202,862	2.9	110,639,487	3.0	77,211,143	2.7
Western	148,873,673	18.7	29,891,801	6.4	110,823,676	51.4	242,800,090	6.5	212,560,664	7.5

[1] Exclusive of Alaska and Hawaii.
[2] Includes structural, abrasive, and chemical materials, pigments, and miscellaneous minerals in addition to fuels and metalliferous minerals.

The North Atlantic states produced only 2.1 per cent of the ores, but the value of fuel amounted to 45.5 per cent and of manufactures to more than half of the total for the United States, indicating a concentration of manufactures to obtain the advantages incident to a liberal supply of fuel and a ready market.

The North Central states produced ore valued at $91,216,846, or 42.3 per cent of the total value of the ores, but the value of the fuels and manufactured products formed only 28.1 per cent of the total value for the United States. This tends to show that the ores were not used where they were mined, and that the mine operators were forced to take advantage of the transportation facilities to supply materials for the factories in the North Atlantic states. Of the ores obtained in these states, a value of $68,932,294 represented iron and copper from the mines of northern Michigan and Minnesota. The largest part of the freight transportation on the Great Lakes is on account of these mines. Transportation facilities here play an important part, the iron ores of Lake Superior being transported to the south Lake ports and to the centers of cheap fuel and iron consumption.

The value, $110,823,676, or 51.4 per cent of the total shown for the ores in the Western states, was composed very largely of the value of precious metals and copper, these minerals forming 67.9 and 29.1 per cent, respectively, of the total for the geographic division. The refined metal obtained from both of these minerals was sent elsewhere for manufacture.

The freight movement on the Great Lakes for 1902, as shown by the receipts at the Lake ports, aggregated 54,074,729 tons.[1] Of this, iron ore and mineral tonnage (not including coal) was 27,898,424 tons and coal 8,256,117 tons, making a total of 36,154,541 tons for mine products. This was 66.9 per cent of all freight.

[1] Department of Commerce and Labor, Bureau of Statistics, "Monthly Summary of Commerce and Finance of the United States," November 1 to February 28, 1902–3, page 1797.

The iron ore production of the upper Lake district, Michigan, Minnesota, and Wisconsin, was 27,056,861 tons, distributed as follows: Michigan, 11,135,215 tons; Minnesota, 15,137,650 tons; and Wisconsin, 783,996 tons. This was 76.1 per cent of the iron ore production of the United States. The copper shipments, though of great value, do not constitute a large tonnage item of the Lake traffic, as most of the ore is smelted at the mines and only the copper shipped. The copper product of northern Michigan for 1902 was 171,102,065 pounds, or 85,551 tons, but a large portion of this product was shipped as mineral to be smelted at Buffalo. The total copper shipments on the Great Lakes were 140,509 tons; this tonnage includes shipments of copper from the head of Lake Superior received from the West. The movement of iron ore on the Great Lakes is shown by the following table:

TABLE 70.—*Movement of iron ore on the Great Lakes: 1902.*

SHIPMENTS.		RECEIPTS.	
Ports.	Tons.	Ports.	Tons.
Total	26,603,616	Total	26,603,601
Lake Superior ports	21,288,455	Lake Michigan ports	3,656,171
Duluth, Minn	5,604,841	Elk Rapids, Mich	39,875
Two Harbors, Minn	5,489,314	Fruitport, Mich	31,382
Ashland, Wis	3,560,213	Chicago, Ill	79,210
West Superior, Wis	4,047,518	South Chicago, Ill	3,250,052
Houghton, Mich	1,036	Milwaukee, Wis	252,652
Marquette, Mich	1,245,583		
Presque Isle, Mich	1,289,950	Lake Erie and connected ports	22,868,314
Lake Michigan ports	5,352,177		
Escanaba, Mich	5,259,312	Detroit, Mich	40,910
Gladstone, Mich	82,140	Ashtabula, Ohio	4,743,679
Manistique, Mich	2,092	Cleveland, Ohio	4,929,279
Menominee, Mich	1,000	Conneaut, Ohio	4,308,392
Green Bay, Wis	1,436	Fairport Harbor, Ohio	1,488,592
Milwaukee, Wis	6,197	Huron, Ohio	461,796
		Lorain, Ohio	1,435,092
		Sandusky, Ohio	161,353
All others	12,984	Toledo, Ohio	1,029,107
		Erie, Pa	1,782,851
		Buffalo, N. Y	2,247,193
		North Tonawanda, N. Y	237,673
		Tonawanda, N. Y	2,397
		All others	79,116

The chief use in manufactures of the various products of mines and quarries, and the aggregate value of the minerals and the manufactured products, so far as they can be reported separately, are shown in the following table:

TABLE 71.—MINE AND QUARRY PRODUCTS AND THE CHIEF MANUFACTURING INDUSTRIES UTILIZING SAME.

MINE AND QUARRY PRODUCTS: 1902.		MANUFACTURING INDUSTRIES: 1900.	
Character.	Value of product.	Character.	Value of product.
Total			$3,464,345,521
Metallic:			
Copper ore	$51,178,036	Bells; brass; brass and copper, rolled; brass castings and finishings; brassware; bronze castings; copper smelting and refining; electrical apparatus and supplies.	346,396,879
Gold and silver	82,482,052	Gold and silver, leaf and foil; gold and silver, reducing and refining, not from the ore; jewelry; pens, gold; plated and Britannia ware; silversmithing; silverware; watch cases.	95,676,333
Iron ore	65,465,321	Cutlery and edge tools; files; firearms; foundry and machine shop products; gas and oil stoves; gas machines and meters; hardware; hardware, saddlery; horseshoes, factory product; iron and steel; iron and steel bolts, nuts, washers, rivets, doors and shutters, forgings, nails and spikes, wrought pipes; ironwork, architectural and ornamental; ordnance and ordnance stores; pens, steel; registers, car fare and cash; safes and vaults; saws; scales and balances; screws, machine and wood; sewing machines and attachments; springs, steel, car, and carriage; steam fittings and heating apparatus; stencils and brands; tin and terne plate; tools; typewriters and supplies; vault lights and ventilators; wire; wirework, including wire rope and cable.	1,793,490,908
Lead and zinc ore	14,600,177	Babbitt metal and solder; paints (pigments); galvanizing; lead, bar, pipe, and sheet; lead, smelting and refining; type founding; zinc, smelting and refining.	222,398,643
Manganese ore	177,911	Iron and steel industries; pottery and glass; chemical and paint industries	(1)
Quicksilver	1,550,090	Amalgamation; manufacture of mineral pigments, chemicals, etc	(1)
Fuels:			
Coal, anthracite	76,173,586	Fuel (manufactures); coke; gas, illuminating and heating; coal-tar products	317,961,580
Coal, bituminous	290,858,483		
Natural gas	30,867,863	Fuel and lighting; gas carbon	(1)
Petroleum	71,397,739	Petroleum, refining	123,929,384
Structural materials:			
Cement	24,268,338	Lime and cement	28,689,135
Clay	2,061,072	Brick and tile; crucibles; pottery, terra cotta and fire-clay products	98,141,170
Limestones and dolomites	30,441,801	Lime (see cement); mantels, slate, marble, and marbleized; marble and stone work; monuments and tombstones; paving and paving materials; masonry, brick and stone; plastering and stuccowork.	368,958,899
Marble	5,044,182		
Sandstones and quartzites	10,601,171		
Siliceous crystalline rocks	18,257,944		
Slate	5,696,051		
Abrasive materials:			
Buhrstones and millstones	59,808	Millstones	75,922
Corundum and emery	104,605	Emery wheels	1,381,675
Crystalline quartz	43,085	Wood finishing and sandpaper	(1)
Garnet	132,820	Abrasives	(1)
Grindstones and pulpstones	667,431	Grindstones	1,088,909
Infusorial earth, tripoli, and pumice.	55,994	Cleansing and polishing preparations	(1)
Oilstones, whetstones, and scythestones.	113,968	Hones and whetstones	196,823
Chemical materials:			
Borax	2,383,614	Chemicals (boric acid); glass and pottery manufacture; terra cotta and fire-clay products (pottery).	(1)
Fluorspar	275,682	Glass; flux for iron furnaces; chemicals	(1)
Gypsum	2,089,341	Plastering and stuccowork (plaster of Paris and wall and cement plaster)	(1)
Phosphate rock	4,922,943	Fertilizers (rock phosphates)	38,565,297
Sulphur and pyrite	947,089	Chemicals (sulphuric acid); explosives (gunpowder)	12,615,795
Pigments:			
Barytes	203,154	Chemicals, paints (pigments)	6,643,215
Mineral pigments, crude	360,885		
Miscellaneous:			
Asbestos	46,200	Fireproofing, heat insulating, and noncombustible manufactures	(1)
Asphaltum and bituminous rock	236,728	Chemicals; paints and varnish; electric wire insulation; paving and paving materials	(1)
Bauxite	128,206	Aluminum; chemicals	[2]1,920,000
Chrome ore	(1)	Furnace linings; hardening steel; chemicals	(1)
Feldspar	250,424	Pottery and tiles; wood filler; scouring soaps; glass manufactures	(1)
Flint	144,209		
Fuller's earth	98,144	Petroleum refining (clarifying oil)	(1)
Graphite	227,508	Graphite and graphite refining (crucibles, stove polish, paint, foundry facings, lead pencils, lubricants).[1]	429,173
Lithium ore	25,750	Chemicals (medicinal)	(1)
Magnesite	(1)	Furnace lining	(1)
Marl	12,741	Fertilizer	(1)
Mica	118,849	Axle grease; electrical apparatus and supplies (insulation); heat insulation; wall papers	(1)
Molybdenum	(1)	Hardening steel; chemicals	(1)
Monazite	64,160	Chemicals (rare earth salts for incandescent filaments)	(1)
Nickel and cobalt	(1)	Nickel: Hardening steel; alloys; coinage; electroplating	(1)
		Cobalt: Chemicals	
Precious stones	328,450	Lapidary work	5,786,281
Rutile	(1)	Hardening steel; coloring porcelain; manufacture of artificial teeth	(1)
Silica sand	421,289	Glass, furnace, engine, and building sand	(1)
Talc and soapstone	1,138,167	Slabs: Hearthstones, furnace linings, etc	(1)
		Flour talc: Fireproof paints; electric insulation; heat insulation; furnace facings; lubricants; paper manufacture.	
Tungsten	5,975	Hardening steel; chemicals	(1)
Uranium	48,125	Hardening steel; chemicals	(1)
Vanadium			

[1] Not reported separately.

[2] United States Geological Survey, "Mineral Resources of the United States," 1902.

XXI.

EXPORTS AND IMPORTS OF MINERALS.

Exports.—While the development of the export trade has been one of the leading features of industrial progress in the United States, the vast majority of mineral products of the country are subjected to manufacturing processes before they are sent out of the country, and therefore the products of the mines and quarries, as reported to the Census, form a very small proportion of the exports. The total exports of domestic merchandise for 1902, exclusive of gold and silver and phosphate rock, amounted to $1,349,493,266, and the exports of the products of mines, including crude mineral oils, amounted to $33,327,517, or only 2.5 per cent. The coining value of gold and the commercial value of silver produced during 1902, as based on the Census reports, and the production of gold and silver in Alaska, as estimated by the Director of the Mint, amounted to $102,695,557. Exclusive of coin the coining value of gold and the commercial value of silver exported was $70,419,846, the exports amounting to 68.6 per cent of the production. The classification followed by the Bureau of Statistics in compiling the statistics of exports does not correspond exactly with the classification of minerals adopted for the census of 1902. Their figures, however, may be used for the purpose of indicating the approximate amount of crude minerals exported. The following table presents the value of the exports of domestic merchandise, exclusive of gold and silver and phosphate rock, and the ratio of the exports of the products of mines to the total exports for each year from 1889 to 1902:

TABLE 72.—*Exports of domestic merchandise and products of mines, exclusive of gold and silver and phosphate rock: 1889 to 1902.*

[Compiled from annual reports of the Bureau of Statistics, on Commerce and Navigation of the United States, year ending June 30.]

YEAR ENDING JUNE 30—	Value of exports of domestic merchandise.	Value of exports of products of the mines, including crude mineral oils.	Per cent of products of mines to total exports.
1902	$1,349,593,266	$33,327,517	2.47
1901	1,455,414,413	34,159,482	2.35
1900	1,364,387,204	31,467,375	2.31
1899	1,197,941,331	22,166,283	1.85
1898	1,205,932,079	19,410,707	1.61
1897	1,027,001,674	20,804,573	2.03
1896	858,799,894	20,045,654	2.33
1895	787,651,337	18,509,814	2.35
1894	864,019,713	20,301,819	2.35
1893	826,877,918	19,794,502	2.39
1892	1,013,035,566	20,653,560	2.04
1891	870,654,467	22,020,428	2.53
1890	841,701,171	20,323,779	2.41
1889	729,213,079	19,866,557	2.72

The value of the exported products of mines has formed such a small proportion of the total exports that the statistics are instructive only in so far as they show the disposition of the different minerals. The following table presents the total value of each variety of the mining products, including crude petroleum oils, exported for each year since 1889:

TABLE 73.—VALUE OF EXPORTS OF PRODUCTS OF MINES, INCLUDING CRUDE MINERAL OILS: 1889 TO 1902.

[Compiled from annual reports of Bureau of Statistics, on Commerce and Navigation of the United States, year ending June 30.]

	1902	1901	1900	1899	1898	1897	1896
Total	$39,479,332	$39,815,162	$38,077,015	$28,197,101	$24,014,670	$26,972,982	$25,225,042
Clay	153,164	148,461	166,835	120,306	63,434	24,810	19,734
Coal, anthracite	7,117,809	8,425,803	7,564,088	6,475,596	5,906,171	5,678,198	5,717,246
Coal, bituminous	13,647,652	13,891,693	11,938,725	7,185,432	5,777,578	5,330,445	4,928,816
Copper ore	2,601,697	1,346,707	1,009,288	440,575	824,165	2,059,779	2,033,858
Iron ore	178,107	175,817	79,042	66,400	34,224	34,168	6,402
Marble and stone, unmanufactured	172,273	93,720	120,397	68,903	95,953	66,665	74,878
Nickel, oxide and matte	1,190,606	1,510,508	1,219,812	1,110,222	1,402,803	725,309	442,795
Oil, mineral, crude	6,084,818	6,686,929	7,364,162	5,202,892	4,348,262	6,171,852	6,121,836
Ore, gold and silver bearing	263,220	607,287	233,273	40,927	244,129	1,162,480	778,795
Phosphates, crude[2]	5,888,595	5,048,393	6,376,367	5,989,891	4,359,834	5,005,929	4,400,593
Quicksilver	425,728	400,298	556,142	516,459	414,938	448,333	628,673
Zinc, dross	369,811	164,140	224,210	367,976	104,838	40,544	17,713
Zinc ore	1,217,907	1,150,695	980,999	448,145	313,370	122,765	1,401
All other products of mining	167,945	164,711	243,676	163,377	129,971	101,705	52,302

	1895	1894	1893	1892	1891	1890	1889
Total	$24,625,294	$25,488,043	$23,947,369	$23,350,005	$24,237,244	$23,916,436	$20,936,087
Clay	21,493	29,880	26,072	23,653	26,857	19,552	18,113
Coal, anthracite	5,918,229	6,656,590	4,854,604	3,419,660	3,796,495	3,319,726	4,217,003
Coal, bituminous	5,180,398	5,252,375	5,149,534	5,229,498	4,594,531	3,536,362	2,473,476
Copper ore	1,104,515	2,485,716	4,591,338	6,936,777	7,260,893	6,053,236	7,518,258
Iron ore	6,000	(1)	(1)	(1)	(1)	(1)	82
Marble and stone, unmanufactured	88,359	142,691	153,428	169,777	191,520	232,205	146,998
Nickel, oxide and matte	316,638	493,964	145,047	370,974	(1)	(1)	(1)
Oil, mineral, crude	5,161,710	4,415,915	4,567,891	5,101,840	5,876,452	6,744,235	5,083,132
Ore, gold and silver bearing	374,218	146,779	225,524	39,325	34,542	1,973,976	80,961
Phosphates, crude[2]	5,741,262	5,038,445	3,927,343	2,657,120	2,182,274	1,618,681	988,569
Quicksilver	425,724	618,297	204,908	149,798	88,359	183,096	294,947
Zinc, dross	31,474	74,800	35,620	(1)	(1)	[3] 1,897	(1)
Zinc ore	415	36	5,990	114,639	142,011	[4] 182,990	25,354
All other products of mining	259,859	182,555	60,570	36,944	43,310	50,480	89,244

[1] Not reported.
[2] Included in manufactures under the head of fertilizers, prior to 1899.
[3] Zinc ashes.
[4] Zinc, ore and oxide of.

With the exception of nickel and phosphate rock, the quantities exported formed only a small proportion of the mining products of the country. The value of the exports of nickel and phosphate rock in 1902 apparently exceeded the value of the total production of those minerals by $2,147,458. It is probable, therefore, that the classification adopted by the Bureau of Statistics included partially manufactured products, or other substances not included in the mining census, else the exports were composed in part of products mined during prior years.

The value of anthracite and bituminous coal formed more than a third of the value of the exports of the mining products in 1889 and in each year since. The $20,765,461 reported as the value of the coal exported in 1902 represents 6,971,184 tons; of this amount 4,732,185 tons, valued at $14,281,425, or 67.9 per cent of the quantity and 68.8 per cent of the value, were exported to Quebec, Ontario, Manitoba, etc.

Crude mineral oil was the next most important mineral product exported. There were 133,536,800 gallons of crude mineral oil exported during the year ending June 30, 1902, valued at $6,084,818. Of this total 89,733,032 gallons, valued at $4,272,144, or 67.2 per cent of the total quantity and 70.2 per cent of the value, were consigned to France; 10,844,913 gallons, valued at $550,694, were exported to Mexico; and 10,132,815 gallons, valued at $497,060, to Spain; leaving only 22,826,040 gallons, valued at $764,920, or 12.6 per cent, as the exports to all other countries.

Crude phosphate ranked third among the exports of mining products. The quantity exported for 1902 amounted to 747,672 tons, valued at $5,888,595. Of this total 372,035 tons, valued at $3,133,477, or 49.8 per cent of the quantity and 53.2 per cent of the value, were exported to the United Kingdom and Germany, and 375,637 tons, valued at $2,755,118, were exported to other countries.

There were 25,076 tons of copper ore exported, valued at $2,601,697; 13,875 tons, valued at $1,895,586, were consigned to the United Kingdom; and 11,139 tons, valued at $699,677, to Mexico, while only 62 tons, valued at $6,434, were shipped to other countries.

Imports.—The methods used in compiling the statistics of imports are also at variance with those followed by the census, and there are comparatively few products for which a satisfactory comparison of the imports and the production can be made, but the statistics for such products are presented in Table 74.

TABLE 74.—*Value of production and imports of certain comparable minerals: 1902.*

[Imports compiled from reports of the Bureau of Statistics on Commerce and Navigation of the United States, year ending December 31.]

MINERAL.	Production.	Imports for consumption.
Asbestos	$46,200	$762,432
Asphaltum and bituminous rock	236,728	492,658
Barytes	203,154	[1] 27,099
Bauxite	128,206	54,410
Borax	2,383,614	20,795
Buhrstones and millstones	59,808	16,158
Cement	24,268,338	2,556,061
Chrome ore	4,567	582,597
Clay	2,061,072	1,107,770
Coal, anthracite	76,173,586	792,469
Coal, bituminous	200,858,483	6,934,668
Copper ore	[2] 71,192,014	[3] 20,537,349
Corundum and emery	104,605	[4] 201,066
Flint	144,209	[5] 85,092
Gold and silver	[6] 92,911,013	[7] 55,688,883
Graphite	227,508	1,169,388
Grindstones and pulpstones	667,431	76,906
Gypsum	2,089,341	308,167
Infusorial earth, tripoli, and pumice	55,994	62,374
Iron ore	65,465,321	2,558,023
Lead and zinc	[8] 27,187,374	[9] 671,576
Magnesite	19,639	250,350
Marble	5,044,182	831,207
Mica	118,849	466,332
Mineral pigments, crude	360,885	195,868
Monazite	64,160	[10] 12
Natural gas	30,867,863	27,436
Nickel and cobalt	8,800	1,185,927
Oilstones, whetstones, and scythestones	113,968	56,456
Petroleum	71,397,739	176
Phosphate rock	4,922,943	388,479
Quicksilver	1,550,090	2,166
Stone (exclusive of marble)	64,996,967	51,657
Sulphur and pyrite	947,089	4,907,842
Talc and soapstone	1,138,167	35,366
Tungsten	5,975	7,046

[1] Baryta, carbonate and sulphate.
[2] Commercial value for copper contents of all ores mined.
[3] Value of imports of ore, regulus and black, and bars, ingots, and pigs.
[4] Emery grains and rock.
[5] Flint and flint stones.
[6] Commercial value of gold and silver contained in auriferous ores and placer bullion.
[7] Imports less foreign exports. Commercial value of gold and silver in ore and base bullion and bullion refined.
[8] Includes values for lead and zinc produced in gold, silver, and copper mines.
[9] Lead ore, dross, pigs, and bars; and zinc, in blocks or pigs.
[10] Monazite sand and thorite.

The minerals enumerated have been selected because the classifications by which they were designated in compiling the statistics of imports compare most nearly with the classifications used in compiling the census reports, but they should not be accepted as representing all minerals imported. Bismuth and lithographic stone were not produced in commercial quantities in the United States, and the entire consumption was dependent upon the imports.

The imports for a number of the minerals shown in Table 74 exceeded the production for 1902, and the conditions prevailing for each of them are summarized as follows:

Asbestos.—Practically the entire amount of asbestos consumed in the United States has been obtained from Canada. The imports for consumption in 1902 amounted to $762,432, as compared with a domestic

production of $46,200. Asbestos of suitable quality and in sufficient quantities to supply the demand has not been uncovered in this country.

Asphaltum and bituminous rock.—While there has been a growing increase in the production of asphaltum and bituminous rock in the United States, the value of the imports for consumption for 1902 exceeded the value of the domestic production by $255,930. The domestic production was crude material, and it is probable that the imports were of a more highly finished character. The material is obtained in an almost pure form from Pitch Lake, in the island of Trinidad, where the cost of production is reduced to a minimum. The quantity imported from this source during the year ending June 30, 1902, was valued at $329,819. The asphaltum imported from Barbados possesses peculiar qualities which make it especially adaptable for the manufacture of varnishes and the insulation of electric cables.

Chrome ore.—Practically all of the chrome ore consumed in the United States was imported. The deposits in the United States are not conveniently located for development and can not compete with the low price of the foreign ore.

Corundum and emery.—The value of the imports of corundum and emery was almost twice as great as the value of the domestic production. The excess of the imports over the production was due chiefly to the fact that the largest domestic deposits are not conveniently located for transportation facilities and can not compete with the large deposits of Canadian corundum that can be more conveniently worked; or the production of Turkish emery, which is produced at a considerably lower cost and imported into the United States as ballast. Artificial corundum, moreover, is also produced in large quantities and will undoubtedly affect the production of the natural material.

Graphite.—While graphite has been developed in a number of different localities throughout the United States, the production still falls far short of the demand, which has increased with the development of the mechanical and electrical industries. Graphite is also being successfully produced by artificial means. The imports, however, are still many times in excess of the domestic production.

Infusorial earth, tripoli, and pumice.—The value of the imports of these minerals exceeded the domestic production by $6,380. This increase was due entirely to the imports of pumice, for this mineral has been found and quarried in the United States in comparatively insignificant quantities. The imports were obtained almost entirely from the island of Lipari, north of Sicily, and were shipped largely as ballast.

Magnesite.—The entire domestic production of magnesite was obtained from mines in the state of California, which apparently are not able to supply the market. No other deposits appear to have been discovered. The imports were obtained almost entirely from Greece and Austria.

Mica.—While this mineral is found in a number of the states and exists in considerable quantities in different localities, the individual deposits have not been developed to a great extent, and the quality is inferior to that of the imported variety which is obtained largely from Canada and India. The good variety of mica obtained from the deposits in India and the cheap labor there enables it to be produced and delivered in the United States in sufficient quantities to almost entirely supply the market.

Nickel and cobalt.—Practically all of the nickel and cobalt consumed in the United States is obtained from Canada, where the deposits are extensive and cheaply mined. Both minerals have been found and mined in various localities in the United States, sometimes in connection with lead ore, but they have not been produced in quantities sufficient to supply the market, because, in part, of the moderate price which has prevailed for nickel.

Sulphur and pyrite.—The excess of the imports over the production of sulphur is not due apparently to its scarcity in the United States, but to the immense deposits of pure sulphur found in Sicily, which are worked by cheap labor. The imports of pyrite more than doubled the production.

Tungsten.—The imports of this mineral exceeded the comparatively small production by only $1,071. The domestic production has been obtained largely in connection with other minerals.

Of the other minerals enumerated in Table 74 the following show the largest amounts imported during the year 1902, the minerals being considered in the order in which they appear in the table.

Cement.—The production of cement reported by the census is confined to the manufacture of cement at and in connection with the operation of limestone quarries. The total production for 1902, as reported by the United States Geological Survey, was valued at $25,366,380. The imports, therefore, formed a comparatively small percentage of the total consumption. There were 423,844,160 pounds of Roman, Portland, and other hydraulic cement imported during the year ending June 30, 1902, and these were valued at $1,478,452. Of these imports 227,056,720 pounds, valued at $834,555, came from Germany; all other countries sent 196,787,440 pounds, or 46.4 per cent, of the quantity, valued at $643,897, or 43.6 per cent of the total.

Clay.—As shown by Table 74, the value of the clay imported for consumption was more than half as great as the value of the domestic production. Common blue clay, used for the manufacture of crucibles, was obtained very largely from Germany. The imports from that country for the year ending June 30, 1902, were valued at $59,492, as compared with $13,603 re-

ported for all other countries. Other clay, including China clay, or kaolin, came largely from the United Kingdom and Germany, the imports from these countries amounting to $1,122,647, or 92.4 per cent of the total for other clay.

Coal.—While the imports of coal form a very small proportion of the consumption, nevertheless considerable quantities of bituminous coal were imported during the year 1902, the imports being stimulated to some extent by the shortage in the production of anthracite coal. The imports from British Columbia, Nova Scotia, and New Brunswick for the year ending June 30 were valued at $3,904,526, forming 73.5 per cent of the total imports. Including anthracite the imports from all other countries amounted to $1,407,882, or 26.5 per cent of the total.

Copper.—The imports for consumption of copper during the calendar year 1902 were valued at $20,537,349, the amount being about one-third as great as the production; this mineral is imported largely from Mexico. The imports from that country for the year ending June 30, 1902, were valued at $9,934,097, or 70.9 per cent of all copper imported.

Gold and silver.—Gold and silver ore and bullion is the most important class of imports, the amount—$55,688,883—reported for 1902 constituting 70.7 per cent of the total for the principal minerals imported, as shown by Table 74. Of this aggregate the value of gold was $32,582,221, or 41.4 per cent, and the value of silver was $23,106,662, or 29.3 per cent. Of the silver approximately 85 per cent was imported from Mexico. Of the gold about 30 per cent was obtained from Quebec, Ontario, etc., and about 27 per cent from Mexico.

Iron ore.—The imports for consumption of iron ore during the calendar year 1902 were valued at $2,558,023. Of the imports for the year ending June 30 iron ore valued at $1,109,205, or 46.9 per cent, was obtained from Cuba; a value of $677,131, or 28.7 per cent, from Quebec, Ontario, Manitoba, etc., and $406,662, or 17.2 per cent, from Spain.

Lead and zinc.—The imports of lead ores came almost entirely from Mexico and British Columbia, the amount received from these countries for the year ending June 30, 1902, being valued at $4,401,390, or 97.9 per cent of the total.

The value of the minerals imported during 1902 was more than twice as great as the value of the exports of similar products. In a number of instances the imports bear an important relationship to the consumption, and the statistics are worthy of more detailed consideration. To assist in such an analysis Table 75 is presented, which gives the value of all the minerals or mineral products, as classified by the Bureau of Statistics, that have been imported for consumption each year from 1889 to 1902. Some of them are not included in the preceding comparative table.

TABLE 75.—IMPORTS FOR

[From reports of the Bureau of Statistics,

	MINERAL.	1902	1901	1900	1899
1	Agate, unmanufactured	$1,379	$960	$635	$195
2	Asbestos, manufactured	25,819	26,209	16,314	9,559
3	Asbestos, unmanufactured	752,125	427,333	292,879	296,508
4	Asphaltum or bitumen, crude	432,005	501,310	357,938	226,635
5	Asphaltum and bitumen, dried or advanced	38,760	42,611	43,196	18,557
6	Asphaltum, manufactures of	4,949	1,935	1,656	1,575
7	Asphaltum and bitumen, crude or dried				
8	Asphaltum and bitumen, limestone rock asphalt containing not more than 15 per cent of bitumen.	21,617	52,529	42,085	39,761
9	Baryta, carbonate of, or witherite	15,870	15,208	15,681	15,552
10	Baryta, sulphate of, or barytes, including barytes earth unmanufactured	14,453	6,959	7,886	1,298
11	Bauxite or terra alba, aluminous	52,245	63,597	11,413	14,168
12	Brazilian pebble		697		877
13	Borax	26,865	18,291	5,960	2,755
14	Borax, refined				
15	Borax, borates of lime or soda or other borate material not otherwise provided for	10,746	7,491	3,594	24,903
16	Borax, borate of lime				
17	Borax, crude, or borate of soda				
18	Cement, Roman, Portland, and other hydraulic, in barrels, sacks, or other packages	1,443,900	2,164,556	3,194,897	2,694,313
19	Cement, Roman, Portland, and other hydraulic; other	52,776	71,928	47,537	43,783
20	Cement, Roman, Portland, and all other				
21	Cement, Portland, Roman, and other hydraulic, in bulk			6	
22	Chromate of iron or chromic ore	525,611	214,762	378,101	264,376
23	Clay, china clay or kaolin	849,314	701,791	694,280	599,650
24	Clay, common blue, in casks	73,100	67,763	111,762	76,014
25	Clay, unwrought or unmanufactured, not specially provided for	146,725	144,050	131,478	101,331
26	Clay, wrought or manufactured, not specially provided for	65,177	58,511	40,435	27,871
27	Clay, all other not specially provided for	13		136	62
28	Coal, anthracite	2,006	6	628	2,686
29	Coal, bituminous and shale	4,541,338	4,585,335	4,022,802	3,479,931
30	Coal, slack or culm, such as will pass through a half-inch screen	757,392	787,515	440,046	109,331
31	Coal, coke	359,438	309,614	232,947	171,995
32	Cobalt and cobalt ore and zaffer	27,237	11,863	7,414	10,986
33	Cobalt, oxide of	137,959	111,740	72,072	67,442
34	Copper ore	2,556,687	2,944,791	1,639,352	608,399
35	Copper, regulus of, and black or coarse copper, and copper cement	11,275,576	7,471,649	1,002,978	586,430
36	Emery ore	137,695	288,424	162,056	138,891
37	Emery, grains and ground, pulverized, refined, or manufactures of emery	55,870	30,509	28,524	28,638
38	Emery, grains and ground, pulverized or refined				
39	Emery, fillet				
40	Feldspar				
41	Fuller's earth, unwrought and unmanufactured	21,142	16,006	19,985	21,569
42	Fuller's earth, wrought or manufactured	68,160	55,450	41,523	54,772
43	Gold ore and bullion[1]	34,203,560	37,238,149	23,499,557	35,740,111
44	Hones and whetstones	59,617	51,333	40,128	30,916
45	Iridium	22,470	6,072	5,053	6,561
46	Iron ore, ores including manganiferous iron ore; also dross or residuum from burnt pyrites	2,333,123	1,131,765	1,497,713	403,298
47	Iron ore, basic slag	9,808	6,398	999	
48	Iron ore, all other ore				
49	Lead, lead-bearing ore of all kinds	224,416	247,627	167,937	185,872
50	Lead, base bullion	48,041	78,845	32,694	21,615
51	Lead contained in silver ore				
52	Lead contained in all other ore and dross				
53	Magnesite, crude or calcined, not purified (purified for 1902)	312,645	281,901	330,102	158,267
54	Magnesite, or native mineral carbonate of magnesia				
55	Manganese, ore and oxide of	1,784,120	1,163,971	2,695,211	876,478
56	Manganese, oxide of				
57	Manganese ore				
58	Mica, unmanufactured or rough trimmed only	361,436	301,740	263,472	182,278
59	Mica				
60	Mica, cut or trimmed	42,769	30,619	32,783	40,481
61	Mica and mica waste				
	Mineral paints:				
62	Brown, Spanish, Indian red, and colcothar or oxide of iron	67,142	66,251	72,860	56,484
63	Brown, Spanish, Indian red, and colcothar or oxide of iron, and Vandyke Cassel earth or Cassel brown.				
64	Brown, Vandyke Cassel earth or Cassel brown	311			
	Ocher and ochery earths, not specially provided for—				
65	Crude, not powdered, washed, or pulverized	600	337	6,423	1,155
66	Powdered, washed, or pulverized	104,656	54,384	63,278	55,686
67	Ocher and ochery earths, dry				
	Sienna and sienna earths, not specially provided for—				
68	Crude, not powdered, washed, or pulverized	10,955	4,777	950	3,489
69	Powdered, washed, or pulverized	13,480	8,878	16,196	7,724
70	Sienna and sienna earths, dry				
	Umber and umber earths, not specially provided for—				
71	Crude, not powdered, washed, or pulverized	6,497	8,103	8,517	5,488
72	Powdered, washed, or pulverized	4,375	5,103	4,176	5,216
73	Umber and umber earths, dry				
74	Minerals, crude, or not advanced in condition by refining or grinding or other process of manufacture, not specially provided for.	112,886	78,715	57,439	62,421
75	Minerals, not dutiable, advanced in value or condition by refining or grinding or other process of manufacture, not specially provided for.	14,690	5,383	24,087	18,893
76	Mineral substances in a crude state, not specially provided for				

[1] Imports less foreign exports.

CONSUMPTION: 1889 TO 1902.

on Commerce and Navigation in the United States, year ending June 30.]

1898	1897	1896	1895	1894	1893	1892	1891	1890	1889	
$322	$17	$248	$9	$23	$6	$101	$199	$21	$116	1
8,753	6,898	21,313	16,718	12,309	7,971	10,284	8,053	4,946	13,735	2
301,516	191,361	231,427	289,959	156,988	251,894	320,279	308,498	249,989	209,245	3
227,562	.....	.....	.....	.....	240,996	388,361	251,137	190,555	88,489	4
22,677	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
7,005	46,255	71,750	46,255	25,684	70,525	84,875	40,860	.....	.....	6
34,157	395,554	259,350	266,951	203,883	.....	.....	.....	.....	.....	7
24,526	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
8,614	7,296	16,387	17,011	12,127	21,640	10,246	13,068	6,222	13,383	9
1,987	953	3,788	7,274	5,620	6,995	11,060	15,482	9,614	8,242	10
1,329	15,269	19,821	18,216	8,415	.....	.....	50,128	70,922	40,813	11
26	228	1,409	521	1,396	1,748	2,295	8,816	31,992	23,656	12
2,541	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	249	796	26,429	225	1,327	426	1,062	275	685	14
4,012	.....	.....	.....	.....	.....	.....	.....	.....	.....	15
27,714	171,101	104,951	87,255	.....	.....	.....	8,631	800	.....	16
.....	.....	.....	18,349	11,427	13,659	6	9,050	.....	.....	17
2,549,992	2,940,199	3,828,722	3,418,249	3,227,754	3,768,691	3,780,633	2,847,202	.....	.....	18
44,003	67,157	68,974	18,493	19,394	22,532	18,566	5,585	.....	.....	19
.....	.....	.....	.....	.....	.....	.....	1,123,303	2,171,450	1,459,876	20
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
196,441	169,492	178,774	84,799	34,357	54,698	126,074	56,982	8,190	50,665	22
546,244	484,446	569,263	405,657	369,950	399,474	347,368	232,699	160,420	104,776	23
58,771	56,454	50,803	31,961	39,909	58,416	58,510	38,621	.....	.....	24
87,140	78,105	114,991	114,401	89,924	157,084	118,708	164,518	139,658	161,579	25
23,191	54,539	63,087	60,423	63,826	76,451	52,808	47,346	36,321	55,370	26
194	.....	.....	.....	.....	.....	.....	.....	.....	.....	27
14,804	202,923	345,964	204,627	187,599	193,602	162,019	45,870	80,435	94,263	28
3,310,880	3,509,646	3,533,796	3,829,025	3,680,607	3,599,038	4,352,420	3,558,932	3,071,366	3,913,168	29
83,322	40,574	20,237	22,029	22,901	15,367	17,266	20,768	16,655	15,562	30
112,010	68,262	117,034	64,886	90,912	87,238	102,688	118,753	115,953	79,402	31
11,165	9,994	9,268	5,192	6,762	7,219	1,364	701	2	52	32
35,985	44,005	30,012	49,844	19,970	55,742	64,830	63,433	57,044	39,378	33
638,893	373,741	140,660	237,248	491,280	454,228	659,564	434,654	298,049	319,136	34
191,129	187,833	113,928	203,267	114,395	139,080	204,935	19,373	16,168	179	35
84,432	122,880	89,410	73,409	58,514	103,513	104,530	74,190	74,967	75,082	36
21,139	21,798	29,282	17,116	.....	.....	.....	.....	.....	.....	37
.....	.....	.....	1,758	15,796	26,522	20,104	26,645	16,233	21,625	38
150	36	.....	.....	.....	.....	.....	.....	.....	.....	39
3,555	15,206	6,561	3,648	1,751	3,033	3,685	1,338	1,771	120	40
20,260	23,083	.....	.....	.....	.....	.....	.....	.....	.....	41
48,715	48,732	.....	.....	.....	.....	.....	.....	.....	.....	42
31,286,488	15,364,615	15,518,657	13,156,673	15,043,919	4,001,100	11,559,487	2,265,763	2,454,588	1,760,171	43
37,910	20,667	35,973	20,841	25,496	28,662	39,862	34,112	33,953	29,688	44
3,071	7,225	1,313	328	968	1,356	2,753	333	402	2	45
466,254	778,117	1,217,314	372,861	.....	.....	.....	.....	.....	.....	46
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	47
.....	.....	.....	46,112	297,510	1,189,636	2,465,497	2,372,754	2,407,514	1,457,003	48
444,446	.....	.....	.....	.....	.....	.....	.....	.....	.....	49
29,199	.....	.....	.....	.....	.....	.....	.....	.....	.....	50
.....	503,143	680,374	608,705	539,822	1,190,462	1,318,816	1,023,133	.....	.....	51
.....	430	14,382	60,881	5,928	177	10,618	12,730	9,860	8,827	52
74,638	.....	.....	.....	.....	.....	.....	.....	.....	.....	53
.....	550	.....	3,498	2,338	10,792	7,953	6,004	4,447	6,499	54
883,716	803,167	567,487	545,326	.....	.....	.....	.....	.....	.....	55
.....	.....	.....	.....	11,954	20,677	8,181	7,858	7,931	6,942	56
.....	.....	.....	.....	523,686	1,147,472	367,173	620,814	134,340	72,012	57
52,180	.....	.....	.....	.....	.....	.....	.....	.....	.....	58
.....	213,373	194,890	169,156	84,430	214,680	170,865	21,750	.....	.....	59
54,721	.....	.....	.....	.....	.....	.....	.....	.....	.....	60
.....	.....	.....	.....	.....	.....	.....	110,094	161,740	93,143	61
50,457	.....	.....	316	65,671	141,615	142,648	103,158	80,868	78,322	62
.....	58,493	59,199	63,501	.....	.....	.....	.....	.....	.....	63
7	.....	.....	55	682	35	.....	424	425	1,590	64
2,598	.....	.....	.....	.....	.....	.....	.....	.....	.....	65
36,888	.....	.....	.....	.....	.....	.....	.....	.....	.....	66
5,567	77,483	63,808	54,421	37,123	71,236	70,939	72,144	54,359	58,074	67
8,029	.....	.....	.....	.....	.....	.....	.....	.....	.....	68
4,239	.....	.....	.....	.....	.....	.....	.....	.....	.....	69
1,738	19,096	12,681	8,181	24,883	20,538	23,761	22,523	24,069	30,390	70
4,126	.....	.....	.....	.....	.....	.....	.....	.....	.....	71
4,634	.....	.....	.....	.....	.....	.....	.....	.....	.....	72
1,163	12,875	9,759	10,078	9,404	15,494	12,550	14,556	11,952	13,545	73
87,064	57,765	88,313	88,437	43,620	62,591	98,289	47,958	51,950	45,599	74
7,658	1,580	1,066	4,308	608	138	1,331	23,965	93,780	89,988	75
.....	8,882	18,691	26,686	28,484	52,833	33,436	42,038	14,720	12,802	76

TABLE 75.—IMPORTS FOR

	MINERAL.	1902	1901	1900	1899
77	Monazite sand or thorite	12			
78	Natural gas	38,964	100,989	131,065	119,430
79	Nickel ore and nickel matte	1,426,083	1,337,597	1,070,980	1,183,924
80	Nickel and nickel matte containing not more than 2 per cent of copper				
81	Nickel in ore, matte, or other crude form, not ready for consumption in the arts				
82	Petroleum, crude	175	17	1,400	82
83	Phosphates, crude	112,461	152,780	86,763	104,747
84	Platinum, unmanufactured	147,926	185,370	196,883	242,321
85	Platinum ore				
86	Plaster rock or gypsum, crude	260,928	213,317	242,643	192,180
87	Plaster rock or gypsum, ground or calcined	19,620	15,606	22,387	13,812
88	Plaster of Paris or gypsum; plaster of Paris and sulphate of lime, unground				
89	Plaster rock or gypsum, calcined				
90	Plaster rock or gypsum, ground				
91	Plumbago	963,356	930,002	2,346,587	1,081,871
92	Pumice stone, unmanufactured	19,803	28,618	27,552	29,530
93	Pumice and pumice stones				
94	Quicksilver	686	899	296	51
95	Rock crystal, manufactures of, not elsewhere specified	9,039	3,734	14,003	26
96	Rotten stone and tripoli	30,534	24,556	9,541	24,495
97	Silver ore and bullion [1]	23,980,977	30,780,697	30,526,668	25,129,142
	Stone:				
98	Ballast	12	12,080	2,197	330
99	Breccia in blocks or slabs	317	816		3,939
100	Curling stones or quoits and curling stone handles	1,116	2,536	1,453	1,020
101	Buhrstones in blocks, rough or unmanufactured	26,368	38,515	21,687	19,968
102	Buhrstones, manufactured or bound up into millstones	1,208	943	635	580
103	Buhrstones in blocks, rough or manufactured or bound up into millstones				
104	Cliff stone, unmanufactured	21,672	50,066	15,745	14,147
105	Flints and flint stones, unground	59,650	64,697	40,475	27,766
106	Flint, flints, and ground flint stones				
	Freestone granite, sandstone, limestone, etc., except marble and onyx, not specially provided for—				
107	Hewn, dressed, or polished	38,911	22,163	111,227	107,248
108	Unmanufactured or undressed	12,616	12,628	16,641	19,270
109	Granite, unmanufactured or undressed	6,523	2,059		
110	Granite, hewn, dressed, or polished	87,792	100,542		
111	Grindstones, finished or unfinished	80,061	90,585	84,930	70,291
112	Lime	92,152	65,413	62,566	58,155
113	Limestone				
114	Lithographic stones not engraved	136,681	123,499	81,441	76,690
115	Marble and onyx, and manufactures of	1,264,866	991,037	778,478	683,435
116	Polishing stones				
117	Polishing and burnishing stones				
118	Slate roofing		3		
119	Slates, slate chimney pieces, mantels, slabs for tables, and all other manufactures of slate	4,817	6,467	6,998	4,625
120	All other manufactures of stone, not otherwise provided for		258	13	110
121	Sulphur ore, as pyrites or sulphuret of iron, natural, containing in excess of 25 per cent of sulphur.	1,571,577	1,184,899	1,207,661	1,064,096
122	Sulphur or brimstone, crude, in bulk	3,582,920	2,875,115	2,702,282	2,382,681
123	Talc, ground, powdered, or prepared	35,957	7,574	760	6,992
124	Talc				
125	Tungsten and ferrochrome	12,014	11,594	14,374	47,708
126	Uranium, oxide and salts of	12,904	15,573	7,496	6,545
127	Wolfram ore				

[1] Imports less foreign exports.

CONSUMPTION: 1889 TO 1902—Continued.

1898	1897	1896	1895	1894	1893	1892	1891	1890	1889	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	77
90,264	84,812	91,007	79,087	66,528	92,199	69,082	.....	.....	.....	78
956,059	537,128	612,755	555,717	397,816	.....	.....	.....	.....	.....	79
.....	.....	.....	.....	.....	280,712	161,891	68,659	.....	.....	80
.....	.....	.....	.....	.....	.....	.....	.....	11,687	.....	81
.....	.....	.....	.....	20	.....	.....	214	.....	272	82
62,598	79,875	163,370	159,169	123,714	130,696	192,733	287,057	309,764	333,957	83
144,313	92,619	70,108	189,028	.....	.....	.....	.....	702,093	548,350	84
.....	.....	.....	.....	.....	.....	.....	.....	5,250	16,367	85
171,745	.....	.....	.....	.....	.....	.....	.....	.....	.....	86
21,303	.....	.....	.....	.....	.....	.....	26,191	49,395	29,972	87
23,269	187,926	222,188	182,315	171,915	208,779	211,225	176,588	180,357	185,236	88
2,089	18,099	23,425	14,666	10,718	25,276	22,554	7,185	.....	.....	89
100	119	97	2,669	8,196	44,618	66,861	58,433	.....	.....	90
472,401	321,355	384,504	208,935	410,819	866,309	726,648	509,719	573,561	248,998	91
16,821	.....	.....	.....	.....	.....	.....	.....	.....	.....	92
3,078	66,037	59,894	47,995	43,788	54,795	52,065	52,414	55,411	57,082	93
9,978	10,293	45	7,014	6,278	38,100	57,870	254,837	298,698	98,506	94
1,202	.....	.....	.....	.....	.....	.....	.....	.....	.....	95
9,886	14,856	6,324	6,053	8,988	15,006	13,041	8,449	7,836	6,660	96
23,163,235	23,550,399	20,126,314	13,915,181	9,728,815	15,674,689	14,838,584	15,051,305	14,802,697	12,318,537	97
.....	827	3,332	5,287	2,776	3,892	6,345	4,223	4,492	2,569	98
878	472	.....	.....	.....	975	583	625	1,189	.....	99
1,222	2,273	981	565	447	1,585	1,332	1,055	2,781	1,184	100
24,008	.....	.....	.....	.....	36,483	25,733	26,459	41,951	85,097	101
1,338	.....	.....	302	827	636	294	639	715	325	102
.....	23,570	28,862	18,048	20,314	.....	.....	.....	.....	.....	103
18,884	26,685	33,312	10,745	17,212	16,687	20,860	16,010	16,067	26,195	104
11,486	.....	16,755	.....	.....	.....	.....	.....	.....	.....	105
.....	10,707	.....	9,456	6,807	9,570	10,247	3,886	4,660	3,322	106
165,148	235,049	320,433	292,382	369,040	439,148	355,251	390,463	314,661	249,071	107
14,088	29,633	21,333	32,454	39,694	47,131	52,882	76,514	115,377	75,095	108
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	109
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	110
53,578	54,494	62,979	50,659	50,671	66,656	63,084	56,402	51,921	52,642	111
60,879	56,385	76,302	90,293	87,513	114,418	115,359	167,729	134,259	110,228	112
.....	.....	.....	.....	6	169	54	.....	749	932	113
51,730	68,505	96,675	95,902	55,295	123,776	100,359	106,652	89,873	93,612	114
626,715	903,269	932,760	861,970	711,290	1,178,403	910,839	822,210	763,705	572,613	115
.....	.....	.....	.....	.....	6,379	5,830	8,879	4,018	4,184	116
185	.....	3,812	6,631	5,196	.....	.....	.....	.....	.....	117
58	72	224	.....	.....	.....	.....	.....	.....	.....	118
4,866	4,997	6,191	6,669	6,342	6,671	4,053	12,373	34,602	35,828	119
151	156	232	860	21	5,914	6,032	12,560	26,466	15,928	120
710,372	687,297	628,733	666,574	702,024	651,814	594,807	77,614	.....	.....	121
3,023,121	2,047,786	1,863,359	1,685,564	1,321,792	2,305,571	2,524,480	2,465,733	2,136,658	2,025,785	122
6,352	.....	.....	.....	.....	.....	.....	.....	.....	.....	123
.....	12,458	28,276	12,557	8,455	9,597	3,285	.....	32,553	6,213	124
71,271	17,765	14,111	.....	.....	.....	.....	.....	.....	.....	125
5,244	3,158	5,021	2,428	3,251	2,879	3,626	1,974	2,257	1,607	126
896	.....	.....	.....	.....	.....	.....	.....	.....	.....	127

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CHAPTER III.

ELECTRICITY IN MINING.

By Thomas Commerford Martin.

The mining industry to-day constitutes one of the most important fields for the application of electric current. There is hardly a country in the world and hardly any department of mining in which electrical appliances are not employed, and in many instances the installation and equipment are of a most extensive character. Indeed, the subject has become so important as to create a literature and a technology of its own, for many of the problems involved are such as do not arise in connection with other work. Hence a brief technical review of the situation can not but prove of interest, especially as the whole tendency of the time is to develop mining industries along electrical lines, and in fact to employ electricity continuously from the very first contact with the ore to the stage at which the finished product is ready for the market. It is proposed, however, to limit the present treatment of the subject to electric mining, as both electro-metallurgy and electro-chemistry are distinct fields of technical work, dealing with manufactured material rather than with the cruder and more primitive processes of winning the minerals from the soil. In its early stages electric lighting was applied to mine work, and this development was followed by the use of electric locomotives for traction as a substitute for human or brute power. Of late years the electric motor has been utilized for all classes of work—drilling, coal cutting, hoisting, pumping, ventilating, etc. The use of electric explosives has long been familiar to every miner, and more recently the telephone has become a familiar adjunct for purposes of intercommunication.

In the United States, as elsewhere, the introduction of electrical mining apparatus has been greatly stimulated of late years by the high degree of perfection attained in the art of power transmission. A great many mines and mining camps in regions where fuel was either very costly or difficult to obtain have been brought within the range of profitable working through the utilization of some distant waterpower. The single and polyphase alternating current, with its flexibility and high range of pressure, has made it possible to transmit power from water courses across valleys and over mountain ranges for scores of miles, so that to-day large areas, which but for the assistance of electricity would have remained neglected, because unavailable, are being worked. The profitableness of American mines and the sources of national wealth have thus been enormously increased.

The practical use of electricity involves a great many questions, of the nature of which some idea may be formed from the report recently issued in England by a departmental committee appointed by the British Home Secretary to consider and report on the subject. As the result of its investigation the committee laid down four general principles which, it considered, should govern the appointment of electrically equipped mines. These points may be summed up as follows:

1. The electric plant should always be treated as a source of potential danger.
2. The plant should be of thoroughly good quality and so designed as to insure immunity from danger by shock or fire, and periodical tests should be made to ascertain that this state of efficiency is being maintained.
3. All the electrical apparatus should be under the charge of a competent person.
4. All electrical apparatus which might be used where there was a possibility of danger arising from the presence of mine gas should be inclosed so as to prevent such gas from being fired by the sparking of the apparatus, and when any machine is working every precaution should be taken to detect the existence of danger, and on the presence of gas being noticed such machinery should be immediately stopped.

Some of these points seem obvious, yet they have frequently been disregarded. With regard to the first and second, the committee pointed out the fact that under the peculiar conditions existing in mines no absolutely safe limit of voltage or of pressure of current could be stated. The committee decided, however, on grounds already recognized in Germany that, provided all reasonable safeguards were adopted, a fairly high pressure had advantages, even from the point of view of safety, over a uniformly low pressure. The standard adopted by the board of trade as to voltage in consumption circuits is, therefore, 650 volts. Under certain conditions voltages as high as 3,000 volts are available for transmission purposes.

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As to the working of electric coal cutting machinery in places subject to fire damp, the committee decided, largely as a result of experiments made, that it was necessary to inclose the entire motor in a flame-tight cover. The committee adopted the view that all permitted explosives should be fired by electricity, and that the armored sheath or covering of all protected cable should be connected to "earth"—i. e., grounded.

Table 1 shows the number of mines in the United States reported as owning or renting electric power in 1902, together with the horsepower reported, for each group of minerals.

TABLE 1.—*Electric power, by minerals: 1902.*

MINERAL.	TOTAL.		OWNED.		RENTED.	
	Number of mines reporting.	Horsepower.	Number of mines reporting.	Horsepower.	Number of mines reporting.	Horsepower.
All minerals	802	154,050	688	130,494	131	23,556
Asphaltum and bituminous rock	1	25	1	25	.....	.....
Bauxite	2	64	2	64	.....	.....
Borax	1	1	1	1	.....	.....
Cement	31	20,862	26	17,420	5	3,442
Coal, anthracite	17	5,755	17	5,755	.....	.....
Coal, bituminous	309	68,139	301	65,972	18	2,167
Copper ore	35	4,648	22	2,312	13	2,336
Fluorspar	1	25	1	25	.....	.....
Gold and silver	292	46,472	224	32,003	71	14,469
Graphite	1	10	.....	.....	1	10
Gypsum	3	68	3	68	.....	.....
Infusorial earth, tripoli, and pumice	1	5	1	5	.....	.....
Iron ore	9	937	9	937	.....	.....
Lead and zinc ore	13	1,482	13	1,475	1	7
Limestones and dolomites	21	871	19	769	3	102
Marble	7	2,220	7	2,220	.....	.....
Mica	1	16	1	16	.....	.....
Natural gas	4	275	4	50	1	225
Petroleum	7	150	4	25	3	125
Phosphate rock	3	500	3	500	.....	.....
Quicksilver	1	15	1	15	.....	.....
Sandstones and quartzites	5	67	5	60	1	7
Siliceous crystalline rocks	27	913	18	442	9	471
Slate	7	225	2	30	5	195
Sulphur and pyrite	2	80	2	80	.....	.....
Talc and soapstone	1	225	1	225	.....	.....

It will be seen from this table that the number of mines reporting electric power was 802, with a total of 154,050 horsepower. By far the larger proportion of these—namely, 688, with a total of 130,494 horsepower—operated their own plants. There were 131 mines, with a total of 23,556 horsepower, which rented power, but of these mines 17 owned power also. It will be gathered from these figures that the 130,494 horsepower, even if it represents the total current-generating capacity, shows a considerable application of electric power; but it should probably be doubled in order to ascertain the capacity of motors installed and using such current. It is a fact well known in electrical plants that motor capacity far beyond the actual current capacity of the generating plant can be installed, for the reason that the consumption of current is variable and intermittent, it being highly improbable that all the consuming apparatus will take full current from the lines at the same time. It is assumable, however, although the fact is not brought out at all in the table, that in a great many instances these plants furnish also considerable current for lighting purposes. With regard to the rented power, it is probable that it is employed almost altogether to drive motors, a very small proportion of it representing electric lighting. Mines in which the operations are so small as not to necessitate the installation of a separate plant are, it is assumed, operated largely by single shifts or during daylight hours; so that while some lighting would be needed, the consumption of current would be quite small in proportion to the consumption for hoists, pumps, and other motor-driven mechanism.

It will be noted that four-fifths of the electric power reported was concentrated in three industries—coal mining, cement working, and the gold and silver industry. By far the largest item is that of bituminous coal mining, such mines, numbering 309, reporting electric power with a total of 68,139 horsepower; and these figures must be supplemented by those for anthracite coal mining, with 17 plants, reporting 5,755 horsepower. It will be seen that those two groups alone represent nearly one-half of the total horsepower. The figures for gold and silver are combined, and the table shows 292 plants reporting, with a total of 46,472 horsepower. The other category is that of cement mining. There were 31 cement mines reporting electric power, with a total of 20,862 horsepower.

It will be observed that these various mines differ considerably as to the magnitude of installation. In the gold and silver mines the plants have an average capacity of about 160 horsepower; in the coal mines the average capacity is 227 horsepower; in the cement mine works the average capacity is greater than for any other kind of mines—about 675 horsepower. The other items in the table, while interesting, do not call for any particular comment.

Power generation and transmission.—Electric current for mining purposes is usually obtained in one of two ways, depending somewhat upon the nature of the mine in the first place, and secondly upon the environment. In coal mining regions it is natural that each mine should draw upon its own fuel resources for power, the plant being stationed at the pit mouth; but even in such cases, where there is a group of mines it is sometimes found convenient to concentrate the power-generating apparatus, transmitting the current to a distance. This has been done in an even more comprehensive way in western mining fields, one steam plant which utilizes coal delivering its energy to mines no less than 26 miles distant, in districts where waterpower is not available. Where the generating plant is at the mouth of the mine it is customary to employ apparatus producing low tension direct current; but where longer distances are involved the alternating current has been resorted to, in the same manner as in central electric lighting and railway plants. The current is generated at high potential by polyphase dynamos and transmitted to substa-

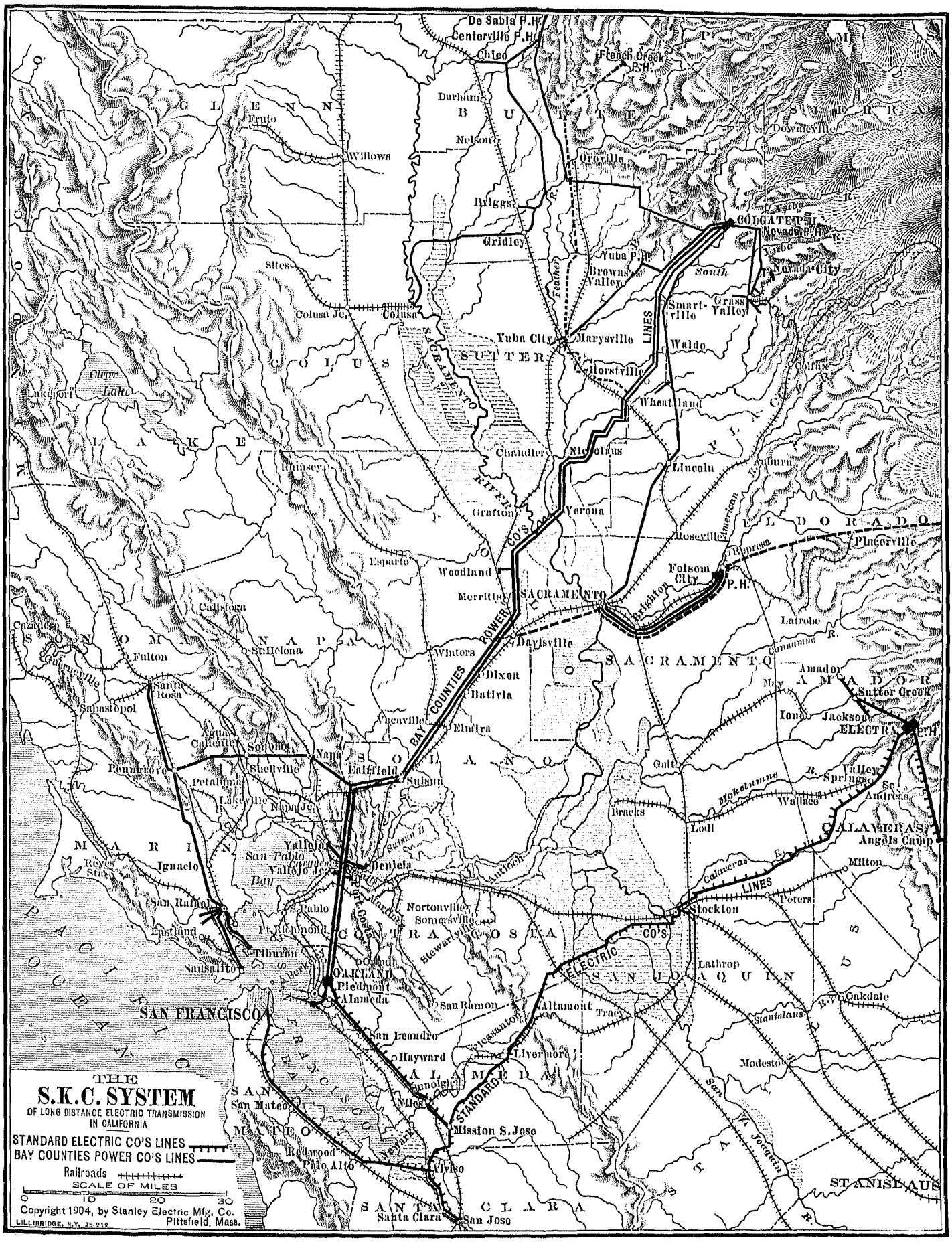

PLATE I.—LONG DISTANCE ELECTRIC TRANSMISSION IN CALIFORNIA.

tions, where it is lowered in pressure and converted into direct current for use.

One of the first plants of this kind for a mine haulage system was installed at Ehrenfeld, Pa. The haulage in this mine was accomplished by rope driving and mules until the main heading, which should eventually extend 5 miles underground, was nearly 2 miles long. This method was then replaced by an electric system embodying the generation of a 3-phase, 25-cycle, 5,600-volt alternating current near the pit mouth. This current is transmitted by insulated cables to a substation in the mine itself, near the center of the actual operations and about 9,000 feet from the power house. Through the intervention of static transformers and a rotary converter, direct current at 275 volts is then delivered to the haulage circuits.

In the Tug River field, near Welch, W. Va., is another plant of the same kind by which three mines are operated, alternating current induction motors being employed for driving coal crushers and conveyors and direct current for the other mine operations.

An interesting variation of this plan is that embodied in the plant constructed for the Raton Coal and Coke Company, at Blossburg, N. Mex. When built, in 1897, the coke plant included some seventy-five 3-foot ovens, in double banks. In the center was erected a large battery of boilers, to which the waste gases from the coal are conducted through central flues; the gas thus made available is employed to drive gas engines and dynamos furnishing power for the hauling plant both inside and outside of the mine. About a mile and a half from the coke ovens is situated the washing and crushing plant, with a capacity of 800 tons in ten hours. All the machinery from tipple to mine opening is driven by electric motors, a trolley line with electric locomotives bringing the pit cars from the main entry to the tipple. This idea of the utilization of waste gas in coke fields and blast furnaces has of late occupied considerable thought and attention on the part of mechanical and mining engineers, and important developments are resulting from the employment of electricity as a means of lessening waste.

In most mining districts, however, the work is intermittent, machinery is widely scattered in places difficult of access, fuel is expensive, and the economical use of steam is not possible. Compressed air, as a means of transmitting power, is handicapped by loss in the compressor and the piping, and is limited to short distances and to the operation of apparatus requiring power regardless of cost. In this connection, reference may be made to the tests reported by Mr. Lewis Searing, in 1896, with electricity and compressed air, in a mine situated at Rouse, Colo., at an altitude of 6,000 feet. The actual results obtained with the two plants show that the work of pumping, which in the case of compressed air required 312 horsepower and 8 boilers, could be done by electricity with but 56 horsepower and 1 boiler. This, of course, is an extreme case, but it indicates the difficulties attendant upon the use of compressed air at such altitudes.

Under the modern conditions of power transmission from waterfalls, etc., electricity has shown itself to be largely independent of distances, so that, as was pointed out by Mr. F. O. Blackwell, before the American Institute of Mining Engineers, in February, 1903, a given amount of power can be delivered either 528 feet away, at 100 volts, or 50 miles away at 50,000 volts, with the same total amount of copper per horsepower and exactly the same loss of power in the transmission circuit. With proper choice of potential and system, this loss need not exceed 10 per cent, even when the current is carried as far as 150 miles.

So much has been done in the matter of power transmission for mining purposes that it is difficult to pick out any specific case as thoroughly typical. But it would be hard to find an instance more notable than that of the Standard and Bay Counties Power Companies, in California. These, consolidating other systems, have a remarkable network of circuits of which one of the largest begins at Colgate, in the foothills of the Sierras, on the North Yuba river, a second at Folsom City, a third at Electra, and a fourth at De Sabla. From Colgate to Oakland, where the Bay Counties Company's line ends, is a distance of 152 miles; from Oakland to San Francisco, by the Standard Company's line, is 70 miles. The tying in at Oakland thus gives a transmission circuit of 232 miles from the latest plant at De Sabla, beyond Colgate, around San Francisco bay and through San Jose to San Francisco. Over the network thus represented, which embraces no fewer than 16 counties, within whose borders lie one-half of the population and three-fourths of the total assessed valuation of property of the state, several thousand horsepower is delivered daily. Alternating current is distributed to substations at pressures of 40,000 to 60,000 volts, and there manipulated and rectified for delivery to establishments engaged in a variety of industries, including a large number of mining plants.

The Bay Counties system is in fact an outcome of earlier mining enterprises, one of which was undertaken for Nevada county to supply the mines there with power. In like manner the Standard system is an outgrowth of work started thirty years ago by the Blue Lakes Water Company, when a ditch system considerably more than 80 miles in length was constructed for the purpose of furnishing water to the mines in Amador county. For a long period this company was very prosperous, but with the decline of mining in that section of the mother lode and the complete abandonment of hydraulic mining the property became much less profitable. At this stage it was taken up again by Prince Poniatowski, to be developed for the purpose of distributing electric power to mines and thus lessening the cost of their operation.

The plant at Colgate had an initial equipment of 15,000 horsepower in 3-phase alternating-current dynamos, situated in a power house at the foot of a hill 1,500 feet high. Water for driving the turbines is brought to this plant through a timber flume over 7 miles long draining 500 miles of watershed, and with a capacity of 33,000 cubic feet of water per minute. This water, received in the reservoir near the crest of the hill, falls with 700-foot head upon the turbines under a pressure of 304 pounds per square inch. The current from the generators is delivered at a pressure of 2,400 volts to step-up transformers, which put it on the circuit at a pressure of 40,000 to 60,000 volts. These transmission circuits, each of three wires, are carried on lofty poles of Oregon cedar and are in duplicate, one set consisting of hard-drawn copper wire and the other of aluminum. At the Karquines straits the circuit crosses in one span of 4,448 feet of sagging steel cable 200 feet above tide water and held up by enormous steel lattice towers. The system has in operation about 700 miles of line at 50,000 volts, 70 miles at 40,000, and a great many miles at 23,000, 16,000, 10,000, and 5,000 volts. It is stated with regard to the efficiency of the transmission that 1,000 horsepower at the Colgate water wheels nets roughly about 750 available horsepower in San Francisco, 222 miles away, the loss being 6 per cent in the generators, 2 per cent in the step-up transformers, 2 per cent in the step-down transformers, and 15 per cent in line losses, etc. This does not represent the general efficiency of the whole system, because there are a great many branches and tap circuits, to mines, etc., but it is understood that the results attained by the system as a whole are such as to have stimulated the construction of similar plants, one of which has been erected for mining purposes, with American apparatus, at the Cauvery Falls, Madras, India. Such a plant as this is a sufficient exemplification of the possibilities involved in electrical power transmission for mining purposes, utilizing the energy of falling water.

Such transmission will again be referred to incidentally in connection with certain utilizations, but before closing this section reference should be made to the important work undertaken for electric power distribution from coal mines in England and Wales, a country with cheap coal but very little available water-power. Since 1901 there have been established a number of plants and companies for long distance transmission, based upon coal mining and intended largely for mining purposes. In fact, one of these, at Newcastle-upon-Tyne, covering a strip of territory in the vicinity of the Tyne river, began on a small scale in 1898; it was greatly enlarged in 1902. One in southern Wales covers the coal and iron field of that section. One in Lancashire covers the coal field of that county, extending on the west to the Irish sea. One in the county of Durham covers 250 square miles of coal territory, extending to the North sea. One in adjacent territory, including the Cleveland iron field in Yorkshire, covers an area of 820 square miles, while one in southern Yorkshire covers 1,800 square miles. One in the counties of Leicestershire and Warwickshire covers 1,699 square miles, while one in the county of Cornwall, particularly designed to revive the decaying mining industries of that famous old tin region, covers 1,356 square miles. Another system in Derbyshire and Nottinghamshire deals with an area of 1,500 square miles.

A few details may be given as illustrative of the extensiveness of the English enterprises, some of which are now actually in operation. Within the area of Derbyshire and Nottinghamshire—containing some of the largest coal fields in the world—are electric power companies with a capital of about $9,000,000. There are within it 564 individual works of importance, of which 159 are coal pits, and no fewer than 400 firms, representing a capital of about $100,000,000, supported the enabling bill when passing through Parliament. It was proposed at first to have for this area four large generating stations, with a total capacity of 60,000 horsepower, but in 1903 the applications for power so far exceeded the estimates that it was even then proposed to enlarge at least two of the generating stations. While in the individual mines and mining enterprises the largest individual dynamo or engine unit is 200 horsepower, the smallest unit for this system is one of 3,000 horsepower. The numerous collieries in the region are counted upon as the principal customers for this supply of current, and, taking as a basis the fact that about 7 per cent of the coal mined is consumed in obtaining the 93 per cent sold, it is estimated that by the use of electricity in mines under these new conditions, in connection with the various purposes of hoisting, traction, pumping, ventilating, etc., 10,000,000 tons of coal can be saved annually. The operations of the power companies at Newcastle-upon-Tyne have shown that power can be delivered to large works in the vicinity at a rate slightly exceeding 2 cents per kilowatt-hour unit—that is, at a rate of about 1½ cents per horsepower per hour. Elsewhere in England and Wales the collieries themselves have demonstrated the efficiency of electric power transmission, as, for example, in the case of the Tredegar Iron and Coal Company, in Monmouthshire, Wales, whose plant is the largest of the kind for individual mining enterprise in England or Wales. Two 300-horsepower engines direct connected to 3-phase generators at one set of mines supply current over pole line transmission circuits at 2,000 volts to other mines about a mile and a quarter away. Both electric haulage and electric pumping are features of this installation, and at the time of the last report it was noted that, although these mines were peculiarly subject to fire damp, no accident of any kind had happened because of the special precautions taken to insure safety.

One installation which will serve to exemplify the latest general features of current transmission, as well as economical generation at the mine, is furnished by the central power plant of 2,000 horsepower installed by the coal mining department of the Delaware, Lackawanna and Western Railroad Company in Scranton, Pa., to supply current for drills, locomotives, hoists, pumps, lights, etc., in the Diamond, Hampton, Brisbin, Hyde Park, and Sloan mines. The alternating current is transmitted at a pressure of 2,300 volts, and reduced at substations at the various mines by step-down transformers and rotary converters to direct current, which is employed in the mines, supplemented by two alternating induction motors of 800 horsepower each in a water-hoisting shaft 600 feet from the power plant. The greatest distance to which power is transmitted is about 15,000 feet, to the Diamond mine, which takes about 175 horsepower. The current is furnished to some 14 electric locomotives in the various mines, ranging from 6½ to 13 tons, and to a 120-horsepower electric hoist. Added to the previous plant of the company the generating apparatus represents a capacity of about 5,000 horsepower, supplying current to 45 electric locomotives, 14 motor-driven pumps, 18 operative hoists, 14 motors in a breaker, and 1 electric drill, or a total of 6,820 horsepower in consumption capacity. It has been decided to increase the plant so as to transmit current 3 miles, to supply power for operating 25 direct-current motors at the Delaware, Lackawanna and Western locomotive repair shops, etc., 100 arc lamps for lighting freight yards, machine shops, etc., and 1,500 incandescent lights for a passenger station, freight office, and roundhouse. The most notable thing about this new plant is the fact that the additions to which special reference has been made employ the latest form of steam equipment in the shape of steam turbines instead of the more familiar reciprocating steam engine. These turbines, two of which were already installed at the time of the compilation of these notes, are each of 500 kilowatts, or about 675 horsepower capacity, and will carry 50 per cent overload for two hours, or 100 per cent overload momentarily, without injurious heating of the generator.

Coal cutting machinery.—Electric coal cutters constitute one of the largest classes of mining machinery employing electric current. The considerable increase during recent years in the proportion of machine mining as compared with that of pick mining is doubtless due to the adoption of these machines. According to the report of Mr. E. W. Parker on the production of coal, published by the United States Geological Survey, the number of coal mining machines in use in this country in 1898 was 2,622, but in 1902 it had increased to 5,418; all of these were employed in bituminous coal mines.[1] The increase during recent years is attested to also by the fact that while in 1891 the mining machines of the country produced slightly less than 7 per cent of the total product of bituminous coal, in 1902 they produced somewhat over 26 per cent.

The older form of machine is of the pick or puncher type run by compressed air, but of late years the chain form driven by electricity has rapidly come into use. Of the 5,418 machines in use in 1902, 58.8 per cent were of the compressed air or pick type, while the other 41.2 per cent were electric or chain machines. Of the 2,233 chain machines, almost all were of breast form, only 51 being of the long-wall style.

Some interesting details with regard to the introduction and utilization of electric coal cutting machinery were recently made public by Mr. S. B. Belden, who is connected with one of the largest concerns manufacturing such apparatus. Speaking of the first chain machines, designed by Mr. J. H. Jeffrey, Mr. Belden stated that their height precluded the possibility of operating them in thin coal, and that for several years no attempt was made to build a machine designed specially for such work. Even when the chain machine was an established success, it was a question whether a machine weighing more than a ton could be employed in coal ranging between 32 and 36 inches in thickness. But after these large machines had proved successful in thick veins they began to be used in lower coal until the minimum thickness of the vein had been reached.

Gradual evolution has produced a smaller and lighter machine, so that there is now in use one which has a height of only 18 inches, or, with the moving truck, of 28 inches, and a weight of only about 2,500 pounds. As this machine rests upon a wide flat shoe board it can easily be moved along the face of the coal by the operator and his helper. A brief description of the apparatus will be of interest. On an outside frame, consisting of two steel channel bars and two angle irons riveted to steel crossties, rests a sliding frame consisting of a heavy channel or center rail, to which is bolted the cutter head. The cutter head is made entirely of two milled steel plates, which bolt together, forming the front guide for the cutter chain. This chain, which is made of solid cast steel links connected by drop-forge straps, is carried around idlers or sprockets placed at each end of the cutter head and along the chain guides at the side to the rear of the machine, where it engages with and receives its power from a third sprocket, under the motor. The electric motor, which is of ironclad multipolar type, rests upon a steel carriage, which forms the bearing for the main shaft. The thin vein machine is equipped with a self-propelling truck, the motor which operates the machine being also geared to the truck axles. A reversing switch is provided, so that the truck can travel in either direction, and when the machine has reached its stopping point, either forward or backward, it is checked by an automatic cut-off. The return travel is made in about one-fourth of the time required to make the cut.

[1] United States Geological Survey, "Mineral Resources of the United States," 1902, pages 325 to 327.

Where the grades are heavy the truck is of advantage, and where the room lies to the dip it obviates the necessity of brushing down the roof for the entry of mules.

It is stated by Mr. Belden that many mines having only 28 to 30 inches of coal are being operated entirely with thin vein machines, and that a fair average for such machines is the cutting of at least 50 tons of coal per eight-hour shift. As nearly all of these machines are operated by two shifts, the output of a machine working in such a vein can be reckoned at 100 tons per day. Many small mines have a daily output of only 400 tons, and it is estimated that $10,000 will cover the necessary expenditure for an electric equipment of about 100 horsepower, affording sufficient power to keep four such machines in simultaneous operation, besides furnishing power for lights, pumping, ventilation, etc.

According to the schedule adopted in No. 8 vein of Ohio coal, the cost of pick mining in rooms is 90 cents per ton, while the cost of machine mining in rooms is 11 cents, with 52½ cents for loading after machines in rooms. This shows a saving through the substitution of machine mining for pick mining of 26½ cents per ton. A liberal allowance for operation and depreciation would leave a net saving of over 13 cents per ton, and the four machines should produce at least 75,000 tons per year. Numerous data received from various mining sections bearing upon the cost of operating such apparatus per ton of coal give figures ranging from one-tenth of 1 cent up to 2 cents, according to the hardness of the coal and the degree of care and skill observed in operating.

Discussing the subject in an admirable article on coal-cutting machinery, Mr. E. W. Parker expressed the opinion that the evolution of the chain machine was one of the most notable steps—and practically the final step—in the development of a successful mining machine. The speed with which the chain machine can do its work seems incredible. After the machine has been placed in position an average period of only five minutes is required to make a cut 44 inches wide, 4½ or 5 inches high, and 6 feet deep, and then withdraw the cutting frame. In fact, for one of these machines there is claimed a record of cutting 1,700 square feet in nine and one-half hours. This would mean that about seven and one-half minutes were required for each cut 44 inches wide and 6 feet deep, including the moving and setting of the machine. An average much lower than this would attest the efficiency and utility of the apparatus.

As to the advantages of the modern chain machine over the earlier forms of pick machine, the former bases its claims upon the rapidity with which the work is done, the very small amount of slack coal that is made in the cutting process, and the fact that the runner is not subjected to the wearisome racking of the pick machine. The advantages of the pick machine, which is driven by compressed air, and strikes about 190 to 210 blows per minute, are, first, that it can be used in mines where the narrow conditions of room and floor do not permit the introduction of chain breast machines; and, second, that in mines where the quantity of gas is so great that safety lamps have to be employed it obviates the dangers which might arise from sparking if a motor-driven machine were employed.

As already noted, several long-wall machines—driven sometimes by compressed air, but frequently by electric motors—are in use. As the name indicates, in long-wall mining the coal is extracted from a long face, which is gradually moved forward in widening, irregular circles. The nature of long-wall work is such that the face must be jagged or circular instead of straight and regular, as in room-and-pillar mining. One of the leading types of long-wall machines, involving to a certain extent the principle of the chain breast machine, consists of an endless chain operated along a narrow frame or arm extending from the side of the machine and so adjusted that it can be operated at any angle up to a right angle. A change in the angle of the cutting frame will increase or diminish the thrust on the track; in the same way the machine can be made to follow any irregularity of the face of the coal. The cutting frame can be extended over the right or left side, so that as the machine moves the cutting can be accomplished in both directions along the coal face. The height of the machine is only 18 inches, and its weight is only about 3,000 pounds, so that it can be operated in very thin veins. It has a wide range of cutting speed, and can be made to undercut to any practical depth. In going through narrow places and also in moving or changing the cutting bits, the cutting frame can be swung out behind the machine instead of from the side. Like the ordinary chain machine it is operated by two men, and is said to be as available for room-and-pillar work as for long-wall mining.

Shearing machines constitute another class of apparatus of this nature. They are built on the general plan of the chain undercutting machine. The cutter frame is located in a position normal to that of the undercutting, the shaft in the armature of the motor being parallel to the center rail. The best way of shearing a room or entry with such machinery is to make the first cut at the top of the vein, and then let the machine down far enough to make another cut. To provide for the secure and rigid support of the machinery the frame is clamped tightly to two columns, at points in line with the balancing position, and the front end is steadied by two auxiliary columns; the four columns vary in length according to the thickness of the vein worked. The capacity of the machine for cutting depends upon local conditions. With a standard type of this machine a single cut is 36 inches high, about 4 inches wide, and from 5 to 7 feet deep. From 50 to 100 feet of entry can be cut in a day of ten hours. Current for moving the machinery from one working

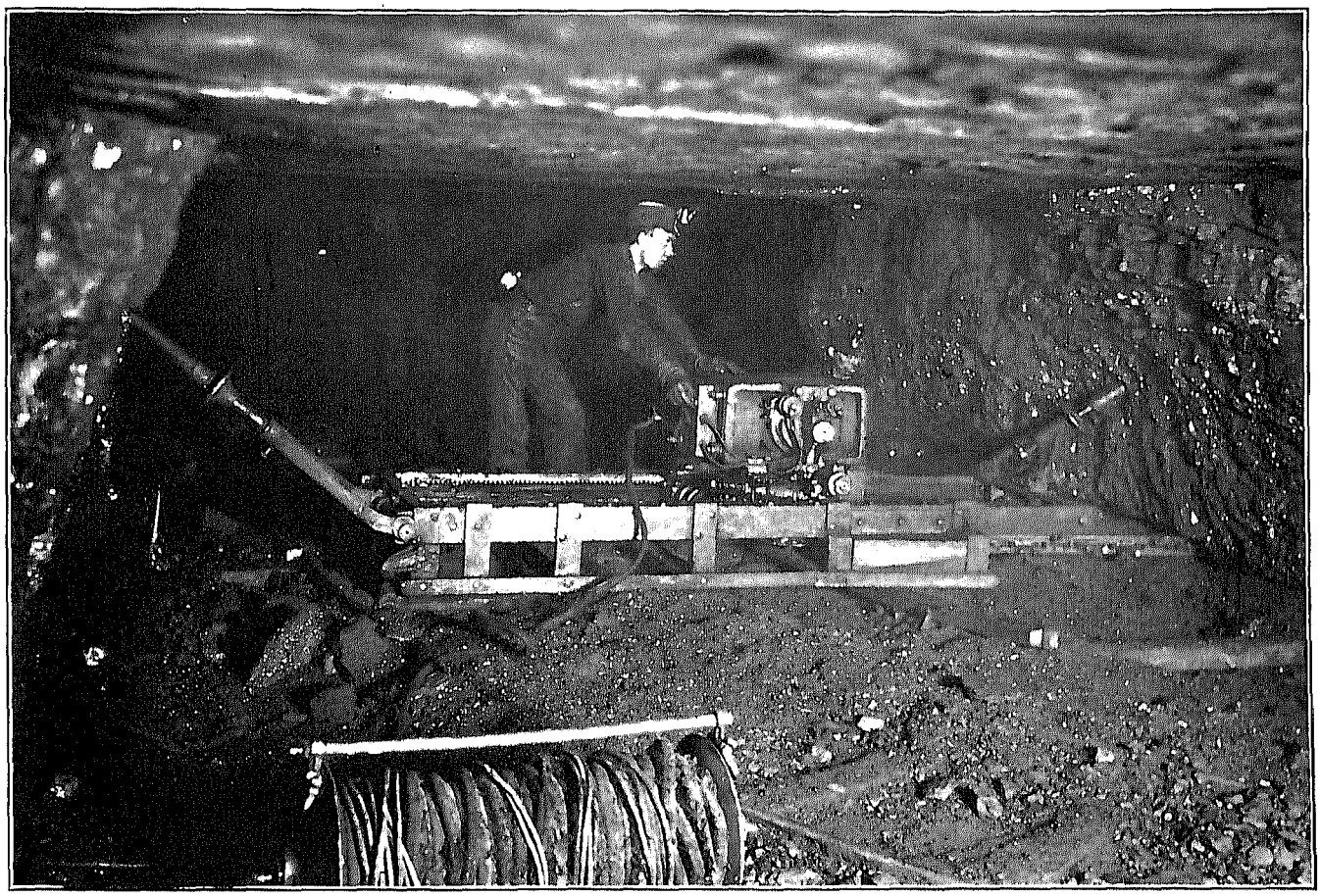

PLATE II.—ELECTRIC COAL CUTTER.

PLATE III.—ELECTRIC COAL CUTTER.

place to another can be taken from trolley wires, and the machine can be run up to the face of the entry, which can be sheared without removing the machine from its truck wheels.

Drills.—The application of electric drills to mining work has been the subject of considerable study and experimentation for many years past, but not until recently have these drills been successful. Drilling is one of the few classes of operation in which a reciprocating motion is preferable if not necessary. The air drill has a reciprocating motion; the electric drill, on the other hand, necessarily has a rotary motion, the effort to develop electric power practically by reciprocating motion having been abandoned at a very early stage in the development of the electric motor. Moreover, the air drill has shown itself very hardy and capable of withstanding unlimited rough usage; whereas the electric drill has usually proved to be a delicate and sensitive piece of mechanism, easily deranged and expensive to repair. On the other hand, the degree of efficiency of the air drill is relatively low, the electric motor being able apparently to do the same work with a consumption of about one-tenth of the power. Moreover, the electric drill does not sustain the further loss in efficiency to which an air compressing plant is subject at a high altitude, nor is it affected by a low temperature, which in an air compressing plant freezes up the exhaust.

A report has recently been made in some detail with regard to results obtained with electric rotary drills as compared with air drills in some potash mines in central Europe. For the electrical equipment current is distributed through the mine by armored cables fastened to the roof. The motor is furnished with a reversing arrangement, such that two wires of the cable can be interchanged; by this means the rotating field of the motor, and therefore the direction of rotation of the motor, is reversed. The motor has a starting resistance; it develops normally about 1 horsepower, but can be overloaded with 1.5 horsepower for a certain length of time. The connection between drill and motor is made by a flexible shaft. The weight of the drill proper, which is fastened between two screw columns, is 99 pounds. The feed has been varied from 4 to 20 inches in one minute.

From a comparison of the weights and initial costs of electric and of air drill outfits presented in the report referred to it appears that the former is considerably heavier and more expensive. The annual cost of maintenance, however, amounts to from $16.63 to $19 for the electric drill, and to $29.69 for the air drill. Moreover, in spite of its greater weight, the electric drill can be erected and dismounted just as quickly as the air drill, principally because of the easier adjustment of the screw columns. To support the air drill these have to be screwed up with considerable force and strengthened, while for the electric drill, which works quietly and without jarring, they do not have to be fixed so rigidly. The adjustment of the electric drill itself is easier than that of the air drill, and when the screw column is moved the electric drill is left fastened to it. Tables of practical tests are given, recording the depth of hole, net time of drilling, drill pauses, total time of drilling, total and net time for 1 meter, and the number of replaced drills. From these tables it appears that the electric system affords a considerable saving of power and time. The efficiency of both kinds of apparatus is calculated in detail from the generating station to the drill; it is stated that the total efficiency of the electric drill is 0.29, while that of the air drill is 0.0223, or about as 1 to 13.

In coal mining operations the use of electric rotary drills and augers is quite common, and appears to be thoroughly successful from the fact that the rotary motion of the motor armature can be fully availed of. These drills are used for boring holes into the coal for shooting it down after it has been undercut. Many admirable types of these drills are illustrated in the catalogues of the manufacturers and are in wide use. They are so arranged that they can be operated at almost any angle, vertically or horizontally. They are generally mounted on light upright stands, with screws at the ends for fastening to the roof and floor, but some of the larger drills are mounted on trucks, so that they can be transported readily from place to place. The motors, which often are very small and light, not much heavier than a good sized fan motor, are mounted with an adjustable clamp, and are geared for either single reduction or double reduction, for reducing the high speed of the armature to that which is suitable for the auger. The larger rotary drills of this class have been equipped with motors of from 4 to 6 horsepower, the power being transmitted from the motor to the drill by means of a telescopic shaft and machine-cut bevel gears. The telescopic shaft consists of a steel tube in which slide two solid shafts, each of which is fitted with a universal joint, and is fastened to the motor and to the drill machine by means of an automatic coupling.

A number of electric percussion drills, striking a percussive or hammer blow, are in use. They are of various sizes. In some of them the power is transmitted from the motor to the drill by a flexible shaft, which may be several feet in length. In one form, equipped with a self-contained motor, the hammer proper is operated by a pair of eccentrics on a shaft connected through simple gearing to the armature of the motor. The raising of the hammer is effected during a three-quarter revolution of the eccentric shaft, and the blow is struck during the remaining quarter. A very powerful hammer blow is thus secured, at the rate of about 400 to 500 blows per minute.

Shot firing.—The electric method of shot firing in mines has reached considerable development of late years, and is now in general use. As a result of its investigations, the British departmental committee,

already referred to, decided in favor of requiring electric shot firing in all pits to which the orders as to explosives in coal mines apply, and it is understood that in the majority of such pits this method has already been adopted. The order regulating the use of permitted explosives lays down the rule that the firing must be done with an efficient electrical apparatus, or by other means equally secured against the ignition of inflammable gas or coal dust.

There are two methods of electric blasting or shot firing—known as the high-tension and the low-tension—in ordinary use at the present time. In the high-tension method the explosion is caused by a spark which is made to jump between two points inside the detonator. The current for this spark is created by what is known as a magneto machine—an armature revolving rapidly in front of a set of permanent magnets, the whole mechanism being inclosed in a small box from which the handle attached to the armature extends. This box is portable and can be set down anywhere, and the wires from it can be carried a considerable distance. In the low-tension method there are employed similar magnetos of low tension, or chemical batteries. In this method the two wires which extend into the charge are connected, or bridged, at their ends within the priming with a short piece of fine platinum or similar wire. This wire offers considerable resistance to the passage of even a small current, so that it rapidly becomes heated to incandescence and thus ignites the priming, which in turn explodes the detonator charge.

The high-tension system is in very common use and can be seen in operation in almost any city where building foundations are being excavated in hard material. The low-tension system is quite popular in mines, however, the principal reason being, apparently, that the fuses are less subject to deterioration and can be stored more safely than high-tension fuses. They differ from the high-tension, spark-jump fuse also in that they can be tested by means of a battery and galvanometer in order to see if they are alive. The shots are fired either in series or in parallel; if the former, the current needs considerably higher tension in order to pass successfully through all the charges, but if in parallel a much lower tension is available, so that a battery of cells can be used.

The British departmental committee already mentioned pointed out two dangers to be apprehended from electric firing: First, the ignition of fire damp from a spark in the magneto machine or between the bare wires when in close proximity; and, second, the premature firing of the shot. To guard against the first danger, high-tension magnetos are inclosed—as has already been stated—in a flame-tight case and the fuses or detonating wires are connected up in such a way that there is no possibility of a spark passing from one wire to the other. Premature firing would appear to be the principal cause of almost all accidents, but in most instances carelessness is a contributory cause. It is difficult to see how the shot can be fired prematurely if the firing cable is first connected to the fuse wires and not attached to the firing apparatus until the shot firer is ready.

The British committee recommends that as an additional precaution the responsibilities be limited and the degree of safety increased by providing all magneto machines and cell batteries with removable handles, keys, or safety plugs, which should always remain in the custody of the shot firer. With regard to the use of batteries, it is urged that unless deterioration is carefully looked after they are of doubtful advantage for shot firing, because while their original cost is but a fraction of that of the magneto the cost of maintenance and of efficient working is much greater.

Mining traction.—The electric locomotive is one of the most striking examples of the application of electricity to mining, and its general use may be inferred from the report of the bureau of mines of Pennsylvania for 1902, which stated that there were 378 electric mining locomotives in use in the bituminous and anthracite regions of that state. Another fact bearing upon this subject is the statement in the Illinois coal report for 1901 that in 12 mines in that state over 2,000,000 tons of coal had been hauled by electricity during that year. These figures deal with haulage within mines, but it should be remembered that in many of the mining regions trolley roads are in use for handling ore, etc., which would correspond to freight roads, and for which no particular type of locomotive is necessary. It is believed that of locomotives built especially for such work about 3,000 are now in use in mines in the United States.

The first specifically electric mine locomotive employed in the United States was built nearly twenty years ago by Mr. W. M. Schlessinger for the Lykens Valley colliery of the Pennsylvania Railroad, and at last reports this machine was still in service. It weighed about 5 tons and was equipped with 32-horsepower electric motors, from which motion was imparted to the driving wheels by a chain and cog or sprocket connection. The conductor for supplying current to the locomotive consisted of a light T-rail carried on supports parallel to the track at a vertical height of about 5 feet and removed horizontally from the track rail about 20 inches. Current was conducted from this rail by means of three wheels pressed against it by a trolley arm, and the track rails were used as the return circuit. The ordinary train for this locomotive, which operated with a current of 450 volts and from 40 to 200 amperes, was 15 cars, each of which weighed 1 ton when empty and carried 2.35 tons of coal or 3 tons of rock. There were two haulage lines, one 9,500 feet long, in a drift, and one 10,400 feet long, in a tunnel.

Another early electric mine locomotive still in use is of 40-horsepower capacity and uses current at a pres-

PLATE IV.—ELECTRIC DRILL AT WORK IN A MINE.

sure of 220 volts, with a wheel gauge of only 36 inches. This machine is 5 feet 6 inches in height and weighs 10,500 pounds, with 1,800 pounds added to increase traction.

Some of the earliest work was done in Ohio, and after fifteen years of continuous service two of the first electric locomotives ever seen in a bituminous coal mine are still in use, hauling the output of a mine operated by the Upson Coal Mining Company, of Shawnee. It is interesting to note that this type of locomotive approximated street car practice, having a single motor with a double-reduction gear.

These locomotives, however, are examples of earlier practice in mounting the motors above the truck and gearing downward, thus requiring greater height than is now usual. Transition was soon made, however, to types of "terrapin-back" or "turtle-back" locomotives, bringing the motor much nearer to the ground, so that it could be coupled with the axles by means of connecting rods. In later types each axle of the locomotive has been connected with a separate and independent truck-mounted motor.

Modern mining locomotives range in size—according to the work they are designed to perform—anywhere from 2 to 20 tons, and their wheel gauges range from 18 inches to the standard railway gauge of 4 feet 8½ inches. The traction locomotive consists, broadly, of two iron frames within which are contained the motor and driving mechanism, the controller wheel being usually placed in front, vertically, within convenient reach of the motorman, who is seated; in some locomotives, however, the controller and hand wheel are placed on top of the locomotive, in a horizontal position. The motors are usually geared to the truck axles by means of cut steel gear wheels, and the traction wheels are shrunk and keyed upon the truck axles, being placed either inside or outside the locomotive frame. Electric headlights and mechanical brakes are used. The current is taken from an overhead copper trolley wire by a grooved brass trolley wheel, mounted on a short, stout trolley pole, and conveyed through the controller to the motors and back to the generators by means of the track rails, which are copper bonded, in order to insure a return circuit of thorough conductivity. A speed of from 6 to 10 miles per hour is usually made.

Because of the limited dimensions of ordinary mine entries and the light weight of rails, the 20-ton mining locomotive is about the largest that can be used to advantage. Greater hauling capacity is sometimes needed, however, and accordingly a double locomotive has been introduced, consisting of two standard 13-ton mining locomotives, one of which is provided with a 4-motor controller and a 4-motor commutating switch, so that the complete machine is operated from the one controller. Here again, mining practice harmonizes with that obtaining in electric railway work in the adoption of what is known as the "multiple-unit control," by means of which the control of motors over a whole train of vehicles can be brought to one point and there manipulated by one motorman, instead of being distributed, with each set under the control of a separate driver.

In an interesting paper, read before the Western Pennsylvania Central Mining Institute, in December, 1903, Mr. W. L. Affelder, superintendent of the Mosgrove coal works, in Pennsylvania, stated that a 10-ton 30-inch gauge "gondola" locomotive which had been in operation there for more than a year had never been idle a day on account of defect or accident. During that time it had hauled nearly 150,000 tons of coal, at a cost of less than one-tenth of a cent per ton for repairs. As many as 35 loaded cars, each weighing 3,700 pounds, are hauled by it up a grade of 3 per cent, 250 feet long. At a point in the mine where the grade is 4.5 per cent in favor of the load for 125 feet, and then 3 per cent for an equal distance, the locomotive holds back as many as 35 loaded cars with every car wheel running free.

Figures taken from various mines in the coal fields, and compiled by Mr. F. J. Platt, show a generally high degree of efficiency in electric haulage. At the Green Ridge colliery, Scranton, Pa., the cost of haulage by mule power was estimated at 7.15 cents per ton and the cost of electric haulage at 2.76 cents, showing a saving by electric haulage of 4.39 cents. At the Sturges shaft of the New York and Scranton Coal Company the cost for haulage by mule power was estimated at 6.58 cents per ton and the cost of electric haulage at 2.62 cents, showing a saving by electric haulage of 3.96 cents.

A special feature of electric haulage in mines is the use of "gathering" locomotives. In most coal mines the cars are gathered or collected from the working faces of the rooms by mules or horses, though in some low-veined mines where it is necessary to use very small cars they are pushed between the working faces and the "room necks" by the miners themselves. They are then collected by locomotives and hauled in trains to the tipple or shaft bottom. In many cases it has been difficult to enlarge the entries sufficiently to accommodate the mule, because of the cost of "brushing" the roof or "taking up the bottom," especially where a hard slate or rough limestone has to be dealt with. One means of obviating this difficulty has been found in the use of compressed air locomotives, but electricity has been found particularly suitable for this class of work. Locomotives used for this purpose are equipped with a reel which carries a flexible insulated cable. One end of this cable is connected to the trolley line, and the current is conveyed to the controller on the locomotive through a contact at the reel. The reel is geared up with the axles or truck of the locomotive, so that the cable can be paid out or coiled up. The gathering locomotive system can be pushed to a considerable distance

from the end of the regular trolley circuit. An illustration of this class of work is to be found in the mines of the Jones and Laughlin Steel Company, at California, Pa. These mines have five 4-ton gathering locomotives. A train of empty cars is taken from the gathering junction and distributed by the motorman into the various rooms in his particular section of the mine, and on the return trip the loaded cars are gathered up. When passing through the entry the locomotive receives its current by means of a regular trolley pole, but when entering the room neck the pole is fastened down and the insulated flexible cable is hooked onto the end of the trolley wire, the rail still serving as the return circuit. It is stated that a crew of two men on such a locomotive can gather up from 100 to 120 cars, or from 300 to 350 tons of coal, in an eight-hour shift. One well-known mine has equipped its gathering locomotives with a separate truck or tender for carrying and operating automatically the cable reel; this, however, is not the preferred practice.

In the case above referred to mining locomotives are spoken of as operating with overhead trolley connections. There are instances, however, in which the third-rail method has been applied to such work. This type of rail is used not only for the conveyance of the current, but always also as a tooth rail, with which a geared wheel on the locomotive can engage frictionally. According to Mr. Affelder, in his paper already referred to, 90 electric locomotives of this sprocket or cog rail type are now in use in coal mines. As a means of climbing grades the electric locomotive possesses advantages which have caused it to be adopted in various parts of the world, subject only to questions as to the advisability of using the cogged third rail also as a conductor for the current. The first of the third and traction rail locomotives of the sprocket type appears to have been installed in this country in 1899 in the Star City (Indiana) mine of the Harder and Hafer Company, of Chicago.

In metalliferous mines, as distinguished from coal mines, the locomotive is usually smaller. An instance of such work is to be found in the haulage system of the United Gold Mines Company, of Victor, Colo.—the Cripple Creek district—where one 8-ton locomotive with a drawbar pull of about 3,500 pounds and a speed of from 8 to 10 miles per hour is used. This locomotive is equipped with a single high speed motor, placed in the center and on top of the frame, the motor shaft being connected to the drivers by gears. Current for this locomotive is generated at a waterpower plant 12 miles distant by a 3-phase alternating-current dynamo, transmitted at a pressure of 13,000 volts, stepped down and rectified at a substation, and delivered to the trolley at 550 volts direct current.

It is, therefore, not to be understood that electric locomotives find their only employment in coal mines. An interesting illustration of the extensive application of the electric mine locomotive is to be found also in the Quincy copper mine, at Hancock, Mich. The Quincy company has installed 15 electric locomotives, one of which is on the 4,400-foot level, current being supplied from the surface through substation transformer plants located underground. Another instance which might be quoted is the 8-ton mine locomotive at the Highland Boy Gold Mining Company's mine, at Murray, Utah, employed for hauling slag cars, and using double overhead trolley, so as to dispense entirely with the track as a return circuit.

Thus far the subject of mine traction has been considered from the point of locomotives supplied by overhead or underrunning trolleys, or by third rail, with current from a distant source of supply. It is possible, however, to employ self-propelling or automobile locomotives, equipped with storage batteries, so as to dispense entirely with the dangers and inconvenience of tracks and wires charged with exposed live current. The weight of the battery and the space that it necessarily occupies, however, increase the size and weight of the locomotives, and thus place a restriction upon this method of traction in many mining operations. Their use is therefore more particularly to be noted in connection with exterior work, and locomotives used for such work have considerable haulage capacity.

Several types of this locomotive are in use, either as simple automobile locomotives or as a combination vehicle employing the trolley over sections of the track where such use is permissible and safe. One well-known American manufacturer builds a locomotive of this type in which the batteries are carried upon a separate truck or tender, thus reducing the height of the locomotive to a minimum. This locomotive can be used for "gathering" purposes in low-veined coal mines, but its hauling capacity is necessarily limited, and by some authorities it is not considered feasible. In another type the batteries are mounted on the locomotive and are so arranged that the cells can be charged while the motors are being driven by current directly from the trolley wire. A smaller size of automobile locomotive is especially adapted to run on curves with a radius of 12 feet and a 21½-inch gauge. The current is estimated to cost about 50 cents per day of ten hours for a locomotive weighing from 4 to 6 tons and up to $1.50 per day for a 16-ton standard gauge locomotive. As a rule, the batteries are not worked quite so hard as those for regular automobile purposes, the requirements per pound of lead, instead of about 7 watts, being not more than 2 or 3. The advantages claimed for the battery, as compared with the trolley system, are that it can be run over any improvised track of appropriate gauge regardless of wire connections; that the first cost of the battery is usually less than the outlay on trolley wires and supports, including erection; and that the expenses of maintenance with good batteries also average lower.

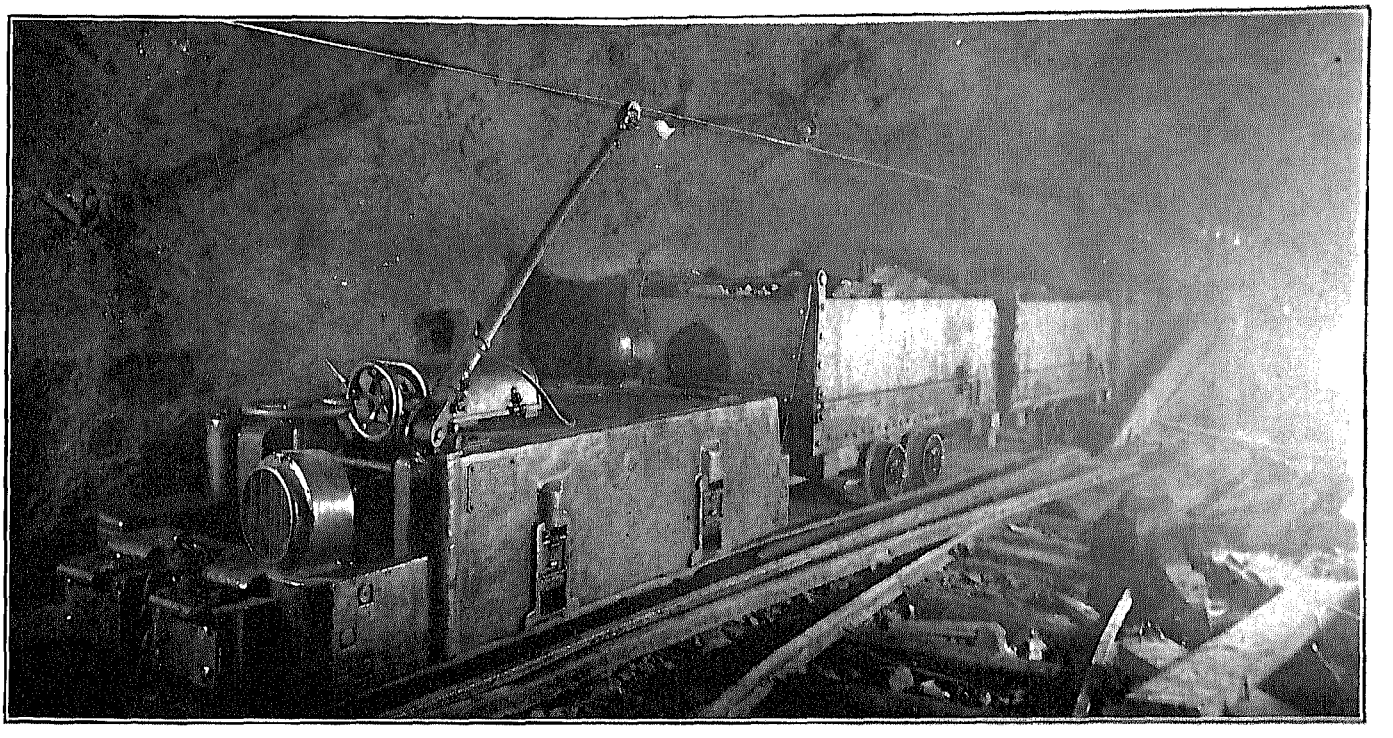

PLATE V.—TROLLEY ELECTRIC LOCOMOTIVE IN COAL MINE.

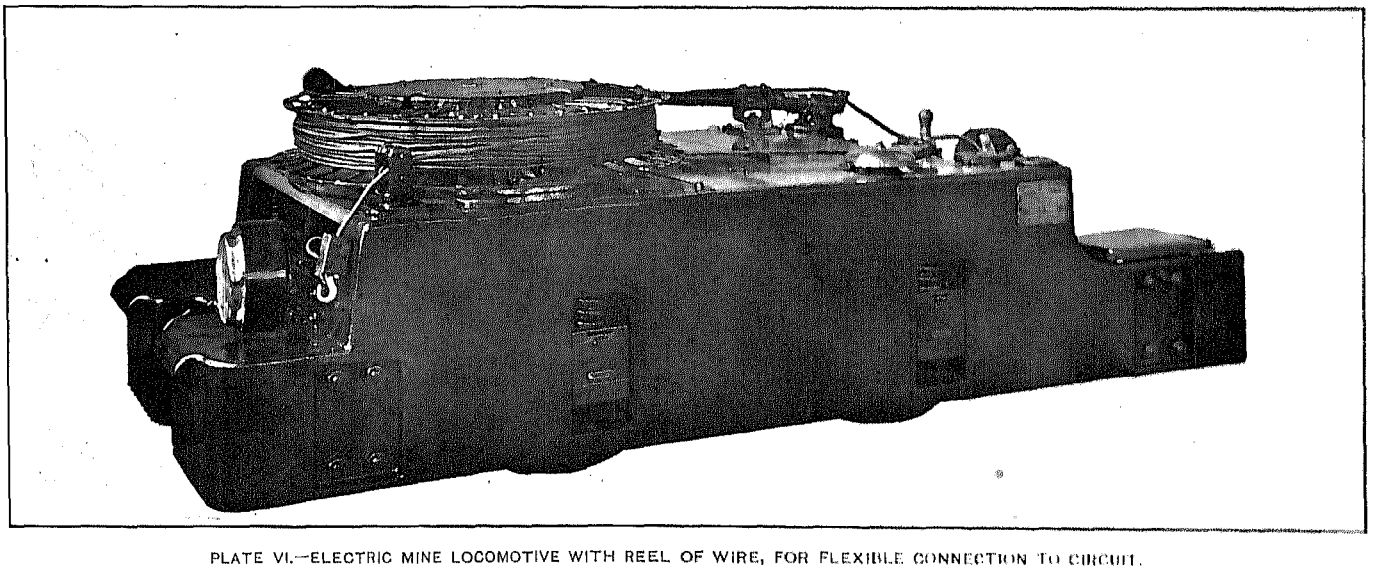

PLATE VI.—ELECTRIC MINE LOCOMOTIVE WITH REEL OF WIRE, FOR FLEXIBLE CONNECTION TO CIRCUIT.

PLATE VII.—TWO 250-VOLT ELECTRIC LOCOMOTIVES IN COAL MINES AT KINGSTON, PENNSYLVANIA.

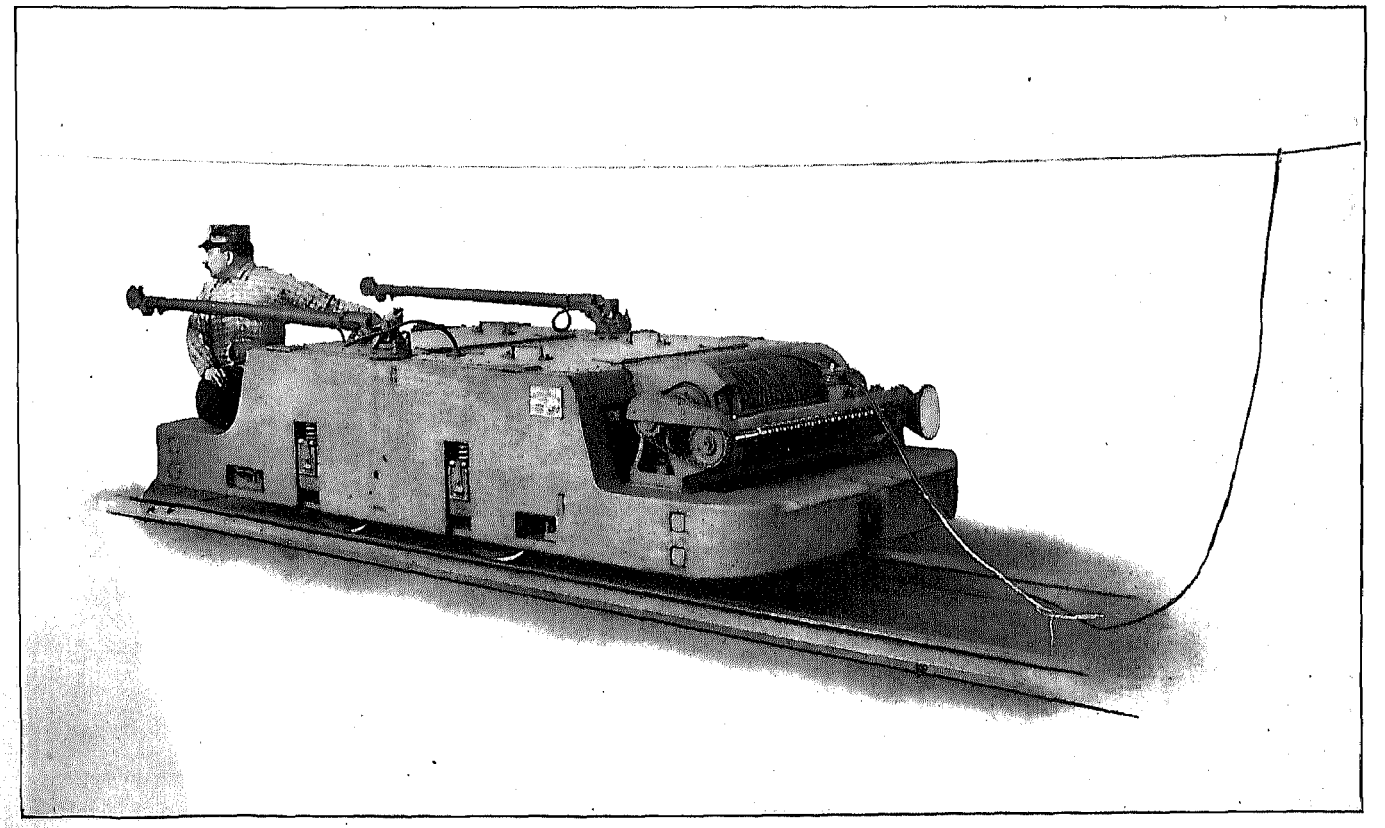

PLATE VIII.—ELECTRIC LOCOMOTIVE WITH REEL FOR AN EXTENSION CABLE.

A further modification of traction or haulage methods is found in the movable automatic loader used by the Illinois Steel Company. It is difficult to classify this apparatus, but it serves to move ore, and therefore belongs possibly as much in the transportation as in the loading group. The machine consists of an endless chain of metal arms or scoops mounted on a stout metal table or base, which in turn is mounted pivotally on a truck, to enable it to adjust itself to the pitch of the ground and to the height to which the material is to be elevated in loading—as, for example, to a line of the trolley mine cars. The chain of scoops, which is driven by an electric motor, passes around sprockets arranged at the opposite ends of the machine. The motor, which takes current through a cable reel from an adjacent trolley or other circuit, also propels the loader, moving it to any desired point by means of chain sprockets and suitable clutches. In operation the front edge of the table of the machine is lowered until it rests upon the ground, and it is then thrust forward against the pile of material. As the arms sweep around each arm or scoop gathers up a certain quantity of material and carries it into channels on the table until it reaches the upper end of the machine, when it is emptied into the desired receptacle. The arms travel at the rate of about 60 to 80 feet per minute, and the capacity of the machine is reported as 90 cubic feet of loose material per minute. This machine is said to have been tested successfully in the handling of limestone, coal, and salt, and to have shown a considerable saving of time and money over hand labor with a shovel.

Telpherage.—An interesting and novel application of electric traction methods is to be found in the modern telpherage system. Up to the present time haulage of ores and other raw material in connection with mining work has often been conducted aerially, by means of a traveling wire rope or cable; and this use of the wire rope represents, in the aggregate, an enormous amount of work. As generally understood, a short stretch of such work, often with a span of several hundred feet between the supports, or between the support and the anchorage, constitutes a "cableway;" in this manner a river or a wide valley is bridged. A "tramway" cable, on the other hand, has frequent supports, and may be several miles in length. Electric telpherage belongs generically in the latter class, as it is not suited to very steep grades.

The fundamental difference between electric telpherage and the traveling rope system is that in the former case all the ropes or cables are stationary, the haulage being effected by means of an electric motor or "telpher" traveling along one of the cables, and taking its current, by means of a short trolley pole, from a trolley wire above. In the simpler form the telpher travels along a flexible wire cable; for heavier work a rigid metal rail supported between posts is employed, and upon this loads up to 20,000 pounds in weight can be moved at a speed of from 800 to 1,500 feet per minute.

This telpherage method was first experimented with several years ago in England and America, but only within the last year or two has it been practically introduced in this country and abroad. Its present feasibility is due to improvements in motors which can stand exposure, in methods of control, in contact devices, in brackets, etc. In an electric telpher system employed in a limestone quarry in the island of Cuba, the telpher with its cars travels upon cables, except at eight curves, where solid rail is employed. The buckets, loaded with limestone and carried below the telpher, take along the cable a maximum load of 1,200 pounds, with a speed of from 12 to 15 miles per hour. Current is derived from a distant power plant, and to start the telpher all that is necessary is to close the switches at the ends of the system. This telpher travels automatically, but in the case of larger apparatus a cab is provided for a telpher man, as on an electric crane, so that he can travel with the load of coal, sulphur, phosphates, etc., and assist in loading and unloading.

Even where regular wire rope haulage, in the shape of cableways, tramways, and surface lines with rails is employed, it has been found feasible to replace with an electric motor the driving engine operating the drums of cable. A number of plants with electric cable haulage have been installed in South Africa, Japan, Europe, and other parts of the world, the hauling motor and cable drums being placed usually at the top of the incline, so as to raise the loaded cars. The speed in such work is usually from 4 to 6 feet per second on a grade of from 10 to 15 degrees.

Hoisting.—Electric hoisting is a growing feature of the use of electricity in mines, and a large amount of work has already been done in this field with the object of replacing the steam engine with the electric motor driven from a central plant. To quote a paper read by Mr. F. O. Blackwell before the American Institute of Mining Engineers, at Albany, in February, 1903, "The throttling of steam to control speed, the necessity for reversing the engine, the variation in steam pressure, the absence of condensing apparatus, the cooling and large clearance of cylinders, and the condensation and leakage of steam in pipes when doing no work are all against the steam hoisting engine. One of the largest hoisting engines in the world was recently tested and found to take 60 pounds of steam per indicated horsepower per hour. The electric motor, on the other hand, is ideal for intermittent work. It wastes absolutely no energy when at rest, there being no leakage or condensation. Its efficiency is high, from one-quarter load to twice full load." As a matter of fact this class of work touches closely that above referred to in connection with inclined traction haulage, for after all an elevator is virtually a railway with 100 per cent grade. With these equipments great care is

taken to regulate and control the apparatus for safety purposes with safety and emergency brakes, etc.

One of the instances cited by Mr. Blackwell in his paper is that of a flat rope double-reel hoist operating in the Free Silver mine, at Aspen, Colo. In this case the hoist works in a vertical single-compartment shaft, with guides for extra weight, and is driven by a direct-current motor of 120 horsepower at 650 revolutions per minute, with different gears to give 20 and 32 revolutions to the drum. The speed of hoisting ore is from 315 to 630 feet per minute, and that of bailing water from 510 to 1,020 feet per minute.

In one gold mine where steampower has been superseded by an alternating current induction motor, the hoist moves through the shaft at the rate of 1,250 feet per minute, double deck cages carrying 3,600 pounds of ore, thus elevating 500 tons daily from a 2,500-foot level. It is stated that this system has shown a net efficiency of 75 per cent, taking into account all electrical and frictional losses, and that the average cost per horsepower per month has been reduced from not less than $20 to $7.

Another illustration of an electric motor mine hoist is furnished by the plant installed in one of the pits of the Gelsenkirchener Bergwerks-Aktiengesellschaft, in Germany. This equipment is designed to raise in one lift, when working at its maximum capacity, a load of 4 tons of coal at a speed of 65 feet per second. The daily hoisting capacity in sixteen effective hoisting hours would be 2,700 tons with a single unloading platform, 3,200 tons with two platforms, and 4,000 tons with three platforms from a depth of 1,641 feet. The two cages are attached to an endless rope which at the top passes half around and fits into an oak-lined sheath on the circumference of a drum 20 feet in diameter. On each side of the winding is a direct current motor, the current supply of which includes a storage battery.

Another interesting hoisting equipment is that installed in the Fortschrittschacht-Brüx mine, Bohemia, where the hoisting engine is driven by a direct current motor of 80 horsepower, with two winding drums, which hoist from a depth of 969 feet at a speed of 787 feet per minute with a single layer of steel rope, the gross load being not quite 4 tons.

Still another instance is the hoisting engine driven by an alternating current induction motor of 120 horsepower, installed in the Germania colliery, in Westphalia, Germany. The winding drums are each 3 feet 8½ inches in diameter, revolving through double reduction gearing at the rate of 16 revolutions per minute. The motor, which develops 200 horsepower at the beginning of the hoist, winds a normal load of 1¾ tons from a depth of 1,500 feet at a speed of nearly 10 feet per second; the load can be increased to 3½ tons, however, with a corresponding decrease in speed.

A large hoist, with winding drums 19 feet 8 inches in diameter, erected for the Harpener Mining Company, at Dortmund, Germany, lifts 100 tons of coal per hour from a depth of 2,300 feet at a speed of 52½ feet per second.

Another interesting illustration is the plant recently constructed for the famous Comstock mine, at Virginia City, Nev. The power plant is situated on the Truckee river, 32 miles from the mine, and the present substation is located at Virginia City. Electric hoists are used extensively, the largest being of the balanced tail-rope system, driven by a 200-horsepower variable-speed alternating current induction motor.

Pumping.—Electric motors have been found extremely useful and successful in a large number of cases for driving the pumps which are employed to remove the accumulations of water in mines. It is said that the efficiency even of small reciprocating pumps is not far from 80 per cent, and that large pumps give as high as 90 per cent.

One of the problems encountered in connection with this application of electricity has been the proper regulation of the speed of the motors for the purpose of varying the amount of water pumped. In direct current motors this is done by varying the field strength; the electric pumps which have been in operation for ten years past in the Calumet and Hecla copper mines, in Michigan, have adjustments of speed of 2 to 1 under this system. When induction motors are used the windings are thrown into different combinations for various numbers of poles and rates of speed, and several frequencies, also, are provided for. Some alternating current motors employed in electric pumping operations are of noteworthy size, developing as much as 650 to 750 horsepower.

For electric pumping the pump itself need embody no special features. Both reciprocating and rotary pumps are used; they may be either horizontal or vertical, and reciprocating pumps may be of either piston or plunger type, according to the circumstances of the installation. Where a reciprocating engine is employed, however, it is generally considered advisable to use a double acting pump, either duplex or triplex. A triplex double acting pump does not require so large a motor as does a simplex acting pump doing the same duty. To raise a great quantity of water against a certain head takes just so much power; but if the work be divided among two or three acting cylinders there will necessarily be a more uniform flow of water, and hence the strain on the motor and the pump will be reduced.

No fewer than 50 electrically driven pumps of the reciprocating class are in operation in the mines around Johannesburg, South Africa, some of them delivering as much as 200 gallons per minute working against a 500-foot head. A striking illustration of electric pumping work is furnished by the Arniston colliery, near Edinburgh, Scotland. One set of pumps of the 3-throw type, with 11-inch rams and 18-inch stroke,

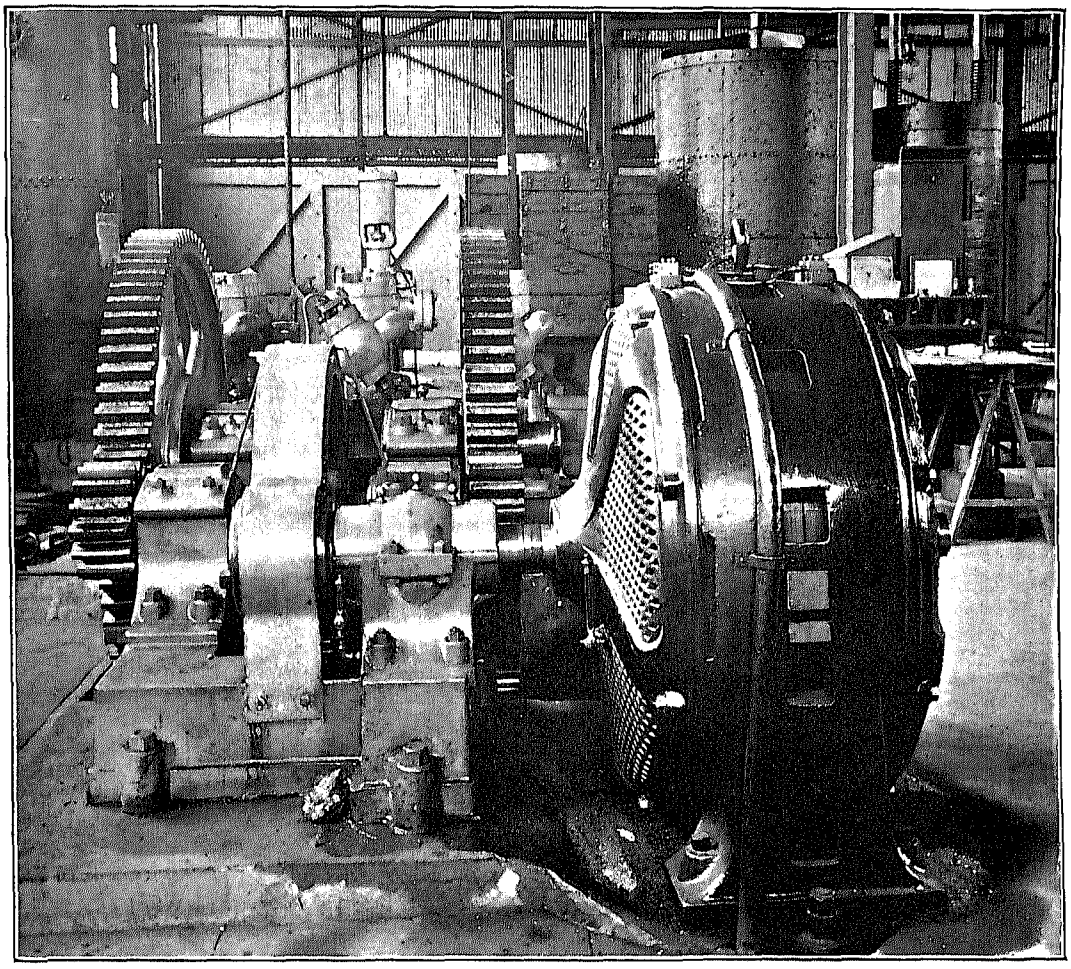

PLATE IX.—MINE PUMP, DRIVEN BY A 150-HORSEPOWER MOTOR.

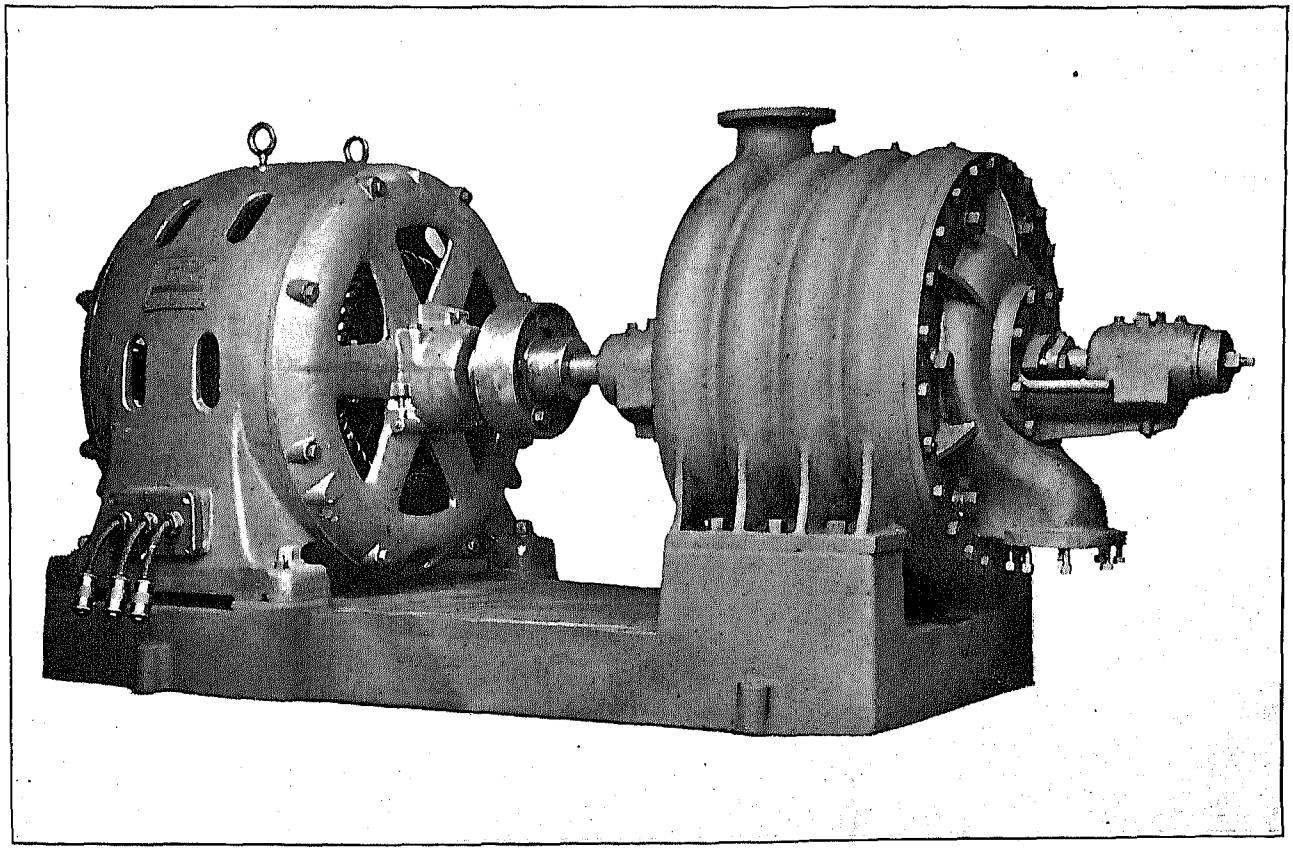

PLATE X.—FOUR-STAGE MINE PUMP, DRIVEN BY A 150-HORSEPOWER MOTOR.

delivers 500 gallons per minute against a head of 678 feet. Each of these pumps is driven by an 80-horsepower motor and runs with a speed of about 30 revolutions per minute. Another set of pumps, similar to the above, delivers 500 gallons per minute against a head of 256 feet through 3,175 feet of cast iron pipe. These pumps are of the same diameter and stroke as the others, and are equipped with 80-horsepower motors. Three sets of pumps have also been installed to the dip, each set capable of delivering 100 gallons per minute against a head of 450 feet. These pumps deliver through 1,200 feet of 6-inch pipe, 9-inch stroke, and are equipped with 25-horsepower motors.

On the continent of Europe what are known as express pumps have been largely installed, the name being applied generally to any reciprocating pump run at high piston speed, although applied also to a special system of large, high-speed pumps with mechanically closed suction valves. An example of an electrically driven express pump in mining is one in Bohemia, which runs at the comparatively high speed of 200 revolutions per minute and is capable of lifting 132 gallons per minute against a head of 1,312 feet.

On account of its rotary motion and its high speed, approximating the speed of a motor, the centrifugal pump also is peculiarly suited for electrical operation, the pump and motor being usually direct connected. This pump has been found of special utility in working against low heads and for handling muddy water.

The use of rotary pumps coupled direct to small motors running at high speed in place of reciprocating ram or plunger pumps has met with approval in Europe. These rotary pumps are made with several chambers placed in tandem and are of a type between an ordinary centrifugal pump and a form of reverse turbine. One built in Germany has 4 chambers and 4 impellers and is coupled direct to an alternating current motor of about 85 horsepower, which, when run at 1,335 revolutions per minute, has lifted 440 gallons of water per minute to a height of 394 feet. By increasing the number of impellers to 6, this pump can be made to reach 1,150 feet in one lift. An efficiency of between 70 and 75 per cent is claimed for this type of pump.

Another type of electric pump is the sinking pump. The electric sinking pump can be lowered from one location to another in much less time than a steam or compressed air pump, and as it can be completely submerged it does not have to be relocated as often as a steam pump. The question of what would happen to an electric motor in a mine if pumps and motors get flooded has often come up. From tests made recently at the University of Liége, Belgium, it appears that a suitably designed polyphase alternating current motor will suffer very little damage. A 3-phase mining motor of a type largely used on the continent of Europe was completely submerged in water. It was run for a quarter of an hour; it was then stopped and allowed to remain submerged, under official seal, for twenty-four hours, at the end of which time it was again run for a few minutes. It was next removed from the water, again put under seal, and left to dry for twenty-four hours. The insulation was then tested, and the motor was found to be in perfect order. It would be hard to imagine a test more severe than this.

As bearing upon this question it is interesting to note that among the pumps in use around Johannesburg, South Africa, at the beginning of the Anglo-Boer War, there were twelve of a well-known American make, each of which was operated by a 50-horsepower induction motor of American construction with three 15-kilowatt transformers. When the mines were shut down, upon the breaking out of the war, the water rose so rapidly that it was impossible to remove the pumps, motors, transformers, etc., and consequently they remained under 500 to 1,000 feet of water. Two and a half years later, when peace was declared in South Africa, the water in the shaft was pumped out and the electrical apparatus was removed to the surface. Three of the motors were stripped and completely rewound, but to the general surprise of the experts the condition of the insulation indicated that the rewinding might not be absolutely necessary. Accordingly the other nine motors were thoroughly dried in an oven and then soaked in oil. After this treatment they were rigidly tested, proved to be all right, and were at once restored to regular service in the mine. The transformers were treated in the same manner as the motors, with equally gratifying results.

An interesting illustration of the flexibility and adaptability of electric motors for pumping purposes is furnished by the Gneisenau mine, near Dortmund, Germany, where a very large electric mining plant was installed in 1903. In this instance the pump is located more than 1,200 feet below the surface, and the difficulties of installing the apparatus were so great, on account of the small cross section of the shaft, that it was necessary to build up the motor in the pumping chamber, the material being transported through the wet shaft and the winding of the coils being performed *in situ*.

An interesting use of the electric pump associated with the telephone in connection with mining is noted by Mr. W. B. Clarke. In one coal mine, where an electric pump is located in a worked out portion of the mine, the circuits are so arranged that the pump is started from the power house, some distance away. Near the pump is placed a telephone transmitter connected to a receiver in the power house. To start the motors, or to ascertain whether the pumps are working properly, the engineer merely listens at the telephone receiver, without leaving his post.

Lighting.—From the earliest days of practical electric lighting, the availability of the method for mining was recognized; and electric illumination in some form

or other is now used very widely. Of the two forms—the arc and the incandescent—the latter is very naturally preferred underground, for various reasons. In the first place, the subterranean spaces to be illuminated are restricted in area, so that small lights are sufficient; in the second place, both the earlier arc lighting circuits and a great many of those in use to-day have involved the employment of dangerously high pressures; and in the third place, there is objection to employing underground an open-flame lamp, such as the ordinary arc lamp has always been. Hence, while a large number of mining plants utilize arc lamps, these are to be found above ground, while the lighting below the surface depends upon incandescents. The advantages claimed for incandescent electric lighting are: The flexibility of the system, making it possible to move circuits readily from one part of the mine to another, the absence of fumes and smoke, less danger of fire, decreased cost, generally better lighting, and reliability of the light under all the variations of temperature and barometric pressure.

It follows that the electric lighting in mines is usually of a composite type, the arc lamp being used at the surface, in buildings, yards, sidings, outworks, etc., while the incandescent lamp is used in the mains, levels, tunnels, etc. At one time, in order to accomplish this dual purpose, it was necessary to install two types of generating dynamos—one for the high-pressure arc lighting and the other for the low-pressure incandescent lighting; but the later developments and improvements in arc lights have made it possible to operate them on the same circuit as the incandescents and in conjunction with motors, and hence recent years have seen the installation of standard types of direct-current dynamos for all services, operating at voltages of 100, 220, 550 volts, etc.

The British departmental committee already cited laid down, with regard to the installation and use of electricity in mines, a few simple rules, aiming at continuity of service and the prevention of the escape of current. It is provided that for lighting purposes only low pressure shall be used, and that lamp holders, switches, or other fittings must not be fixed directly to the timber or metal work, but must be attached to hardwood or other incombustible, nonhygroscopic insulated base blocks. Small wires or derived circuits for lighting must be noninflammable or suspended from porcelain insulators, or fastened to them with some nonconducting material which will not cut the insulated covering and which will not permit the wires to touch any timber or metal work. Staples of all kinds are prohibited. If metallic pipes are used, they must be electrically continuous, and must be earthed or connected to ground. If separate uncased wires are used, they must be kept at least 2 inches apart, being brought together only at switches or fittings. Wire for lighting purposes underground is not to be of flexible cord; in other words, it is not to undergo the mechanical strain of supporting a lamp. It is especially required that in places where there is liability to fire damp, etc., incandescent lamps must be used, inclosed in gas-tight fittings of strong glass without any flexible cord connections, and with the wires protected by a strong exterior metallic sheathing, sufficiently grounded.

These general conditions are observed in all well-conducted mines, both in this country and in England, and special pains are taken with regard to the fittings, so as to protect the lamps from injury, and also to get as much light as possible from each lamp. Where the incandescent lamps are subject to vibration special types, with anchored filaments similar to those employed on trolley cars, are used.

One feature of electric lighting worthy of note, but not of great importance, is the use of portable miners' lamps. A great many efforts have been made in this direction with electricity, the lamps depending for their supply of current upon either primary or storage batteries. In either case, the drawbacks have been the weight, delicacy, high cost, and uncertainty of the apparatus, and the fact that such lamps are not usually of the safety type by which the presence of choke damp or other dangerous gases is revealed. In connection with these portable electric lamps for miners, small bulbs and filaments are used, so as to reduce the consumption of current to a minimum, thus making the batteries last longer.

Very few records of tests as to electric mine lighting are obtainable; in fact, very few such tests appear to have been made. The most important series is that made some six years ago in behalf of the Westphalian miners in the testing gallery of the consolidated collieries near Gelsenkirchen, dealing with the dangers that arise from the use of electrical appliances in gaseous mines. The results of the investigation, embodied in a report made public during the present year, may be summarized as follows:

Naked filaments raised to high incandescence may or may not cause explosions, and may remain intact and burn after explosion; in most cases ignition seems to follow the breakage or burning of the filament and the accompanying sparking. Lamps with their bulbs attached were purposely shattered, the bulbs and filaments breaking simultaneously and producing bad sparking, sometimes with and sometimes without an explosion. In other cases the filaments remained intact when the bulbs were smashed, and here again explosions sometimes followed and sometimes did not. Currents of not less than 9.6 amperes, continuous or alternating, did not produce ignition, but often produced sparking; stronger currents generally did give ignition.

Electric incandescent lamps are recommended, as affording probably the safest underground illumination. The conclusions as to lamps are: Use stout globes with round bulbs, to prevent cracking from the dripping of

water on the hot bulbs; and for further protection, inclose them in wire cages. Use low-current lamps (maximum of 9.6 amperes) and high voltage—but not above 150 volts, for all excessive voltages are dangerous. Have short leading-in wires for the lamps, far apart, to guard against their being bent together and thus making a short circuit; for the same reason avoid lamps with two filaments in series. This summing up is against the common portable lamp, which has the further disadvantage of not indicating the presence of fire damp.

But little was done in these tests with arc lamps. They appear not to ignite coal dust, even in an atmosphere of 4 per cent of marsh gas, and it is noteworthy that a dust storm did not make the arc flare up; but in 6 per cent of marsh gas explosions took place, whether the lamp was already burning or was switched in. Arc lamps, both continuous and alternating, must be condemned for fiery mines, although it should be noted that arc lamps have been used with impunity in rubber works, where the air is saturated with benzine vapor.

As regards switches for one or more lamps, it was found that current strength, and still more the voltage and self-induction in the current, play an important part; and while in general slow switching in is dangerous, on account of arcs forming, rapid motion of the switch is to be avoided in the case of circuits with high self-induction, continuous or alternating. In some cases the switch was thrown 30 times before ignition occurred. Carbon points may glow without causing an explosion so long as there is no arc. Spark extinguishers which form a momentary arc are to be condemned.

Hot wire resistances seem in themselves harmless, but danger threatens from contact. A set of resistances was placed horizontally, and one hot spiral touching another caused an immediate explosion. Glowing wires did not cause explosions, even when the explosive atmosphere was driven through them by means of a fan; and an iron wire buried in coal dust and heated by the current until it arcked strongly did not ignite the dust, either when it was quiet or when it was stirred into a cloud. Fusing wires protected by a shunt may be considered harmless; but ordinary safety fuses of lead and tin acted poorly.

Ventilation.—A considerable amount of work is done in mines to-day in the way of ventilation by electric motors, the driving of ventilating fans and blowers by electricity having been found to possess many advantages. In addition to the large amount of work done in tunnels, there is considerable work done in galleries in the way of operating the main fans or blowers for the general ventilation of mines. The larger fans of this class are belt-driven, on account of their very low rates of speed, but the smaller ones are also to be found direct connected to the motors.

As pointed out by Mr. Daniel Burns, in his treatise on electricity in British mining practice, in most mines where galleries are driven some distance from the main airway it becomes difficult to ventilate properly by the ordinary methods. The ventilation of such places is always an important matter, especially in coal mines, where a considerable quantity of gas is likely to be given off. It can best be accomplished by placing a small fan at the entrance to the heading or drift, and by this means forcing in the required amount of air. The fans employed for this purpose are sometimes driven by belt from the motor, but in many instances the motor is direct connected. It is found desirable to inclose both the motor and the switches as thoroughly as possible, in order to minimize the possibility of explosions which might result from the gaseous conditions under which such ventilating systems may work.

The work of ventilation in galleries may be illustrated by the case of a Westphalian mine with a 40-horsepower motor driving a Pelzer fan, and producing 50,000 cubic feet of air per minute with a water gauge of 3 inches. The motor, which is of the alternating type, is located about half a mile from the generator. Another instance is the case of the Glückauf mine, at Sondershausen, Germany, where a belted motor of 100 horsepower has been installed to furnish the general ventilation, although the blower is in the immediate vicinity of the steam plant. Still another instance is the 400-horsepower polyphase motor employed in the Germania mine for general ventilation.

Placer mining.—A considerable amount of placer mining work has been done by electricity of late, particularly in the Western states. The best way to afford an idea of work of this character is to cite some of the later examples.

The Gold Pan Mining Company, of Breckenridge, Colo., which has the largest placer mining plant in the state, if not in the United States, depends chiefly upon electricity for its operation. The current is generated at a plant some 5 miles from the deposits and is carried to a substation at the mine at a line pressure of 10,000 volts, 3-phase alternating. It is used principally for the driving of pumps and the illumination of the works. Large bowlders are moved by two electrically driven portable cranes of the boom type, which use alternating current from the line, without transformation, and each of which is equipped with a motor capable of developing 30 horsepower. A large 150-horsepower constant-speed motor is used to drive a centrifugal pump which assists in keeping the pit dry. A large machine shop, in which are made the large wrought steel water mains employed in the placer system, is supplied with power by a 50-horsepower constant-speed motor.

In California the earliest placer mining, represented in a later stage by hydraulic working, upon which legislation imposed severe restrictions, has been largely superseded by dredging, which appears to have developed into a very profitable enterprise where power can be obtained cheaply. In fact, it is stated that,

with cheap electric-power dredging, land in which the gold averages less than 10 cents to the cubic yard pays for treatment.

The gold bearing placer soil of California has a depth of from 10 to 50 feet, being a gravel deposit left in the old river channels. After one or two holes have been put down by drills, for test purposes, and an analysis of gold bearing soil made, the dredges are put to work should conditions warrant it. Two types of electric dredge are used to secure the gravel for treatment. In one method the gravel is lifted through centrifugal pumps, while in the other—the method more generally used—it is handled by an endless chain of buckets.

The method of operation is very interesting. A boat is built in the basin or excavation where the operations are to be carried on, the necessary equipment is put on board, and the hole is then filled with water to a depth of from 25 to 40 feet. Current is brought to the operating motors on the boat by means of overhead wires and cables, the cable being usually run out from 400 to 500 feet from the shore. As a general thing, the current used is high pressure, alternating 2 or 3 phase, and the transformers for receiving it and stepping it down for use, although sometimes put on the boat, are generally placed on the bank, on a pole, or in a small substation. The dredge digs its own channel ahead of it, depositing behind it the soil which has been worked over. It may thus be said to carry its own little pool with it as the work shifts from point to point. The gravel is elevated into a grizzly or similar device, where the rocks are washed out of the soil and delivered to the carrier, which deposits them on the dump behind the dredger. The fine soil is next washed through shakers and riffles, the gold being deposited on saving tables, to be taken up with quicksilver, while the worked-over soil is deposited at the stern of the boat with the other residue.

Some idea of the character of the work may be formed from the equipment of the chain-bucket dredge operated by the Butte Gold Dredging Company. This dredge, which has a draft of 5 feet and is about 36 by 90 feet on the water line, is fitted with two spuds, each 50 feet long; one, of wood, weighing about 10 tons, and the other, of steel, weighing about 17 tons. The swing permits of a cut about 90 feet in width. There are 85 buckets to the chain, each bucket having a capacity of 5 cubic feet. The dredge is operated at a normal speed of 22 buckets per minute, and ordinarily will handle from 50,000 to 75,000 cubic yards of raw material per month. The stacker at the stern of the boat is about 90 feet long and 2½ feet wide.

The largest dredge yet installed is that of the Ashburton Mining Company, near Folsom, Cal., with 7½-foot buckets. Some idea of the electric power equipment may be formed from the fact that the induction motors for this dredge include one of 150 horsepower for the digger or bucket line, one of 20 horsepower for the winch, one of 75 horsepower for the centrifugal pump, one of 20 horsepower for the stacker, and one of 10 horsepower for the deck pump.

The Central Gold Dredging Company, of Oroville, Cal., has a typical equipment of motors of somewhat smaller size and greater variety, including one of 50 horsepower for driving the buckets, one of 15 horsepower for the winches, one of 40 horsepower for the centrifugal pump which delivers the water for washing the soil under treatment, one of 15 horsepower for driving the stacker or conveying belt which disposes of stones, one of 15 horsepower for the operation of the shaking screens, one of 3 horsepower for the deck and bilge pump, and one of 30 horsepower for operating the sand pump, which is used occasionally, when the sand accumulates too quickly at the back of the boat to deliver it out of the rock pile through a long pipe. The cost of operation in the Oroville territory, including the cost of electric power, maintenance, labor, repairs, and superintendence, but not including any allowance for depreciation or for interest on the investment, is estimated at from 5½ to 6 cents per cubic yard. The cost of power is estimated at 1½ cents per kilowatt hour metered. This seems low, but is an actual price. Some of the dredges operate 80 per cent of the time, and their electric power capacity and current consumption are indicated by the fact that the cost of current per month ranges from $800 to $1,200.

Miscellaneous use of electricity.—In addition to the more important applications of electricity to mining, already described, numerous applications of a miscellaneous character might be mentioned. The flexibility of electric circuits and the general adaptability of electric power have led to a wide range of applications, some of which are still in the experimental stage, while many others have already proved successful.

An instance may be found in the substitution of electric motors for steampower for driving air compressors, where the latter are still used for the operation of small tools, coal cutters, drills, etc. By this means the compressor can be placed conveniently near the point of application of the air, so as to avoid long and complicated systems of piping, with consequent inefficiency and heavy loss, whether of steam or of air. Electrically driven compressors sometimes have belt connections, but in many instances the motor and compressor are more directly connected. An alternating-current induction motor having a capacity of as much as 200 horsepower has been connected to the air compressor by spur gearing. In one California mine the installation of an electric motor to take the place of steampower for driving a 100-horsepower air compressor is reported to have reduced the average cost of operation per month from $1,800 to $672.

A novel and interesting application of electricity to mining is furnished in the large sand wheel equipment at the Calumet and Hecla mine, driven by a 700-horse-

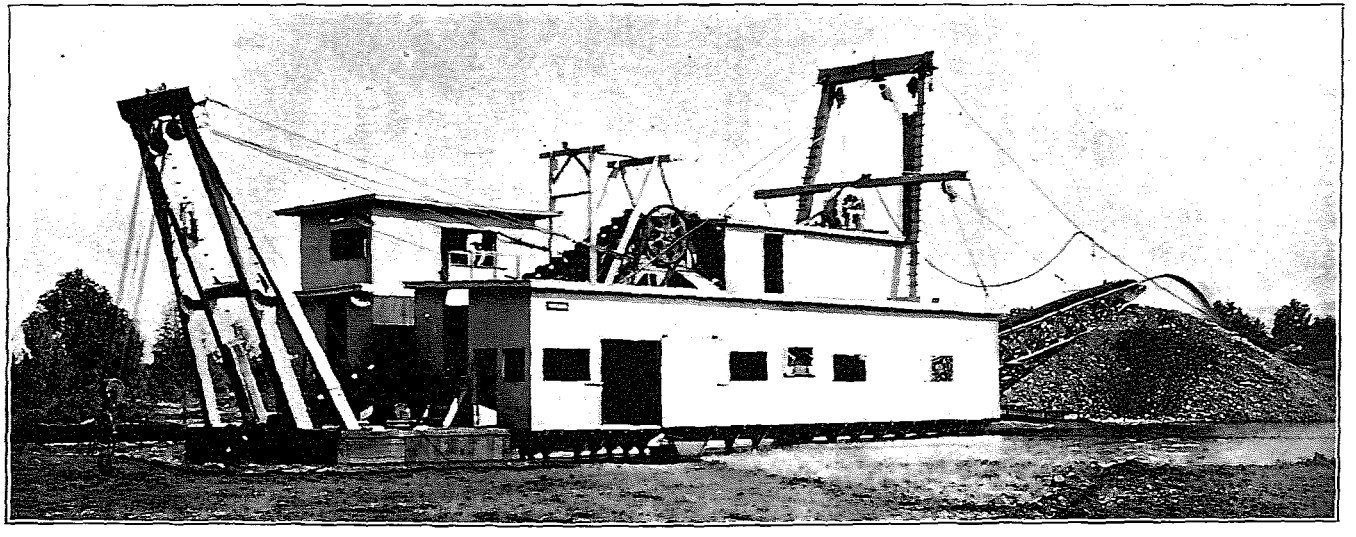

PLATE XI.—ELECTRIC GOLD DREDGER AT WORK IN CALIFORNIA.

power induction motor. To the rim of this wheel, which revolves in its pit at a speed of 10 revolutions per minute, are attached about 550 buckets for lifting the sand from the copper ore crushings. The electric sand wheel is considered to effect a considerable economy over the previous methods.

Signaling in mines requires a great variety of apparatus, such as telephones, telegraphs, bells, and appliances for sending signals according to the indications upon a dial. Of late years the telephone has gained ground rapidly over other methods of signaling. Several telephone manufacturers in the United States make types of telephones intended for mining work, with special regard to conditions of exposure, damp, etc. The British committee referred to previously records the fact that all of the witnesses before it, except one, spoke in favor of electric signaling in the shaft. Although admitting the fact that the difficulties in mines are greater than those in buildings, on account of the juxtaposition of heavy power cables and the presence of moisture, the committee recommends that as a means of ready communication between the power house and the motor equipments underground—a matter of great importance—telephones be put in all permanently installed motor rooms, so as to enable the men in charge underground to inform the engineer at once of any breakdown of motors, machinery, etc., and, if necessary, obtain assistance speedily. The committee notes the fact that for many years bare wires had been in use for transmitting signals without causing a single accident, and that, in fact, they had frequently prevented accidents.

In addition to the apparatus already described, a variety of appliances are employed for counting wagons, indicating the level of water, and kindred uses.

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