

THE ENGINEERING, SHIPBUILDING, &c.,  
TRADES.

## THE ENGINEERING TRADES.

### General Report.

#### Contents.

	Page
INTRODUCTORY .. .. .	205
Principal results for 1924 .. .. .	206
Comparability of results with those for 1912 and 1907 .. .. .	207
PRODUCTION .. .. .	207
Net output per head in 1924 and 1907 .. .. .	208
EMPLOYMENT .. .. .	209
Employment in 1924 .. .. .	209
Classification of persons employed in a specified week .. .. .	209
Monthly fluctuations in employment .. .. .	209
Employment in 1924 and 1907 .. .. .	210
Classification of average numbers employed .. .. .	211
Sex and age distribution of operatives .. .. .	211
Administrative, technical and clerical staff .. .. .	211
WAGES IN 1924 .. .. .	212
MECHANICAL POWER .. .. .	213
Power equipment of the various Engineering Trades in 1924, 1912 and 1907 .. .. .	213
Classification of power equipment of the Engineering group .. .. .	214
Power equipment in use and not in use in 1924 .. .. .	215
Power available for mechanical and electrical application in 1924 .. .. .	216
FUEL AND ELECTRICITY IN 1924 .. .. .	218
Fuel consumption .. .. .	218
Production and consumption of electricity .. .. .	221

#### Introductory.

The following general report deals with the Engineering Trades, including mechanical and electrical engineering, shipbuilding and the construction and repair of motor cars, motor cycles, cycles, aircraft, and railway carriages and wagons. Work of construction and repair carried out by Railway Companies, Local Authorities, Government Dockyards, etc., is not included but will be dealt with in the report on Public Utility Services. Measured by the numbers engaged in the various trades, the largest member of the present group in 1924 was the Mechanical Engineering Trade, which accounted for 443,525 persons employed, or 44·7 per cent. of the group total of 993,103. The next largest was the Motor, Cycle and Aircraft Trades with 222,278 persons employed, or 22·4 per cent. of the group total.

Each of the trades included in the group forms the subject of a separate report, in which the detailed results of the 1924 Census of Production are set out, and such comparisons as are possible with the results of the Censuses for 1912 and 1907 are made. The object of the present General Report is to bring together the principal results for the whole group of trades, and, in addition, to set out certain particulars (e.g., as to fuel consumption) which are more conveniently dealt with here than in the separate trade reports.

*Principal results for 1924.*

The number of separate returns received from firms engaged in the Engineering Trades group in 1924 was 17,193. About 7,670 firms to which schedules were sent did not furnish Returns, but the great majority of these firms had very small establishments, many of them being mainly engaged in repair and jobbing work, and they included a number which were no longer carrying on business at the end of the censal year. On the basis of the information available, it is estimated that they did not employ more than about 20,400 persons in all and that their aggregate net output was probably not in excess of £3,100,000. These figures represent an omission of, at most, about 2 per cent. and 1.5 per cent. respectively of the total figures for the group; and the absence of returns from the firms in question does not materially affect the uses made of the figures in this general report.

The main particulars obtained for 1924 are set out in the following table:—

*Engineering, Shipbuilding, etc., Trades.  
Output in 1924.\**

Trade.	Gross output (selling value of goods made and value of work done).	Cost of materials used and amount paid to other firms for work given out.	Net output (excess of col. (1) over col. (2)).	Persons employed.	Net output per person employed as shown in col. (4).
	(1)	(2)	(3)	(4)	(5)
	£'000	£'000	£'000	Number.	£
Mechanical Engineering ..	156,369	71,860	84,509	443,525	192
Electrical Engineering ..	70,306	36,736	33,570	154,096	218
Shipbuilding ..	54,671	30,228	24,443	143,607	170
Motor, Cycle and Aircraft ..	104,057	52,737	51,320	222,278	231
Railway Carriage and Wagon Building ..	16,270	10,950	5,320	29,597	180
TOTAL FOR UNITED KINGDOM	401,673	202,511	199,162	993,103	201
England and Wales ..	344,285	171,214	173,071	843,329	205
Scotland ..	51,214	28,053	23,161	131,330	176
Northern Ireland ..	6,174	3,244	2,930	18,444	159

\* Not including the output of, nor the persons employed by, Government dockyards, etc., Railway companies, Local authorities, Canal, Dock and Harbour authorities, etc.; particulars relating to these establishments are dealt with in the Report on Public Utility Services, which forms part of a separate volume. The value of the constructional and repair work carried out by these establishments is stated in the individual trade reports concerned (see pages 227, 290, 311, and 328 of this volume).

*Comparability of results with those for 1912 and 1907.*

The scope of the Census was not quite the same in the three censal years, and the comparability of the totals for 1924 with those for other years is affected by the changes referred to in the following paragraphs:—

(1) The Censuses of 1907 and 1924 extended to all firms, however small, but in 1912 firms employing not more than five persons (excluding proprietors) were merely required to state the average number of persons employed by them in the year. The exemption of the small firms in 1912 resulted in the exclusion of a certain proportion of the Engineering group of trades and, both for that reason and because the outbreak of war interrupted the task of dealing with incomplete or incorrect returns, the information available for that year, for the group as a whole, is not sufficiently complete to warrant its use for detailed comparisons. For these reasons the 1907 figures only are, in general, taken for comparison with those for 1924 in the trade reports and, except in respect of power equipment, in this general report.

(2) The Census of 1907 covered Great Britain and the whole of Ireland, but that of 1924 applied only to Great Britain and Northern Ireland. According to the Census of Production carried out by the Government of the Irish Free State in respect of the year 1926, the value of the engineering work carried out in that country was £784,000 and the number of persons employed was not more than 3,400, that is to say about 0.2 per cent. of the gross output and not more than 0.3 per cent. of the total number of persons employed as returned for the Engineering group of trades in the United Kingdom in 1924.

(3) In any comparison of figures representing money values, the changes in the level of prices which occurred in the period between the first and third Censuses should be kept in mind.

At the Census of 1907, shipbuilding firms returned the whole of their output on the schedule for the Shipbuilding Trade, whereas, in 1924, the output of the marine engineering departments of shipbuilding firms was returned on the schedule for the Mechanical Engineering Trade. This change, which is referred to at greater length on pages 226 to 228, affects the comparability of the results for the Shipbuilding and Engineering Trades for the two censal years.

**Production.**

It is difficult to find a satisfactory basis on which to compare production in the several trades in the same year, or in any trade or trades in different years. Obviously, no comparisons between trades could be based on the aggregate quantities of goods produced owing to their varied character, even if the necessary particulars

were available for this purpose. The gross output values recorded in the Census of Production are affected in varying degrees by the duplication of goods or processes which they involve, and hence they do not form a practicable basis for comparisons. Some of the difficulties can be avoided by basing comparisons on net output, which, being arrived at by deducting, from the value of the gross output, the total cost of materials used and the amount paid to other firms for work given out to them, represents completely and without duplication the value added to the materials in the course of manufacture. The net output thus constitutes for any industry the fund from which wages, salaries, rent, royalties, rates, taxes, depreciation, advertisement and sales expenses, and all other similar charges have to be provided, as well as profits; and if the net output for any trade is divided by the number of persons employed by firms in that trade, the resulting figure of net output per head furnishes a basis of comparison between the positions of different trades in the same year (or the same trade in different years) which takes account of differences in the numbers of persons employed and the continuity of their work. The use of net output per head as a basis of comparison was discussed at length in the Final Report on the first Census of Production (1907), where it was pointed out that "as the net output is the fund out of which all charges on industry, except the cost of materials as delivered at the works, are met, it will naturally vary with the amount of those charges" (page 12 of Cd. 6320). The conclusion reached was that "the average net output per head gives a somewhat fictitious representation of the condition of a trade" and that it constitutes only a rough measure on which to base comparisons (pages 14, 15). Hence, while it remains true that the net output for a trade represents a fact, i.e. the value added to materials by capital and labour, and constitutes the best available basis for the comparisons in view, the qualifications to which its use for this purpose is subject must be kept in mind.

*Net output per head in 1924 and 1907.*—The following table shows, for each of the trades included in the Engineering group, the net output per head of persons employed in 1924 and 1907.

*Net output per head of persons employed.\**

Trade.	1924.	1907.
Mechanical Engineering .. .. .	192	198
Electrical Engineering .. .. .	218	
Shipbuilding .. .. .	170	
Motor, Cycle and Aircraft .. .. .	231	
Railway Carriage and Wagon Building .. .. .	180	
ALL TRADES .. .. .	201	107

\* It has been ascertained from the Census records that the exclusion of particulars relating to Southern Ireland from the 1907 figures would not materially affect the calculations.

The net output per head of persons employed increased by 88 per cent. for the group as a whole, the greatest increase (112 per cent.) being recorded in the Motor, Cycle and Aircraft Trades, and the smallest (46 per cent.) in the Railway Carriage and Wagon Building Trade. The net output per head in the Shipbuilding Trade was below the group average in each year, while in the Railway Carriage and Wagon Building Trade and the combined Engineering Trades it fell from 15 per cent. and 2 per cent. respectively above the average in 1907 to 10 per cent. and 1.5 per cent. below the average in 1924. Electrical Engineering taken alone, however, was nearly 9 per cent. above the group average in 1924.

### Employment.

#### *Employment in 1924.*

*Classification of persons employed in a specified week.*—The following table classifies by sex, age and character of employment the numbers of persons who were recorded as employed in the various Engineering Trades in the week ended 18th October, 1924:—

*Number of persons employed in the week ended 18th October, 1924.*

Trade.	Operative staff.				Administrative, technical and clerical staff.			
	Males.		Females.		Males.		Females.	
	Under 18.	Total.	Under 18.	Total.	Under 18.	Total.	Under 18.	Total.
	In Thousands							
Mechanical Engineering .. .. .	44.0	373.5	3.5	13.7	4,294	48,373	1,998	13,590
Electrical Engineering .. .. .	18.2	94.1	12.5	37.2	2,161	21,289	1,791	9,125
Shipbuilding .. .. .	13.5	129.3	0.1	0.8	826	9,451	157	1,626
Motor, Cycle and Aircraft .. .. .	21.8	171.2	4.4	20.0	2,121	21,688	1,670	8,685
Railway Carriage and Wagon Building .. .. .	3.2	25.1	0.1	0.3	294	2,356	74	708
TOTAL .. .. .	100.7	793.2	20.6	72.0	9,696	103,157	5,690	33,734

The proportion of female operatives was greatest in the Electrical Engineering Trade and the Motor, Cycle and Aircraft Trades. These two trades accounted for nearly four-fifths of the total number of female operatives employed in the group, but for only one-third of the male operatives in the group.

*Monthly fluctuations in employment.*—In order to ascertain what fluctuations in employment there might be in the course of the censal year, firms were also required to state the average numbers of the operative staff employed in one week in each month. The figures for each trade are shown in the respective reports, and the following table gives the monthly aggregates for all the trades together.

*Operative staff in the Engineering Trades in 1924.*

Week ended.	Males.	Females.	Total.
12th January .. .. .	750,081	65,678	815,759
16th February .. .. .	768,334	67,894	836,228
15th March .. .. .	772,888	69,140	842,028
12th April .. .. .	778,439	69,305	847,744
17th May .. .. .	791,627	69,732	861,359
21st June .. .. .	794,779	69,327	864,106
19th July .. .. .	798,696	68,751	867,447
16th August .. .. .	792,023	68,605	860,628
13th September .. .. .	792,826	69,518	862,344
18th October .. .. .	793,201	71,965	865,166
15th November .. .. .	795,473	74,061	869,534
13th December .. .. .	806,711	75,482	882,193
AVERAGE FOR THE 12 MONTHS .. .. .	786,257	69,955	856,212

During the first seven months of the year the total number of male operatives increased continuously. A decrease which began in June in the case of females, occurred in August in the case of males. The July total was exceeded only in December for males, while the May total was passed in October in the case of female operatives. The total number employed in December exceeded the number employed in January by 66,434, or 8·1 per cent., the increase being composed of 56,630 males and 9,804 females.

The average numbers employed were divided between males and females in the proportion of about 918 to 82.

*Employment in 1924 and 1907.*

The following table shows the average numbers of male and female operatives (wage earners), and administrative, technical and clerical staff (salaried persons), in each of the Engineering Trades in the two censal years. The average numbers shown in the table have been determined in the manner explained in Note (19) on page xi.

*Numbers employed in 1924 and 1907 in the several Engineering Trades.*

Trade.	Operatives (wage earners). Average for year.		Administrative, technical and clerical staff (salaried persons).		Total.
	Males.	Females.	Males.	Females.	
Mechanical Engineering .. 1924	367,958	13,604	48,373	13,590	443,525
Electrical Engineering .. 1924	89,149	34,533	21,289	9,125	154,096
Engineering (including Electrical) 1907	408,390	14,037	36,410	2,866	461,703
Shipbuilding .. .. . 1924	131,724	806	9,451	1,626	143,607
.. .. . 1907	177,825	685	9,270	532	188,312
Motor, Cycle and Aircraft .. 1924	171,159	20,746	21,688	8,685	222,278
.. .. . 1907	41,663	6,003	5,410	967	54,043
Railway Carriage and Wagon Building .. .. . 1924	26,267	266	2,356	708	29,597
.. .. . 1907	26,939	166	1,667	85	28,857
ALL TRADES { 1924	786,257	69,955	103,157	33,734	993,103
.. .. . 1907	654,817	20,891	52,757	4,450	
TOTAL .. .. . 1924	856,212		136,891		993,103
.. .. . 1907	675,708		57,207		

The total numbers employed increased between 1907 and 1924 by 260,188, or 35·5 per cent. The greatest increase, both relative and actual, occurred in the Motor, Cycle and Aircraft Trades, where the total number of employees was greater in 1924 than in 1907 by 168,235, or 311 per cent. The Engineering Trades as a whole showed an increase of 29 per cent. and the Shipbuilding Trade a decrease of 24 per cent., but, as already explained on page 207, the 1907 results for these trades are not wholly comparable with those for 1924.

*Classification of average numbers employed.*—The following table shows the distribution, according to sex, age and character of employment, of the average number of persons employed in the Engineering group of trades in 1924 and 1907:—

*Average numbers employed in all Engineering Trades in the two censal years.*

Sex and age.	1924.		1907.	
	Operative staff.	Total staff.	Wage earners.	Total staff.
<i>Males:—</i>				
Under 18 .. .. .	99,506	109,202	89,444	96,323
Over 18 .. .. .	686,751	780,212	565,373	611,251
TOTAL .. .. .	786,257	889,414	654,817	707,574
<i>Females:—</i>				
Under 18 .. .. .	19,870	25,560	6,364	7,251
Over 18 .. .. .	50,085	78,129	14,527	18,090
TOTAL .. .. .	69,955	103,689	20,891	25,341
<i>Males and females:—</i>				
Under 18 .. .. .	119,376	134,762	95,808	103,574
Over 18 .. .. .	736,836	858,341	579,900	629,341
TOTAL .. .. .	856,212	993,103	675,708	732,915

*Sex and age distribution of operatives.*—Labour in the Engineering group of trades was predominantly male in both years. The increased employment of operatives recorded in 1924 for this group affected all the classes shown in the above table, being most marked in the case of female operatives, where the increase was nearly 235 per cent. The total number of operatives employed in the group in 1924 was nearly 27 per cent. greater than in 1907.

The proportion of operatives under 18 differed little in the two Censuses, being a little over 14 per cent. of the total operative staff in 1907 and a little under 14 per cent. in 1924.

*Administrative, technical and clerical staff.*—The increase in the administrative, technical and clerical staff in 1924 (described in 1907 as salaried persons) was 79,684, or nearly 140 per cent. Of this increase males accounted for 50,400 and females for 29,284.

The increase in males probably signifies an increase in management and sales staffs; the increase in females probably related largely to

clerical staff, reflecting a widespread adoption of more detailed accounting methods, and to clerical labour associated with selling organisation.

The proportion of males in the administrative staff in 1907 was 92 per cent. and of females 8 per cent., as compared with 75 per cent. and 25 per cent. respectively in 1924.

The following table shows the proportions of the administrative, technical and clerical staff in 1924, and of the salaried staff in 1907, to the total staff in those years.

Trade.	Proportion of total staff represented by	
	Administrative, technical and clerical staff in 1924.	Salaried persons in 1907.
Mechanical Engineering .. .. .	14.0	} 8.5
Electrical Engineering .. .. .	19.7	
Shipbuilding .. .. .	7.7	5.2
Motor, Cycle and Aircraft .. .. .	13.7	11.8
Railway Carriage and Wagon Building .. .. .	10.4	6.1
ALL TRADES .. .. .	13.8	7.8

#### Wages in 1924.

The following table summarises the information contained in the reports on the separate trades as to the amount of wages paid by firms in those trades in 1924. The particulars of wages shown in column (5) of the table are those ascertained by the Ministry of Labour as a result of the voluntary enquiry undertaken by that Department into wages and hours of labour in the United Kingdom in 1924. The numbers of operatives shown in column (1) are those returned to the Census of Production as employed by the firms concerned in the week ended 18th October, 1924. The proportion of each trade represented by the firms that furnished particulars of their wage-bills is shown in columns (2) and (4) on the bases of numbers of operatives employed and of net output, respectively.

Trade.	Firms furnishing returns of wages.					
	Operatives employed.		Net output.		Wages paid.	
	Number. (1)	Proportion of trade total. (2)	Amount. (3)	Proportion of trade total. (4)	Amount. (5)	Proportion of net output. (6)
		Per cent.	£'000	Per cent.	£'000	Per cent.
Mechanical Engineering .	269,974	70	59,545	70	33,340	56.0
Electrical Engineering ..	105,631	80	26,477	79	11,199	42.3
Shipbuilding .. .. .	81,272	62	15,038	62	10,851	72.2
Motor, Cycle and Aircraft	101,426	53	29,653	52	15,519	52.0
Railway Carriage and Wagon Building ..	19,142	76	3,985	75	2,770	69.5
TOTAL .. .. .	577,445	67	134,698	68	73,679	54.7

The proportion of wages to net output was highest in the Shipbuilding Trade and the average wage per head was highest in the Motor, etc., Trades; both were lowest in the Electrical Engineering Trade, in which a relatively high proportion of the operative staff was females.

#### Mechanical Power.

The power equipment of factories consists in the first instance of the prime movers installed in the works, part being used to apply power mechanically and part to actuate generators for the production of electrical energy. Only a portion of that electrical energy is used for power, i.e., to drive electric motors, the remainder being used for lighting, heating and other purposes. In addition, many factories derive part or all of their power from electricity purchased and used for driving electric motors.

*Power equipment of the various Engineering Trades in 1924, 1912 and 1907.*—The particulars furnished at the three Censuses regarding prime movers and electric generators in factories in the Engineering group of trades are shown in the following table. Particulars of electric motors were not obtained in 1907, and particulars relating to 1924 and 1912 only can be given.

The summary figures of power equipment secured at the 1912 Census are included in this and the following paragraphs, though they are omitted from most of the individual trade reports. The exclusion in that year of firms employing not more than five persons and the incompleteness of many of the returns rendered the results secured for the most part ineffective for purposes of comparison. The figures relating to power equipment are, however, likely to have been affected in a less degree than other aggregates by the omission of the small enterprises. The main interest of the figures given for 1912 lies in the indication which they afford of the increase that has occurred since that year in the use of electricity, particularly purchased electricity, as a source of power. The omission of small firms in 1912 may have had a particular importance in reference to this feature.

In connexion with the omission of the Irish Free State from the 1924 Census (see page 207), it may be mentioned that, according to the Census of Production conducted by the Free State Government in respect of the year 1926, the total capacity of prime movers in the Engineering group of trades in that year was not more than 2,800 horse-power, which is about 0.5 per cent. of the total recorded for the United Kingdom in 1924; and the capacity of the electric motors driven by purchased electricity was not more than 4,900\* horse-power, or 0.4 per cent. of the United Kingdom figure for 1924. The effect of the absence of the Irish Free State from the 1924 Census may, therefore, be considered as negligible in this group of trades.

\* This figure includes electric motors of a capacity of 4,000 horse-power, the source of the electricity for which was not distinguished.

*Power equipment of the several Engineering Trades.*

Trade.	Prime movers.			Electric generators.		
	1924.	1912.	1907.	1924.	1912.	1907.
	Thousand H.P.			Thousand Kw.		
Mechanical Engineering ..	323.5	} 338.4	331.3	143.4	} 131.6	93.2
Electrical Engineering ..	48.7		31.3	32.2		35.2
Shipbuilding .. .. .	46.1	61.5	114.5	19.3	31.3	35.2
Motor, Cycle and Aircraft	58.2	20.4	15.4	26.0	6.3	2.2
Railway Carriage and Wagon Building ..	23.2	27.1	30.4	14.2	7.9	8.2
TOTAL .. .. .	499.7	447.4	491.6	235.1	177.1	138.8

Trade.	Electric motors driven by electricity generated in same works.		Electric motors driven by purchased electricity.		All electric motors.	
	1924.	1912.	1924.	1912.	1924.	1912.
	Thousand H.P.		Thousand H.P.		Thousand H.P.	
Mechanical Engineering ..	234.3	} 175.8	630.3	} 184.3	864.6	} 360.1
Electrical Engineering ..	48.0		114.1		162.1	
Shipbuilding .. .. .	28.2	45.8	334.1	72.7	362.3	118.5
Motor, Cycle and Aircraft	31.6	4.1	153.5	17.6	185.1	21.7
Railway Carriage and Wagon Building ..	22.4	10.9	41.0	9.0	63.4	19.9
TOTAL .. .. .	364.5	236.6	1,273.0	283.6	1,637.5	520.2

The distribution of the power equipment recorded in 1924 among the three geographical areas covered by the Census was as follows:—

Area.	Prime movers.	Electric generators.	Electric motors driven by	
			Electricity generated in same works.	Purchased electricity.
	Th. H.P.	Th. Kw.	Th. H.P.	Th. H.P.
England and Wales .. ..	427.9	198.5	314.2	935.6
Scotland .. .. .	54.0	25.2	34.7	307.1
Northern Ireland .. ..	17.8	11.4	15.6	30.3
TOTAL .. .. .	499.7	235.1	364.5	1,273.0

*Classification of power equipment of the Engineering group.*—The next table, which relates to the power equipment of all the trades taken together, classifies the prime movers according to kinds, the electric generators according to the description of prime movers by which they were driven, and the electric motors according as they were actuated by purchased electricity or by electricity generated in the same factory or works.

Power equipment.	1924.	1912.	1907.
	Th. H.P.	Th. H.P.	Th. H.P.
<b>PRIME MOVERS:—</b>			
Reciprocating steam engines .. .. .	234.1	290.1	366.1
Steam turbines .. .. .	115.6	23.9	7.3
Gas and oil engines .. .. .	148.9	129.0	106.9
Water power .. .. .	1.1	4.4	4.3
Other power .. .. .	—	*	7.0
TOTAL .. .. .	499.7	447.4	491.6
<b>ELECTRIC GENERATORS:—</b>	Th. Kw.	Th. Kw.	Th. Kw.
Driven by—			
Reciprocating steam engines .. .. .	82.8	95.1	107.5
Steam turbines .. .. .	97.8	17.4	6.1
Gas and oil engines .. .. .	54.1	} 64.6	} 25.2
Water power .. .. .	0.4		
Other power .. .. .	—	—	—
TOTAL .. .. .	235.1	177.1	138.8
<b>ELECTRIC MOTORS:—</b>	Th. H.P.	Th. H.P.	Th. H.P.
Driven by—			
Electricity generated in same works ..	364.5	236.6	} (not as- certained†
Purchased electricity .. .. .	1,273.0	283.6	
TOTAL .. .. .	1,637.5	520.2	..

\* Less than 50 H.P.

† The total amount of electric energy recorded as purchased for all purposes in 1907 was 86,858,000 Board of Trade units (kilowatt-hours) and it would appear that the quantity generated by the dynamos operated by the firms in this group of trades may have amounted to nearly 200,000,000 Board of Trade units.

In all three years steam engines formed the bulk of the prime movers in the Engineering Trades. Steam turbines increased markedly, the main purpose for which they were installed being the driving of electric generators. The capacity of electric generators increased by nearly 70 per cent. between 1907 and 1924, the rate of increase being greater before than after 1912. After 1912, however, the rate of increase in motors driven by purchased electricity was over six times as great as that in motors driven from generators in the works, and over ten times that of such generators, though this comparison does not allow for the limitations in the range of the 1912 enquiry.

*Power equipment in use and not in use in 1924.*—The firms that made returns to the Census for 1924 were required to distinguish between the prime movers, electric generators, and electric motors ordinarily in use in the course of the year and those that were in reserve or idle. The proportion not in use should not be taken as a direct measure of the inactivity of trade during the year. While some of the engines, generators, and motors were not in use on account of lack of orders for goods, some were idle because they were

normally in reserve against a breakdown or sudden rush of trade and others may have been in various stages of obsolescence, awaiting the time for being dismantled. The particulars recorded as to power ordinarily in use and not in use in 1924 are given in the following table.

*Power ordinarily in use and not in use in the Engineering Trades in 1924.*

Trade.	Prime movers.		Electric generators.		Electric motors.	
	(a) Ordinarily in use; (b) not in use.	Percentage not in use.*	(a) Ordinarily in use; (b) not in use.	Percentage not in use.*	(a) Ordinarily in use; (b) not in use.	Percentage not in use.*
	Th. H.P.		Th. Kw.		Th. H.P.	
Mechanical	{ (a) 232.0	} 28.3	88.6	} 38.2	697.9	} 19.3
Engineering	{ (b) 91.5		54.8		166.7	
Electrical	{ (a) 37.3	} 23.4	24.1	} 25.2	147.1	} 9.3
Engineering	{ (b) 11.4		8.1		15.0	
Shipbuilding	{ (a) 28.2	} 38.9	9.1	} 52.9	270.6	} 25.3
	{ (b) 17.9		10.2		91.7	
Motor, Cycle and Aircraft	{ (a) 49.4	} 15.1	21.5	} 17.4	165.2	} 10.8
	{ (b) 8.8		4.5		20.0	
Railway Carriage and Wagon Building	{ (a) 17.6	} 24.3	10.2	} 27.8	53.9	} 14.9
	{ (b) 5.6		4.0		9.4	
TOTAL	{ (a) 364.5	} 27.1	153.5	} 34.7	1,334.7	} 18.5
	{ (b) 135.2		81.6		302.8	

\* Based in each case upon the actual figures returned, not upon the round figures shown in this table.

*Power available for mechanical and electrical application in 1924.*— In order to ascertain the actual amount of power available in the several trades, and the proportion of that power applied electrically, the capacity of the prime movers used to actuate electric generators must be replaced by the capacity of the electric motors driven by the electricity so produced. How far it may be legitimate to add together the capacity of engines applying, or intended to apply, power mechanically and the capacity of the electric motors, so as to obtain the power capacity of a factory using both forms of energy, will depend on the organisation of the factory. The information supplied furnishes no guidance as to the effective capacity of the power equipment, for, on the one hand, actual working capacity is not necessarily identical with the indicated horse-power nor with that which an engine was originally built to develop, data which served largely as the basis of returns; and, on the other hand, it cannot be assumed that an engine can run uniformly at its peak load, and some engine-power is generally provided as a reserve against breakdowns and not for regular use. In particular, a series of motors (whose aggregate capacity would be returned to the Census) may

be installed to run on successive processes, some of which are carried on intermittently as the materials to be treated become available, so that the series always includes some units not actually in operation. In such cases the aggregate horse-power of the motors, being greater than the power called for at any moment, may be greater than the horse-power of the prime movers required to actuate the generators from which the series of motors is driven. Since, however, the mechanical power available per operative employed is regarded as significant of the efficiency of an organisation, an attempt has been made to provide such a measure, though the result can only be regarded as a rough indication claiming no high degree of precision.

In calculating this measure, the power allocated for driving electric generators has to be deducted from the total capacity of prime movers; for this purpose, 746 kilowatts of electrical energy are taken as the equivalent of 1,000 horse-power of mechanical energy, and an average loss of 10 per cent. is allowed in the conversion of mechanical into electrical energy, except in the case of steam turbines, which are usually bolted direct to the shafting of the generator. The power available to be applied mechanically is thus ascertained; and the electrical power available is the sum of the capacities of motors driven by purchased electricity and of those driven by electricity generated in the same works. Comparison with power available in 1907 is not possible, since the capacity of electric motors was not ascertained in that year.

The calculation relating to power available has been made on the basis of the power equipment installed and not on that recorded as being in use. For reasons already given it must be recognised that the figures representing power available per operative employed are, to some extent which cannot be determined from the data available in the Census office, in excess of the average power utilisable.

The following table sets out the results of the calculation :—

*Power available in the several Engineering Trades in 1924.*

Trade.	Power for mechanical application.	Power for electrical application.	Total power.	Per head of average number of operatives employed.
	Th. H.P.	Th. H.P.	Th. H.P.	H.P.
Mechanical Engineering .. ..	119.0	864.6	983.6	2.6
Electrical Engineering .. ..	3.4	162.0	165.4	1.3
Shipbuilding .. ..	17.8	362.3	380.1	2.9
Motor, Cycle and Aircraft .. ..	20.7	185.2	205.9	1.1
Railway Carriage and Wagon Building .. ..	3.3	63.4	66.7	2.5
TOTAL .. ..	164.2	1,637.5	1,801.7	2.1



In the aggregate the power available for mechanical application and that available for electrical application were roughly in the proportion of 1 to 10.

### Fuel and Electricity in 1924.

All firms that received schedules were asked to furnish voluntarily particulars of their consumption of fuel (of specified kinds) and electricity (distinguishing that purchased from that generated in the works) under two headings, namely (i) for power (driving engines), and (ii) for heating or lighting the premises, transport, etc. Firms whose aggregate net output was 62.4 per cent. of the net output of all firms in the Engineering Trades in 1924 furnished information in response to this request, though, as will appear later, many of them were unable to divide their particulars into the two categories indicated. Moreover, the information returned was not equally representative of fuel consumption, of production of electricity, and of consumption of purchased electricity, as the data supplied under these three headings respectively covered 65.8 per cent. of the capacity of all the prime movers (not hydraulic) in use in the group of trades, 56.7 per cent. of the capacity of the electric generators, and 66.7 per cent. of that of the electric motors driven by purchased electricity.

#### Fuel consumption.

In 1907, when firms were only asked to state their consumption of coal and coke without specification of purpose, the firms that furnished particulars had 68.6 per cent. of the net output of the trades as a whole, and they recorded a consumption of 2,344,000 tons of coal and 648,000 tons of coke. The consumption recorded in 1924 by firms representing 62.4 per cent. of the net output of the group included 1,735,000 tons of coal and 641,000 tons of coke.

In 1924 the particulars furnished appear to indicate that the Mechanical Engineering Trade was the largest consumer of coal, coke and heavy oils, and the Motor, Cycle and Aircraft Trades was the largest consumer of light oils and gas.

The table on page 219 summarises the information which was received from firms regarding the quantities of different kinds of fuel which they consumed in 1924. These quantities are divided into (a) the amounts used for power purposes, i.e., driving engines, and (b) the amounts used for the lighting or heating of premises, transport, etc., so far as the particulars furnished enable the classification to be made. It appears from the returns, however, that the basis of classification adopted by the various firms which furnished information was by no means uniform; and, apart from this, considerable quantities were reported for which no particulars of purpose could be assigned. These quantities are shown under heading (c) in the table.

### Consumption of fuel (so far as reported) in the several Engineering Trades in 1924.

NOTES.—(1) The figures in italics below the name of the trade represent respectively (1) the percentage of the total net output of the trade represented by the firms giving information, and (2) the percentage of the total capacity of prime movers (not hydraulic) in use in the trade represented by the firms giving information.

(2) The fuel consumed is, in each case, classified according to the purpose for which it was used, as follows:—(a) For power (driving engines); (b) for heating and lighting premises and for transport, etc.; (c) for purposes not separately distinguished.

Trade.	Coal and slack.		Coke and breeze.		Heavy oils.	Light oils.	Gas.*
	Th. tons.	Th. tons.	Th. tons.	Th. tons.	Th. galls.	Th. galls.	Th. therms.
Mechanical Engineering ..	(a) 235.1	2.0	853.3	137.9	1,266.2		
(1) <i>61.4</i> , (2) <i>69.7</i> .	(b) 523.2	377.7	2,296.2	1,049.0	4,613.7		
	(c) 240.8	28.8	407.1	37.2	895.2		
Electrical Engineering ..	(a) 129.9	6.3	95.2	11.4	193.4		
(1) <i>63.5</i> , (2) <i>71.7</i> .	(b) 87.0	29.6	597.8	307.3	3,064.0		
	(c) 44.7	2.4	17.3	3.0	673.6		
Shipbuilding ..	(a) 31.2	1.7	318.3	23.9	144.3		
(1) <i>65.8</i> , (2) <i>58.9</i> .	(b) 97.3	45.2	843.2	491.0	635.9		
	(c) 20.3	4.7	118.7	27.7	47.4		
Motor, Cycle and Aircraft ..	(a) 12.8	1.2	48.3	114.2	2,017.9		
(1) <i>60.0</i> , (2) <i>39.2</i> .	(b) 76.1	50.0	957.7	742.3	6,956.0		
	(c) 46.3	4.7	0.4	1,195.8	3,017.3		
Railway Carriage and Wagon Building ..	(a) 40.4	0.3	29.1	5.2	31.6		
(1) <i>77.3</i> , (2) <i>87.6</i> .	(b) 87.1	72.1	1,070.3	30.1	171.1		
	(c) 62.4	14.8	41.9	4.1	8.5		
ALL TRADES ..	(a) 449.4	11.5	1,344.2	292.6	3,653.4		
(1) <i>62.4</i> , (2) <i>65.8</i> .	(b) 870.7	574.6	5,765.2	2,619.7	15,440.7		
	(c) 414.5	55.4	585.4	1,267.8	4,642.0		
GRAND TOTAL (ALL PURPOSES) ..	1,734.6	641.5	7,694.8	4,180.1	23,736.1		

\* The amount of gas purchased was, in some cases, returned in terms of cubic feet; in such cases 200 cubic feet have been taken as equivalent to 1 therm.

In the Engineering Trades fuel is used for manufacturing purposes other than the production of power. The quantities of fuel so consumed were intended as a general rule to be included under heading (b), i.e., for lighting or heating premises, transport, etc., and have been included under that heading in the preceding table. In all the trades in the Engineering group information was invited as to the quantities used for special trade purposes and the particulars recorded, which form part of the totals shown against the lines marked (b) in the preceding table, were as follows :—

*Special consumption of fuel (so far as reported).*

Trade.	Coal.	Coke.	Heavy oils.	Light oils.	Gas.*
	Th. tons	Th. tons	Th. galls.	Th. galls.	Th. therms.
Mechanical Engineering (at furnaces, forges and cupolas) ..	426·8	339·3	2,019·5	196·3	2,907·9
Electrical Engineering (at forges, etc.) ..	25·3	15·6	554·3	65·5	2,559·2
Shipbuilding (at forges, etc.) ..	84·1	40·2	807·8	117·2	156·4
Motor, Cycle and Aircraft (at forges and foundries) ..	31·9	23·4	929·3	142·8	5,841·1
Railway Carriage and Wagon Building (at forges, etc.) ..	72·9	71·4	1,070·0	4·4	78·0
<b>TOTAL .. .. .</b>	<b>641·0</b>	<b>489·9</b>	<b>5,380·9</b>	<b>526·2</b>	<b>11,542·6</b>

\* See footnote to table on page 219.

The difficulty of drawing conclusions and making generalisations on the basis of the figures shown in the table on page 219 is due primarily to the large percentages of fuel consumption for which no particulars of purpose could be specified by firms that furnished information. The following table shows these percentages for the trades in the Engineering group :—

*Proportion of fuel consumption for purposes not defined.*

Trade.	Coal and slack.	Coke and breeze.	Heavy oils.	Light oils.	Gas.*
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Mechanical Engineering .. ..	24·1	7·0	11·4	3·0	13·2
Electrical Engineering .. ..	17·1	6·3	2·4	0·9	17·1
Shipbuilding .. ..	13·7	9·2	9·3	5·1	5·7
Motor, Cycle and Aircraft .. ..	34·2	8·3	—	58·3	25·2
Railway Carriage and Wagon Building .. ..	32·9	17·0	3·7	10·4	4·0
<b>ALL TRADES .. .. .</b>	<b>23·9</b>	<b>8·6</b>	<b>7·6</b>	<b>30·3</b>	<b>19·6</b>

\* See footnote to table on page 219.

Where the quantities of fuel consumed for purposes not distinguished form only small percentages of the total quantities reported, it may involve no great error to distribute them, e.g., in the proportions recorded for the purposes for which consumption was specified; but where the undistributed portion is large in proportion to the total consumption such a process might lead to erroneous conclusions.

In these circumstances it is not practicable to estimate with any degree of confidence the quantities of the different kinds of fuel used for power, and for other purposes, by the firms who replied to the question in the Census schedules on the subject. Any attempt to extend the particulars furnished so as to estimate the quantities of different kinds of fuel used by all the firms in each of the Engineering Trades would encounter other difficulties, even if distinction of purpose be ignored and attention be confined to the fuel used for all purposes combined. The table on page 219 shows that the firms which furnished information represented varying proportions of the several trades, and only in one of the trades was the proportion, as measured by net output, over 75 per cent. Any assumption that the firms which did not furnish information distributed their consumption among the different kinds of fuel in the proportions represented by the practice of those firms which supplied particulars would be extremely hazardous in the absence of information regarding the general practice of the several trades.

For the foregoing reasons, therefore, the information given in the table referred to should not be used as being of more than face value without extreme caution.

*Production and consumption of electricity.*

For 1907 the Census returns showed that about 176,000,000 units of electricity were generated in establishments with dynamos of 124,000 kilowatt capacity, equivalent to 90 per cent. of the total capacity of 138,000 kilowatts in the trades as a whole. In 1924, firms with generators of 87,100 kilowatt capacity (56·7 per cent. of the group total) recorded an aggregate of 155,000,000 units of electricity generated and consumed in their works. As regards purchased electricity, a return was obtained from all firms at the 1907 Census, and this showed a total of over 86,900,000 units purchased for all purposes. In 1924 the information received showed that about 489,600,000 units were purchased by firms owning 66·7 per cent. of the electric motors driven by purchased electricity. While the figures form only a slender basis for generalisation, the indications which they yield harmonise with the information available from other sources as to the increase in the use of electricity in the Engineering Trades between 1907 and 1924, and probably also with the conclusion indicated on page 213 as to

the increased tendency to rely on electricity purchased from public supply undertakings rather than on the installation of generating plant in the works themselves.

The table on page 223 summarises the detailed information received from firms in the Engineering group of trades as to the generation and consumption of electricity in 1924. The figures must, however, be regarded as subject to qualifications similar to those which apply to the particulars given on page 221 respecting consumption of fuel; and for the same reason they cannot be appropriately used as the basis of generalised deductions. The percentages of the reported consumption of electricity for which no particulars of purpose could be given were as follows:—

*Proportion of consumption of electricity for purposes not defined.*

Trade.	Electricity.	
	Purchased.	Generated in own works.
Mechanical Engineering .. .. .	24.9	41.0
Electrical Engineering .. .. .	36.3	41.5
Shipbuilding .. .. .	13.2	85.8
Motor, Cycle and Aircraft .. .. .	24.2	74.1
Railway Carriage and Wagon Building .. .. .	21.2	21.8
<b>ALL TRADES .. .. .</b>	<b>23.6</b>	<b>42.7</b>

Reference to the table on page 223 will show that the percentage of the electric generators in use in these trades that was represented by the information furnished regarding electricity generated, was, in the aggregate, smaller than the percentage of the electric motors driven by purchased electricity that was represented by the information furnished regarding electricity purchased. This may be due in part to the predominance, among the firms replying to the voluntary question, of firms drawing the bulk of their electric power from public supply authorities and not from generators installed in their own works; but at the same time it may reflect the fact that, while all firms necessarily know the quantity of electricity they purchase, many do not record the quantity generated in their own works.

The particulars representing the average amount of electricity generated per kilowatt capacity (column (3) of the table) show considerable variation. These variations doubtless correspond to some extent with differences in the continuity with which the electric generators were operated in the works of the firms that furnished information. The difficulty of basing general conclusions regarding the several trades on the partial data shown in the table applies not less to this particular aspect of the matter than to the others.

*Consumption of electricity (so far as reported) in the several Engineering Trades.*

NOTES.—(1) The figures in italics below the name of the trade represent respectively (1) the percentage of the total capacity of electric generators in use in the trade represented by the firms which stated the quantity of electricity generated in their works; and (2) the percentage of the total capacity of electric motors, driven by purchased electricity, in use in the trade represented by the firms which stated the quantity of electricity purchased by them.

(2) The electricity generated and the electricity purchased are, in each case, classified according to the purpose for which they were used, as follows:—(a) for power (driving engines), (b) for heating and lighting premises and for transport, etc., (c) for purposes not separately distinguished.

Trade.	Electricity generated in works of firms giving information.				Electricity purchased by firms giving information.	
	Capacity of electric generators (in use). (1)	Quantity of electricity generated. (2)	Average per kilowatt capacity of generators. (3)	Capacity of electric motors (in use) driven thereby. (4)	Quantity of electricity purchased. (5)	Capacity of electric motors (in use) driven thereby. (6)
	Th. Kw.	Million B.T. Units.	B.T. Units	Th. H.P.	Million B.T. Units.	Th. H.P.
Mechanical Engineering <i>(1) 57.0, (2) 66.0</i>	50.5	(a) 41.2 (b) 9.1 (c) 35.0	1,690	125.6	(a) 125.1 (b) 30.2 (c) 51.5	343.2
Electrical Engineering <i>(1) 68.4, (2) 64.4</i>	16.5	(a) 19.5 (b) 2.8 (c) 15.8	2,307	31.3	(a) 38.4 (b) 4.3 (c) 24.4	65.5
Shipbuilding .. .. . <i>(1) 38.7, (2) 70.7</i>	3.5	(a) 0.3 (b) 0.1 (c) 2.8	938	13.1	(a) 92.2 (b) 4.0 (c) 14.7	175.1
Motor, Cycle and Aircraft .. .. . <i>(1) 34.8, (2) 62.6</i>	7.5	(a) 3.0 (b) 0.2 (c) 9.2	1,659	12.0	(a) 55.5 (b) 9.2 (c) 20.7	84.6
Railway Carriage and Wagon Building .. .. . <i>(1) 88.8, (2) 72.4</i>	9.1	(a) 11.5 (b) 1.0 (c) 3.5	1,758	14.8	(a) 14.1 (b) 1.2 (c) 4.1	27.1
<b>TOTAL .. .. .</b> <i>(1) 56.7, (2) 66.7</i>	<b>87.1</b>	(a) 75.5 (b) 13.2 (c) 66.3	<b>1,781</b>	<b>196.8</b>	(a) 325.3 (b) 48.9 (c) 115.4	<b>695.5</b>