THE AUTOMOTOR

AND

HORSELESS VEHICLE

POCKET BOOK

OF

AUTOMOTIVE FORMULÆ.

AND

COMMERCIAL INTELLIGENCE

FOR

1899.

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PREFACE.

THAT the former issues of this work have met a distinct want on
the part of those engaged in the Moto-Vehicle industry is shown
by the fact that every copy of them has been sold. In the present Edition
many alterations will be noticed. Matter which seemed to the Compiler
either obsolete or inappropriate has been eliminated, being replaced by
other and, in many cases, original matter. On the appearance of the 1898
Edition, it was criticised in some quarters as being too scientific and
technical, and embodying much information of but little or any use to
the Automobilist. The reply to this is that, as the result of consultation
with leading Engineers, this information has been increased. To
mention but a few criticisms: It was asked, What had the Morse Code
of Signals to do with Automobilism? The answer is, Moto-Vehicles
now play an important part in military operations. On fairly good roads,
they are superior to cavalry for scouting purposes, while a knowledge of
the Morse Code enables a Volunteer Automobilist to become a most
important unit. This has been abundantly demonstrated during the recent
Military Manœuvres on the Continent. In the present Pocket Book not
only is the Morse Code retained, but Coulomb's Flashing Signals are added.
Similarly, certain Nautical Tables have been retained, to enable the time
of sunset—*i.e.*, the time for lighting lamps—to be ascertained accurately,
as cases have already arisen in which the liability for collision, &c., is
largely determined by the exhibition of lamps at the proper time. It must
be remembered, too, that the object in view in publishing this Pocket Book
is partly educational and partly a desire to issue in a convenient and compact
form, for the use of Designers, Constructors, and Mechanics, a Handbook
embodying most of the information likely to be required by them.

The second part of the Pocket Book is devoted to the Commercial aspect
of Automobilism. This part of the work will be especially valuable to
the business man, as it not only tells him Who's Who in the industry, but
gives the financial status of every Company engaged in the manufacture
of Moto-Vehicles or of their component parts. In order to indicate the
growth of the Automobile industry, it may be mentioned that last year
the Automotor Directory was comprised in the compass of five pages:
this year it occupies twenty. Last year the list of Foreign Manufac-
turers filled eight pages, this year the list occupies thirteen. A feature
which will doubtless be much appreciated is the French and English
Glossary of Technical Terms. This has been prepared with special
reference to the construction and handling of Moto-Vehicles.

It only remains to say that the reception of last year's Pocket Book is
most encouraging and gratifying to its Compiler and Editor,

GEO. HERBERT LITTLE, C.E.

62, St. Martin's Lane,
    London, *December* 22, 1898.

CONTENTS.

ALMANACK FOR 1899.

BEGINNING OF THE SEASONS.

						d.	h.
Spring	..	..	Sun enters	Aries	March 20	8	
Summer	..	..	,,	Cancer	June 21	4	
Autumn	..	..	,,	Libra	Sept. 22	18	
Winter	..	..	,, ..	Capricornus	Dec. 21	13	

The Equinoxes occur when Spring and Autumn begin, and the Solstices at the beginning of Summer and Winter.

DATES OF FESTIVALS, &C.

Ash Wednesday	..	..	..	..	..	..	Feb.	15
Lady Day	..	..	..	..	..	..	Mar.	25
Good Friday	..	..	..	..	..	..	,,	31
Easter Sunday	..	..	..	..	..	..	April	2
St. George	..	..	..	..	..	..	,,	23
Whit Sunday..	..	..	..	..	..	..	May	21
Trinity Sunday	..	..	..	..	..	..	,,	28
Accession of Queen Victoria		..	..	..	..	..	June	20
Midsummer Day	..	..	..	..	..	..	,,	24
Michaelmas Day	..	..	..	..	..	..	Sept.	29
Birth of Prince of Wales	..	..	..	..	..	..	Nov.	9

PRINCIPAL FIXTURES FOR 1899.

Jan. 14–21.	Bradford Cycle and Moto-Car Exhibition.
April	Accumulator Trials in Paris, Organised by Automobile Club, Paris.
April 11.	Annual General Meeting of the S.P.T.A., Liverpool.
May	Mid-European Moto-Car International Exhibition, Berlin.
June 1.	Moto-Cab Competition. Organised by Automobile Club, Paris.
June	Moto-Vehicle Exhibition and Competition. Organised by Automobile Club, London.
June 19.	Royal Agricultural Society's Show at Maidstone.
June–Sept.	Exhibition of Moto-Vehicles at Ghent.
Sept.	Heavy Moto-Vehicle Trials. Organised by S.P.T.A., Liverpool.
Oct.	Les Poids Lourds Trials. Organised by Automobile Club, Paris.

JANUARY, 1899.

		The SUN at LONDON				Ap't Decli-nation at Mean Noon	Equation of Time.	The MOON at LONDON.		
		Rises.		Sets.			Sub. f'm M'n Time	Rises Aft.	Sets Morn.	Age. Noon.
		h.	m.	h.	m.	° '	m. s.	h. m.	h. m.	d.
S	1	8	8	4	0	S23 0	3 47	9 5	9 54	19·0
M	2	8	8	4	1	22 55	4 15	10 14	10 8	20·0
Tu	3	8	8	4	2	22 49	4 43	11 23	10 23	21·0
W	4	8	8	4	3	22 43	5 11	Morn.	10 39	22·0
Th	5	8	8	4	4	22 36	5 38	0 36	10 56	23·0 ◖
F	6	8	7	4	6	22 29	6 4	1 52	11 18	24·0
S	7	8	7	4	7	22 22	6 30	3 11	11 46	25·0
S	8	8	6	4	8	22 14	6 56	4 29	A0 24	26·0
M	9	8	6	4	9	22 5	7 21	5 44	1 16	27·0
Tu	10	8	5	4	10	21 56	7 46	6 48	2 25	28·0
W	11	8	5	4	12	21 47	8 10	7 38	3 48	29·0 ●
Th	12	8	4	4	14	21 38	8 33·1	8 16	5 18	0·6
F	13	8	3	4	15	21 28	8 56	8 44	6 49	1·6
S	14	8	2	4	17	21 17	9 18·1	9 6	8 16	2·6
S	15	8	1	4	19	21 6	9 40	9 25	9 39	3·6
M	16	8	0	4	20	20 55	10 0·1	9 44	11 0	4·6
Tu	17	7	59	4	21	20 43	10 21	10 2	Morn.	5·6
W	18	7	58	4	23	20 31	10 40	10 22	0 18	6·6 ☽
Th	19	7	57	4	24	20 19	10 58	10 45	1 33	7·6
F	20	7	56	4	26	20 6	11 16	11 13	2 46	8·6
S	21	7	55	4	28	19 53	11 33	11 49	3 53	9·6
S	22	7	54	4	30	19 39	11 50	A0 33	4 54	10·6
M	23	7	53	4	32	19 25	12 5·1	1 25	5 45	11·6
Tu	24	7	52	4	33	19 11	12 20	2 26	6 25	12·6
W	25	7	51	4	34	18 56	12 34	3 31	6 58	13·6
Th	26	7	50	4	36	18 41	12 47	4 39	7 23	14·6 ◗
F	27	7	49	4	38	18 26	12 59·1	5 47	7 43	15·6
S	28	7	48	4	40	18 10	13 11	6 56	8 1	16·6
S	29	7	46	4	42	17 54	13 21	8 4	8 17	17·6
M	30	7	45	4	44	17 38	13 31	9 13	8 32	18·6
Tu	31	7	43	4	46	17 21	13 40	10 24	8 47	19 6

The times given above are Greenwich Mean times or Railway times. In order to obtain the *actual* or apparent time of the Rising and Setting of the Sun and Moon, the equation of time must be applied. For latitudes other than those of London, another correction must be applied.

FEBRUARY, 1899.

		The SUN at LONDON		Ap't Decli-nation at Mean Noon	Equation of Time. — Sub. f'm M'n Time.	The MOON at LONDON.		
		Rises.	Sets.			Rises Aft.	Sets Morn.	Age. Noon.
		h. m.	h. m.	° ′	m. s.	h. m.	h. m.	d.
W	1	7 41	4 48	S17 4	13 48	11 37	9 4	20·6
Th	2	7 40	4 49	16 47	13 56	Morn.	9 22	21 6
F	3	7 38	4 50	16 29	14 2	0 52	9 47	22·6 ☾
S	4	7 36	4 52	16 11	14 8	2 9	10 19	23·6
S	5	7 34	4 54	15 53	14 13	3 23	11 3	24·6
M	6	7 32	4 56	15 35	14 18	4 31	A0 1	25·6
Tu	7	7 30	4 57	15 16	14 21	5 25	1 15	26·6
W	8	7 29	4 59	14 57	14 24	6 9	2 40	27·6
Th	9	7 27	5 0	14 38	14 26	6 41	4 10	28 6
F	10	7 25	5 2	14 19	14 27	7 6	5 40	0·1 ●
S	11	7 24	5 4	13 59	14 27	7 28	7 7	1·1
S	12	7 22	5 6	13 39	14 27	7 47	8 32	2·1
M	13	7 20	5 8	13 19	14 26	8 6	9 53	3·1
Tu	14	7 18	5 10	12 59	14 24	8 25	11 13	4·1
W	15	7 16	5 12	12 38	14 21	8 48	Morn.	5.1
Th	16	7 14	5 14	12 17	14 17	9 15	0 29	6·1
F	17	7 12	5 16	11 56	14 13	9 49	1 41	7·1 ☽
S	18	7 10	5 18	11 35	14 8	10 29	2 45	8·1
S	19	7 8	5 19	11 14	14 3	11 20	3 40	9.1
M	20	7 6	5 21	10 53	13 56	A0 18	4 24	10·1
Tu	21	7 4	5 23	10 31	13 49	1 23	4 59	11·1
W	22	7 2	5 25	10 9	13 42	2 29	5 26	12·1
Th	23	7 0	5 27	9 47	13 34	3 36	5 49	13·1
F	24	6 58	5 29	9 25	13 25	4 45	6 8	14·1
S	25	6 56	5 30	9 3	13 15	5 54	6 24	15·1 ○
S	26	6 54	5 32	8 41	13 5	7 3	6 40	16·1
M	27	6 52	5 34	8 18	12 54	8 14	6 55	17·1
Tu	28	6 50	5 36	7 55	12 43	9 27	7 11	18·1

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MARCH, 1899.

| | | The SUN at LONDON | | Ap't Declination at Mean Noon | Equation of Time. Sub. f'm M'n Time. | The MOON at LONDON. | | |
		Rises.	Sets.			Rises Aft.	Sets Morn.	Age. Noon.
		h. m.	h. m.	° ′	m. s.	h. m.	h. m.	d.
W	1	6 48	5 37	S7 33	12 31	10 41	7 30	19·1
Th	2	6 46	5 39	7 10	12 19	11 56	7 53	20·1
F	3	6 45	5 41	6 47	12 6	Morn.	8 22	21·1
S	4	6 42	5 43	6 24	11 53	1 11	9 0	22·1
S	5	6 40	5 45	6 1	11 40	2 18	9 52	23·1 ℂ
M	6	6 38	5 46	5 37	11 26	3 16	10 57	24·1
Tu	7	6 36	5 48	5 14	11 11	4 2	A0 14	25·1
W	8	6 34	5 50	4 51	10 57	4 38	1 39	26·1
Th	9	6 31	5 51	4 27	10 42	5 6	3 6	27·1
F	10	6 28	5 53	4 4	10 26	5 29	4 34	28·1
S	11	6 26	5 55	3 40	10 11	5 49	5 59	29·1●
S	12	6 23	5 57	3 17	9 54	6 8	7 23	0·7
M	13	6 21	5 58	2 53	9 38	6 28	8 45	1·7
Tu	14	6 18	6 0	2 29	9 21	6 50	10 5	2·7
W	15	6 16	6 2	2 6	9 5	7 16	11 20	3·7
Th	16	6 13	6 4	1 42	8 47	7 47	Morn.	4·7
F	17	6 11	6 6	1 18	8 30	8 25	0 29	5·7
S	18	6 9	6 8	0 55	8 13	9 14	1 30	6·7
S	19	6 7	6 10	0 31	7 55	10 9	2 19	7·7 ☽
M	20	6 5	6 11	0 7	7 37	11 11	2 58	8·7
Tu	21	6 3	6 12	N0 16	7 19	A0 16	3 28	9·7
W	22	6 1	6 14	0 39	7 1	1 24	3 53	10·7
Th	23	5 59	6 15	1 3	6 42	2 32	4 12	11·7
F	24	5 57	6 17	1 26	6 24	3 41	4 30	12·7
S	25	5 54	6 18	1 50	6 5	4 50	4 46	13·7
S	26	5 52	6 20	2 14	5 47	6 1	5 2	14·7
M	27	5 50	6 22	2 37	5 28	7 13	5 18	15·7○
Tu	28	5 48	6 24	3 1	5 10	8 28	5 37	16·7
W	29	5 45	6 26	3 24	4 52	9 44	5 59	17·7
Th	30	5 43	6 28	3 47	4 33	10 58	6 27	18·7
F	31	5 41	6 30	4 10	4 15	Morn.	7 3	19·7

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APRIL, 1899.

		The SUN at LONDON		A'pt Declination at Mean Noon	Equation of Time. Sub. f'm Add to M'n Time.	The MOON at LONDON.		
		Rises.	Sets.			Rises Morn.	Sets Morn.	Age. Noon.
		h. m.	h. m.	° '	m. s.	h. m.	h. m.	d.
S	1	5 38	6 31	N4 34	3 57	0 10	7 49	20·7
S	2	5 36	6 33	4 57	3 39	1 11	8 49	21·7
M	3	5 34	6 35	5 20	3 21	1 59	10 2	22·7 ◑
Tu	4	5 32	6 37	5 43	3 3	2 37	10 23	23·7
W	5	5 29	6 38	6 6	2 45	3 7	▲0 46	24·7
Th	6	5 27	6 40	6 28	2 28	3 31	2 10	25·7
F	7	5 24	6 41	6 51	2 11	3 52	3 33	26·7
S	8	5 22	6 43	7 13	1 54	4 11	4 56	27·7
S	9	5 20	6 44	7 36	1 37	4 30	6 17	28·7 ●
M	10	5 18	6 45	7 58	1 21	4 52	7 37	0·2
Tu	11	5 15	6 46	8 20	1 5	5 16	8 56	1·2
W	12	5 13	6 48	8 42	0 49	5 44	10 9	2·2
Th	13	5 11	6 50	9 4	0 33	6 21	11 14	3·2
F	14	5 9	6 52	9 25	0 18	7 6	Morn.	4·2
S	15	5 7	6 53	9 47	0 3	7 58	0 10	5·2
S	16	5 5	6 55	10 8	0 11	8 59	0 53	6·2
M	17	5 2	6 57	10 30	0 25	10 4	1 28	7·2 ☽
Tu	18	5 0	6 59	10 51	0 39	11 11	1 54	8·2
W	19	4 58	7 0	11 11	0 52	▲0 17	2 16	9·2
Th	20	4 56	7 2	11 32	1 5	1 24	2 36	10·2
F	21	4 55	7 4	11 52	1 18	2 34	2 52	11·2
S	22	4 53	7 6	12 13	1 30	3 45	3 7	12·2
S	23	4 51	7 8	12 33	1 42	4 56	3 23	13·2
M	24	4 49	7 10	12 53	1 53	6 10	3 42	14·2
Tu	25	4 47	7 11	13 12	2 4	7 27	4 2	15·2 ○
W	26	4 45	7 13	13 32	2 15	8 44	4 28	16·2
Th	27	4 43	7 14	13 51	2 25	9 58	5 1	17·2
F	28	4 41	7 16	14 10	2 34	11 3	5 46	18·2
S	29	4 38	7 17	14 29	2 43	11 56	6 44	19·2
S	30	4 37	7 19	14 47	2 51	Morn.	7 53	20·2

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MAY, 1899.

		The SUN at LONDON		Ap't Decli-nation at Mean Noon	Equation of Time. Add to M'n Time.	The MOON at LONDON.		
		Rises.	Sets.			Rises Morn.	Sets Morn.	Age. Noon.
		h. m.	h. m.	° '	m. s.	h. m.	h. m.	d.
M	1	4 35	7 21	N15 5	2 59	0 38	9 12	21·2
Tu	2	4 33	7 23	15 23	3 6	1 10	10 35	22·2 ☾
W	3	4 31	7 25	15 41	3 13	1 35	11 56	23·2
Th	4	4 29	7 26	15 59	3 19	1 56	A1 18	24·2
F	5	4 28	7 27	16 16	3 25	2 16	2 39	25·2
S	6	4 26	7 29	16 33	3 30	2 35	3 58	26·2
S	7	4 24	7 30	16 49	3 34	2 55	5 16	27·2
M	8	4 22	7 31	17 6	3 38	3 17	6 34	28·2
Tu	9	4 21	7 33	17 22	3 41	3 43	7 49	29·2 ●
W	10	4 19	7 34	17 38	3 44	4 16	8 58	0·8
Th	11	4 17	7 36	17 53	3 46	4 58	9 58	1·8
F	12	4 15	7 38	18 9	3 47	5 47	10 47	2·8
S	13	4 14	7 39	18 24	3 48	6 45	11 25	3·8
S	14	4 12	7 41	18 38	3 49	7 50	11 55	4·8
M	15	4 11	7 42	18 53	3 48	8 57	Morn.	5·8
Tu	16	4 10	7 44	19 7	3 48	10 4	0 19	6·8
W	17	4 8	7 45	19 20	3 46	11 11	0 38	7·8 ☽
Th	18	4 6	7 47	19 34	3 44	A0 18	0 55	8·8
F	19	4 5	7 48	19 47	3 42	1 27	1 11	9·8
S	20	4 4	7 49	19 59	3 39	2 36	1 27	10·8
S	21	4 3	7 50	20 12	3 36	3 48	1 44	11·8
M	22	4 2	7 51	20 24	3 32	5 4	2 3	12·8
Tu	23	4 0	7 53	20 35	3 27	6 21	2 27	13·8
W	24	3 59	7 55	20 46	3 22	7 38	2 57	14·8
Th	25	3 58	7 57	20 57	3 17	8 49	3 37	15·8 ○
F	26	3 57	7 58	21 8	3 11	9 50	4 31	16·8
S	27	3 56	7 59	21 18	3 5	10 36	5 39	17·8
S	28	3 55	8 0	21 28	2 58	11 11	6 57	18·8
M	29	3 54	8 1	21 37	2 50	11 46	8 21	19·8
Tu	30	3 53	8 2	21 47	2 42	Morn.	9 44	20·8
W	31	3 52	8 3	21 55	2 34	0 2	11 7	21·8 ☾

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JUNE, 1899.

		The SUN at LONDON		Ap't Declination at Mean Noon	Equation of Time. Add to Sub. f'm M'n Time	The MOON at LONDON.		
		Rises.	Sets.			Rises Morn.	Sets Aft.	Age. Noon.
		h. m.	h. m	° ′	m. s.	h. m.	h. m.	d.
Th	1	3 51	8 4	N22 4	2 25	0 22	0 28	22·8
F	2	3 51	8 5	22 12	2 16	0 41	1 46	23·8
S	3	3 50	8 6	22 19	2 6	1 0	3 5	24·8
S	4	3 50	8 7	22 26	1 56	1 21	4 21	25·8
M	5	3 49	8 8	22 33	1 46	1 45	5 36	26·8
Tu	6	3 48	8 9	22 39	1 35	2 15	6 45	27·8
W	7	3 47	8 10	22 45	1 24	2 53	7 48	28·8
Th	8	3 47	8 11	22 51	1 13	3 39	8 41	0·2 ●
F	9	3 46	8 12	22 56	1 1	4 35	9 22	1·2
S	10	3 46	8 12	23 1	0 50	5 37	9 56	2·2
S	11	3 45	8 13	23 5	0 38	6 42	10 21	3·2
M	12	3 45	8 14	23 9	0 25	7 50	10 42	4·2
Tu	13	3 45	8 15	23 13	0 13	8 57	11 0	5·2
W	14	3 45	8 16	23 16	0 0	10 4	11 16	6·2
Th	15	3 44	8 16	23 19	0 11	11 11	11 32	7·2
F	16	3 44	8 16	23 21	0 24	A0 19	11 48	8·2 ☽
S	17	3 44	8 17	23 23	0 37	1 28	Morn.	9·2
S	18	3 44	8 17	23 25	0 50	2 41	0 6	10·2
M	19	3 44	8 17	23 26	1 3	3 57	0 27	11·2
Tu	20	3 44	8 18	23 26	1 16	5 13	0 54	12·2
W	21	3 45	8 18	23 27	1 29	6 28	1 28	13·2
Th	22	3 45	8 18	23 26	1 42	7 34	2 16	14·2
F	23	3 45	8 19	23 26	1 55	8 27	3 17	15·2 ○
S	24	3 45	8 19	23 25	2 7	9 10	4 32	16·2
S	25	3 46	8 19	23 24	2 20	9 41	5 57	17·2
M	26	3 46	8 18	23 22	2 33	10 6	7 25	18·2
Tu	27	3 46	8 18	23 20	2 45	10 28	8 50	19·2
W	28	3 46	8 18	23 17	2 57	10 47	10 14	20·2
Th	29	3 47	8 18	23 14	3 9	11 6	11 34	21·2
F	30	3 47	8 18	23 11	3 21	11 27	A0 53	22·2 ☾

The times given above are Greenwich Mean times or Railway times. In order to obtain the *actual* or apparent time of the Rising and Setting of the Sun and Moon, the equation of time must be applied. For latitudes other than those of London, another correction must be applied.

JULY 1899.

| | | The SUN at LONDON | | Ap't Declination at Mean Noon | Equation of Time. — Sub. f'm M'n Time. | The MOON at LONDON. | | |
		Rises.	Sets.			Rises Aft.	Sets Aft.	Age. Noon.
		h. m.	h. m.	° '	m. s.	h. m.	h. m.	d.
S	1	3 48	8 18	N23 7	3 33	11 50	2 10	23·2
S	2	3 49	8 17	23 2	3 45	Morn.	3 26	24·2
M	3	3 50	8 17	22 58	3 56	0 17	4 37	25·2
Tu	4	3 51	8 16	22 53	4 7	0 53	5 41	26·2
W	5	3 52	8 16	22 47	4 17	1 35	6 37	27·2
Th	6	3 53	8 15	22 41	4 28	2 27	7 21	28·2
F	7	3 54	8 15	22 35	4 38	3 27	7 57	29·2 ●
S	8	3 55	8 14	22 29	4 47	4 31	8 25	0·6
S	9	3 56	8 14	22 22	4 57	5 37	8 48	1·6
M	10	3 57	8 13	22 14	5 5	6 45	9 7	2·6
Tu	11	3 58	8 13	22 6	5 14	7 52	9 24	3·6
W	12	3 59	8 12	21 58	5 22	8 59	9 39	4·6
Th	13	4 0	8 11	21 50	5 29	10 5	9 55	5·6
F	14	4 1	8 10	21 41	5 36	11 14	10 11	6·6
S	15	4 2	8 9	21 32	5 42	A0 24	10 30	7·6 ☽
S	16	4 3	8 8	21 22	5 48	1 36	10 53	8·6
M	17	4 4	8 7	21 12	5 54	2 50	11 23	9·6
Tu	18	4 5	8 6	21 2	5 59	4 4	Morn.	10·6
W	19	4 6	8 5	20 51	6 3	5 14	0 2	11·6
Th	20	4 7	8 4	20 40	6 7	6 14	0 55	12·6
F	21	4 9	8 3	20 28	6 10	7 0	2 4	13·6
S	22	4 10	8 2	20 17	6 12	7 38	3 25	14·6 ○
S	23	4 11	8 0	20 4	6 14	8 7	4 53	15·6
M	24	4 12	7 58	19 52	6 16	8 31	6 22	16·6
Tu	25	4 14	7 56	19 39	6 17	8 52	7 49	17·6
W	26	4 15	7 54	19 26	6 17	9 12	9 14	18·6
Th	27	4 17	7 53	19 13	6 17	9 32	10 37	19·6
F	28	4 19	7 51	18 59	6 16	9 56	11 57	20·6
S	29	4 21	7 50	18 45	6 14	10 23	A1 14	21·6 ☾
S	30	4 23	7 49	18 31	6 12	10 53	2 28	22·6
M	31	4 24	7 47	18 16	6 10	11 34	3 35	23·6

The times given above are Greenwich Mean times or Railway times. In order to obtain the *actual* or apparent time of the Rising and Setting of the Sun and Moon, the equation of time must be applied. For latitudes other than those of London, another correction must be applied.

AUGUST, 1899.

		The SUN at LONDON		Ap't Decli-nation at Mean Noon		Equation of Time. — Sub. f'm M'n Time.	The MOON at LONDON.		
		Rises.	Sets.				Rises Morn.	Sets Aft.	Age. Noon.
		h. m.	h. m.	° '		m. s.	h. m.	h. m.	d.
Tu	1	4 26	7 46	N18 1		6 7	Morn.	4 33	24·6
W	2	4 27	7 44	17 46		6 3	0 23	5 21	25·6
Th	3	4 28	7 43	17 30		5 58	1 20	5 59	26·6
F	4	4 30	7 42	17 14		5 53	2 22	6 29	27·6
S	5	4 32	7 40	16 58		5 48	3 28	6 54	28·6
☉	6	4 33	7 38	16 42		5 42	4 35	7 14	0 0 ●
M	7	4 35	7 36	16 25		5 35	5 43	7 31	1·0
Tu	8	4 36	7 34	16 8		5 28	6 50	7 47	2·0
W	9	4 37	7 32	15 51		5 20	7 56	8 3	3·0
Th	10	4 39	7 31	15 34		5 11	9 3	8 19	4·0
F	11	4 40	7 29	15 16		5 2	10 13	8 36	5·0
S	12	4 42	7 27	14 58		4 52	11 23	8 57	6·0
☉	13	4 44	7 25	14 40		4 42	A0 34	9 23	7·0
M	14	4 45	7 23	14 21		4 31	1 46	9 59	8·0 ☽
Tu	15	4 46	7 21	14 3		4 20	2 55	10 43	9·0
W	16	4 47	7 19	13 44		4 8	3 58	11 42	10·0
Th	17	4 49	7 17	13 25		3 55	4 50	Morn.	11·0
F	18	4 51	7 15	13 5		3 42	5 32	0 55	12·0
S	19	4 52	7 13	12 46		3 29	6 4	2 19	13·0
☉	20	4 53	7 11	12 26		3 15	6 31	3 47	14·0
M	21	4 55	7 9	12 6		3 0	6 54	5 16	15·0 ○
Tu	22	4 57	7 7	11 46		2 46	7 14	6 44	16·0
W	23	4 59	7 5	11 26		2 30	7 36	8 10	17·0
Th	24	5 1	7 3	11 6		2 14	7 58	9 34	18·0
F	25	5· 2	7 1	10 45		1 58	8 24	10 55	19·0
S	26	5 3	6 59	10 24		1 42	8 55	A0 12	20·0
☉	27	5 5	6 57	10 3		1 25	9 34	1 24	21 0 ◖
M	28	5 7	6 55	9 42		1 7	10 20	2 26	22·0
Tu	29	5 8	6 53	9 21		0 50	11 15	3 17	23·0
W	30	5 10	6 51	8 59		0 32	Morn.	3 59	24·0
Th	31	5 12	6 49	8 38		0 13	0 15	4 32	25·0

The times given above are Greenwich Mean times or Railway times. In order to obtain the *actual* or apparent time of the rising and setting of the Sun and Moon, the equation of time must be applied. For latitudes other than those of London, another correction must be applied.

SEPTEMBER, 1899.

		The SUN at LONDON		Ap't Decli-nation at Mean Noon	Equation of Time. — Add to M'n Time.	The MOON at LONDON.		
		Rises.	Sets.			Rises Morn.	Sets Aft.	Age. Noon.
		h. m.	h. m.	° '	m. s.	h. m.	h. m.	d.
F	1	5 13	6 46	N8 16	0 5	1 20	4 58	26·0
S	2	5 15	6 44	7 54	0 23	2 27	5 19	27·0
⑤	3	5 16	6 42	7 32	0 43	3 33	5 37	28·0
M	4	5 18	6 40	7 10	1 2	4 41	5 54	29·0
Tu	5	5 20	6 37	6 48	1 22	5 47	6 11	0·4●
W	6	5 21	6 35	6 25	1 42	6 55	6 27	1·4
Th	7	5 23	6 32	6 3	2 2	8 3	6 45	2·4
F	8	5 25	6 29	5 40	2 22	9 12	7 4	3 4
S	9	5 26	6 27	5 18	2 43	10 23	7 29	4·4
⑤	10	5 27	6 25	4 55	3 3	11 34	8 0	5·4
M	11	5 29	6 22	4 32	3 24	A0 43	8 40	6·4
Tu	12	5 31	6 20	4 9	3 45	1 47	9 32	7·4 ☽
W	13	5 32	6 18	3 46	4 6	2 41	10 37	8·4
Th	14	5 33	6 16	3 23	4 27	3 25	11 54	9·4
F	15	5 35	6 14	3 0	4 48	4 1	Morn.	10·4
S	16	5 36	6 12	2 37	5 10	4 30	1 16	11·4
⑤	17	5 38	6 10	2 14	5 31	4 54	2 43	12·4
M	18	5 40	6 7	1 51	5 52	5 15	4 10	13·4
Tu	19	5 42	6 5	1 28	6 14	5 37	5 36	14·4○
W	20	5 43	6 2	1 4	6 35	5 59	7 2	15·4
Th	21	5 45	6 0	0 41	6 56	6 23	8 26	16·4
F	22	5 46	5 58	·0 18	7 17	6 54	9 47	17·4
S	23	5 48	5 56	S0 5	7 38	7 31	11 3	18·4
⑤	24	5 49	5 54	0 28	7 59	8 15	A0 12	19·4
M	25	5 51	5 52	0 52	8 20	9 7	1 10	20·4
Tu	26	5 53	5 50	1 15	8 40	10 7	1 56	21·4 ☾
W	27	5 55	5 47	1 38	9 0	11 11	2 32	22·4
Th	28	5 56	5 45	2 2	9 20	Morn.	3 0	23·4
F	29	5 58	5 53	2 25	9 40	0 17	3 24	24·4
S	30	5 59	5 41	2 49	10 0	1 23	3 44	25·4

The times given above are Greenwich Mean times or Railway times. In order to obtain the *actual* or apparent time of the rising and setting of the Sun and Moon, the equation of time must be applied. For latitudes other than those of London, another correction must be applied.

OCTOBER, 1899.

		The SUN at LONDON		Ap't Declination at Mean Noon	Equation of Time — Add to M'n Time	The MOON at LONDON.		
		Rises.	Sets.			Rises Morn.	Sets Aft.	Age. Noon.
		h. m.	h. m.	° ′	m. s.	h. m.	h. m.	d.
S	1	6 1	5 40	S3 12	10 19	2 30	4 1	26·4 ●
M	2	6 3	5 38	3 35	10 38	3 36	4 17	27·4
Tu	3	6 5	5 35	3 58	10 56	4 34	4 34	28·4
W	4	6 7	5 32	4 22	11 15	5 53	4 52	29·4
Th	5	6 9	5 30	4 45	11 33	7 2	5 11	0·7
F	6	6 10	5 27	5 8	11 50	8 12	5 35	1·7
S	7	6 12	5 25	5 31	12 7	9 24	6 4	2·7
S	8	6 14	5 22	5 54	12 24	10 34	6 42	3·7
M	9	6 16	5 20	6 17	12 41	11 38	7 31	4·7
Tu	10	6 17	5 18	6 40	12 57	A0 36	8 30	5·7
W	11	6 19	5 15	7 2	13 12	1 22	9 41	6·7
Th	12	6 20	5 13	7 25	13 27	1 59	10 59	7·7 ☽
F	13	6 22	5 11	7 47	13 42	2 29	Morn.	8·7
S	14	6 24	5 8	8 10	13 56	2 55	0 21	9·7
S	15	6 25	5 6	8 32	14 9	3 17	1 44	10·7
M	16	6 27	5 4	8 54	14 22	3 38	3 8	11·7
Tu	17	6 28	5 2	9 16	14 34	3 59	4 32	12·7
W	18	6 30	5 0	9 38	14 46	4 23	5 55	13·7 ○
Th	19	6 31	4 58	10 0	14 57	4 51	7 18	14·7
F	20	6 32	4 56	10 22	15 8	5 25	8 37	15·7
S	21	6 34	4 54	10 43	15 18	6 6	9 51	16·7
S	22	6 36	4 52	11 4	15 27	6 58	10 55	17·7
M	23	6 38	4 50	11 25	15 36	7 55	11 46	18·7
Tu	24	6 40	4 47	11 46	15 43	8 58	A0 29	19·7
W	25	6 42	4 45	12 7	15 51	10 5	1 0	20·7
Th	26	6 44	4 43	12 28	15 57	11 11	1 26	21·7 ☾
F	27	6 46	4 41	12 48	16 3	Morn.	1 47	22·7
S	28	6 48	4 39	13 8	16 7	0 18	2 5	23·7
S	29	6 50	4 37	13 28	16 12	1 24	2 22	24·7
M	30	6 51	4 36	13 48	16 15	2 30	2 39	25·7
Tu	31	6 53	4 34	14 1	16 17	3 38	2 56	26·7

The times given above are Greenwich Mean times or Railway times. In order to obtain the *actual* or apparent time of the Rising and Setting of the Sun and Moon, the equation of time must be applied. For latitudes other than those of London, another correction must be applied.

· NOVEMBER. 1899.

		The SUN at LONDON.		Ap't Decli- nation at Mean Noon	Equation of Time. Add to M'n Time.	The MOON at LONDON.		
		Rises.	Sets.			Rises Morn.	Sets Aft.	Age. Noon.
		h. m.	h. m.	° ′	m. s.	h. m.	h. m.	d.
W	1	6 55	4 32	S14 27	16 19	4 47	3 15	27·7
Th	2	6 57	4 31	14 46	16 20	5 58	3 38	28·7
F	3	6 59	4 29	15 5	16 20	7 10	4 6	0·1 ●
S	4	7 0	4 27	15 24	16 19	8 22	4 41	1·1
S	5	7 2	4 25	15 42	16 18	9 31	5 27	2·1
M	6	7 4	4 24	16 0	16 15	10 30	6 24	3·1
Tu	7	7 5	4 23	16 18	16 12	11 20	7 32	4·1
W	8	7 7	4 22	16 36	16 8	A0 2	8 49	5·1
Th	9	7 9	4 20	16 53	16 3	0 33	10 9	6·1
F	10	7 10	4 19	17 10	15 58	0 57	11 30	7·1 ☽
S	11	7 12	4 17	17 27	15 51	1 20	Morn.	8·1
S	12	7 14	4 16	17 43	15 44	1 41	0 50	9·1
M	13	7 16	4 14	17 89	15 36	2 2	2 12	10·1
Tu	14	7 18	4 12	18 15	15 27	2 24	3 33	11·1
W	15	7 19	4 11	18 30	15 17	2 50	4 54	12·1
Th	16	7 21	4 10	18 46	15 6	3 20	6 13	13·1
F	17	7 23	4 9	19 0	14 55	3 57	7 29	14·1 ○
S	18	7 25	4 8	19 15	14 42	4 44	8 38	15·1
S	19	7 27	4 7	19 29	14 29	5 40	9 36	16·1
M	20	7 28	4 6	19 43	14 15	6 42	10 23	17·1
Tu	21	7 30	4 4	19 56	14 1	7 48	10 59	18·1
W	22	7 31	4 3	20 9	13 45	8 56	11 26	19·1
Th	23	7 33	4 2	20 22	13 29	10 3	11 50	20·1
F	24	7 34	4 0	20 34	13 11	11 9	A0 10	21·1
S	25	7 36	3 59	20 46	12 53	Morn.	0 27	22·1 ☾
S	26	7 37	3 58	20 58	12 35	0 15	0 43	23·1
M	27	7 39	3 57	21 9	12 15	1 22	1 0	24·1
Tu	28	7 40	3 56	21 19	11 55	2 30	1 18	25·1
W	29	7 42	3 55	21 30	11 34	3 38	1 40	26·1
Th	30	7 44	3 54	21 40	11 12	4 50	2 4	27·1

The times given above are Greenwich Mean times or Railway times. In order to obtain the *actual* or apparent time of the Rising and Setting of the Sun and Moon, the equation of time must be applied. For latitudes other than those of *London,* another correction must be applied.

DECEMBER, 1899.

		The SUN at LONDON		Ap't D eli-nation at Mean Noon	Equation of Time. Add to Sub. f'm M'n Time	The MOON at LONDON.		
		Rises.	Sets.			Rises Morn.	Sets Aft.	Age. Noon.
		h. m.	h. m.	° ′	m. s.	h. m.	h. m.	d.
F	1	7 46	3 53	S21 49	10 50	6 3	2 36	28·1
S	2	7 47	3 52	21 58	10 27	7 15	3 18	29·1
S	3	7 48	3 52	22 7	10 3	8 19	4 12	0·5 ●
M	4	7 49	3 51	22 15	9 39	9 15	5 19	1·5
Tu	5	7 51	3 51	22 23	9 14	9 59	6 35	2·5
W	6	7 52	3 51	22 30	8 49	10 35	7 56	3·5
Th	7	7 53	3 50	22 37	8 23	11 3	9 19	4·5
F	8	7 54	3 50	22 44	7 57	11 26	10 40	5·5
S	9	7 56	3 50	22 50	7 30	11 48	Morn.	6·5 ☽
S	10	7 57	3 49	22 55	7 3	A0 8	0 1	7·5
M	11	7 58	3 49	23 1	6 35	0 29	1 20	8·5
Tu	12	7 59	3 49	23 5	6 7	0 53	2 38	9·5
W	13	8 0	3 49	23 9	5 39	1 20	3 56	10·5
Th	14	8 1	3 49	23 13	5 10	1 54	5 12	11·5
F	15	8 2	3 49	23 17	4 42	2 36	6 22	12·5
S	16	8 3	3 49	23 19	4 12	3 27	7 24	13·5
S	17	8 4	3 49	23 22	3 43	4 27	8 15	14·5 ○
M	18	8 5	3 50	23 24	3 14	5 32	8 55	15·5
Tu	19	8 5	3 50	23 25	2 44	6 40	9 27	16·5
W	20	8 6	3 50	23 26	2 14	7 47	9 53	17·5
Th	21	8 6	3 51	23 27	1 45	8 54	10 14	18·5
F	22	8 6	3 51	23 27	1 15	10 1	10 32	19·5
S	23	8 7	3 51	23 26	0 45	11 6	10 48	20·5
S	24	8 7	3 52	23 25	0 15	Morn.	11 5	21·5
M	25	8 7	3 53	23 24	0 14	0 12	11 22	22·5 ☾
Tu	26	8 8	3 53	23 22	0 44	1 19	11 41	23·5
W	27	8 8	3 54	23 20	1 14	2 29	A0 4	24·5
Th	28	8 8	3 55	23 17	1 43	3 41	0 32	25·5
F	29	8 9	3 56	23 13	2 13	4 52	1 9	26·5
S	30	8 9	3 57	23 10	2 42	6 1	1 56	27·5
S	31	8 9	3 58	23 6	3 11	7 1	2 58	28·5

The times given above are Greenwich Mean times or Railway times. In order to obtain the *actual* or apparent time of the Rising and Setting of the Sun and Moon, the equation of time must be applied. For latitudes other than those of London, another correction must be applied.

Table for finding the Rising and Setting of the Sun, Moon, and Planets.

From Latitude 50° N. to 58° N.

The times given in the Almanac being adapted to Latitude 51° 30′ N., the following Table shows the number of minutes to be added or subtracted for each half degree of Latitude.

Declination.

N. Decl.—Add to rising, subtract from setting.
S. Decl.—Subtract from rising, add to setting.

Subtract from rising and add to setting if Declination is North.
Add to rising and subtract from setting if Declination is South.

Latitude	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
50 0	0	0	1	1	1	1	1	2	2	2	3	3	3	3	4	4	5	5	6	6	6	7	7	8	9	9	10	11
50 30	0	0	0	1	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	5	5	6	6	6	7	7	8	8
51 0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4
51 30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52 0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4
52 30	0	0	0	1	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	5	5	6	6	6	7	7	8	8
53 0	0	0	1	1	1	1	1	2	2	2	3	3	3	3	4	4	5	5	6	6	6	7	7	8	9	9	10	11
53 30	1	1	1	1	2	2	2	3	3	3	4	4	5	5	6	6	7	8	8	9	10	10	11	12	13	13	14	16
54 0	1	1	1	2	2	2	3	3	4	4	5	5	6	6	7	8	9	9	10	11	12	13	14	15	16	18	19	20
54 30	1	1	2	2	3	3	4	4	5	5	6	7	7	8	9	10	11	12	13	14	15	16	17	18	20	22	23	25
55 0	1	1	2	2	3	4	4	5	6	6	7	8	9	10	11	11	12	13	14	16	18	20	22	23	25	27	30	35
55 30	1	1	2	3	3	4	5	6	6	7	8	9	11	13	14	16	18	20	21	23	25	27	29	31	34	37	40	
56 0	1	2	3	3	4	5	6	7	8	9	10	11	12	13	15	16	18	20	21	23	25	27	30	33	36	39	42	46
56 30	1	2	3	4	5	6	7	8	9	10	11	13	14	15	17	18	20	22	23	25	27	28	30	32	34	37	40	44
57 0	1	2	3	4	5	6	7	8	9	10	12	13	15	17	18	20	22	24	26	28	30	33	35	37	40	44	48	52
57 30	1	3	4	4	5	7	8	9	11	12	14	15	17	18	20	22	24	26	28	30	32	35	38	41	45	49	53	55
58 0	1	3	4	6	7	8	9	10	11	13	15	16	18	20	22	24	26	28	31	33	37	39	42	46	49	54	59	68

Example—At what time must the lamps on a motor vehicle be lit at Edinburgh on May 20?

On referring to the almanack it is seen that the sun's declination for that date is 20° N., and Edinburgh is in Lat. 56° N. From the table the correction is 22 minutes, and from the almanack the sun sets at 7.49 p.m. Since the declination is N., the correction has to be added. We thus have :—

		h. m.	
Time of sunset, London	....	7 49	p.m.
	Correction +	0 22	
Time of sunset, Edinburgh	.. ..	8 11	,,
Allow one hour extra by Act of Parliament		1 0	
Time of lighting lamps at Edinburgh	....	9 11	,,

To Find the Time of Rising or Setting of the Sun Accurately.

Rule—To the log. tangent of the latitude add the log. tangent of the correct declination, the sum will be the log. cosine of the hour angle or the time of setting; or the time *from* noon if rising. The time so found must be corrected for equation of time, parallax and refraction, and also for the elevation of the observer.

DIFFERENCE OF TIME.						MINS.	SECS.
Birmingham is slow on Greenwich			..	..	..	7	33
Chester	,,	,,	..	..	..	11	32
Dublin	,,	,,	..	..	..	25	22
Edinburgh	,,	,,	..	..	..	12	43
Exeter	,,	,,	..	..	..	14	18
Glasgow	,,	,,	..	..	..	17	00
Hull	,,	,,	..	..	..	1	8
Leeds	,,	,,	..	..	..	6	4
Liverpool	,,	,,	..	..	..	11	53
Manchester	,,	,,	..	..	..	9	00
Newcastle	,,	,,	..	..	..	6	24
Oxford	,,	,,	..	..	..	5	00
Portsmouth	,,	,,	..	..	..	4	24
York	,,	,,	..	..	..	4	24
Office of the Automotor Journal is slow on Greenwich						0	32
Cambridge is fast on Greenwich	..	..	..	..	..	0	23
Colchester	,,	,,	..	..	..	..	3	32
Dover	,,	,,	..	..	..	..	5	16
Norwich	,,	,,	..	..	..	..	0	12
Boston	,,	,,	..	..	..	..	0	0
Grimsby	,,	,,	..	..	..	..	0	0
Paris	,,	,,	..	..	..	..	9	21
Rome	,,	,,	..	..	..	..	49	54
Vienna	,,	,,	..	..	..	..	65	32
St. Petersburg	,,	,,	..	..	..	..	121	00
Constantinople	,,	,,	..	..	..	.	115	41
Frankfort	,,	,,	..	..	..	..	34	00
Berlin	,,	,,	.	.	..	..	53	35
Geneva	,,	,,	..	..	..	..	24	2

SIGNS OF WEATHER.

Whether clear or cloudy, a rosy sky at sunset presages fine weather; a red sky in the morning, bad weather, or much wind, perhaps rain; a grey sky in the morning, fine weather; a high dawn, wind ; a low dawn, fair weather.

Soft-looking or delicate clouds foretell fine weather, with moderate or light breezes ; hard-edged, oily-looking clouds, wind. A dark, gloomy blue sky is windy ; but a light, bright-blue sky indicates fine weather. Generally, the *softer* the clouds look, the less wind (but, perhaps more rain) may be expected; and the harder, more " greasy," rolled, tufted, or ragged, the stronger the coming wind will prove. Also, a bright yellow sky at sunset presages wind; a pale yellow, wet; and thus, by the prevalence of red, yellow, or grey tints, the coming weather may be foretold very nearly—indeed, if aided by instruments, almost exactly.

Small inky-looking clouds foretell rain ; light scud clouds driving across heavy masses show wind and rain ; but if alone, may indicate wind only.

High upper clouds crossing the sun, moon, or stars in a direction different from that of the lower clouds, or the wind then felt below, foretell a change of wind.

After fine, clear weather, the first signs in the sky of a coming change are usually light streaks, curls, wisps, or mottled patches of white distant clouds, which increase, and are followed by an overcasting of murky vapour that grows into cloudiness. This appearance, more or less oily, or watery, as wind or rain will prevail, is an infallible sign.

Light, delicate, quiet tints or colours, with soft, undefined forms of clouds, indicate and accompany fine weather; but gaudy or unusual hues, with hard, definitely-outlined clouds, foretell rain, and probably strong wind.

When sea-birds fly out early and far to seaward, moderate wind and fair weather may be expected. When they hang about the land, or over it, sometimes flying inland, expect a strong wind, with stormy weather. As many creatures beside birds are affected by the approach of rain or wind, such indications should not be slighted by an observer who wishes to foresee weather.

Remarkable clearness of atmosphere near the horizon, distant objects, such as hills, unusually visible, or raised (by refraction), and what is called " a good *hearing* day," may be mentioned among signs of wet, if not wind, to be expected.

More than usual twinkling of the stars, indistinctness or apparent multiplication of the moon's horns, haloes, " wind dogs " (fragments or pieces of rainbows, sometimes called " wind galls "), seen on detached clouds, and the rainbow, are more or less significant of *increasing* wind, if not approaching rain, with or without wind.

Lastly, the dryness or dampness of the air, and its temperature (for the season) should *always* be considered, *with other* indications of change, or continuance of wind and weather.

On Barometer scales, the following contractions may be useful:—

A Rising Barometer.

A "rapid" rise indicates unsettled weather.

A "gradual" rise indicates settled weather.

A "rise" with dry air, and cold increasing in summer, indicates wind from northward, and if rain has fallen better weather is to be expected.

A "rise" with moist air and a low temperature, indicates wind and rain from northward.

A "rise" with southerly wind, indicates fine weather.

A Steady Barometer.

With dry air and a seasonable temperature, indicates a continuance of very fine weather.

A Falling Barometer.

A "rapid" fall indicates stormy weather.

A "rapid" fall, with westerly wind, indicates stormy weather from northward.

A "fall," with a northerly wind, indicates storm, with rain and hail in summer, and snow in winter.

A "fall," with increasing moisture in the air, and the heat increasing, indicates wind and rain from southward.

A "fall," with dry air and cold increasing (in winter) indicates snow.

A "fall," after very calm and warm weather, indicates rain, with squally weather.

Dr. Clarke's Weather Table.

If the Moon change between	Summer.	Winter.
12 and 2 p.m.	Very rainy..........	Snow and rain.
2 — 4 ,,	Changeable	Fair and mild.
4 — 6 ,,	Fair	Fair.
6 — 8 ,,	Fair, if wind at N.W.	Frosty, if wind N. or N.E.
6 — 8 ,,	Rainy, if at S. or S.W.	Rain or snow, if S. or S.W.
8 —10 ,,	Rainy, if at S. or S.W.	Rain or snow, if S. or S.W.
10 —12 ,,	Fair	Fair and frosty.
12 — 2 a.m.	Fair	Hard frost, unless S. or S.W.
2 — 4 ,,	Cold and showery....	Snow and stormy.
4 — 6 ,,	Rain	Snow and stormy.
6 — 8 ,,	Wind and rain	Stormy weather.
8 —10 ,,	Changeable	Rain if wind W., snow if E.
10 —12 ,,	Frequent showers....	Cold, with high wind.

TABLE OF MOONLIGHT NIGHTS.

When the moon is 4 days old, it shines till about 10 p.m.
,,	,,	5	,,	,,	11	,,
,,	,,	6	,,	,,	12	,,
,,	,,	7	,,	,,	1 a.m.	

When the moon is 15 days old, full moon rises about 6 p.m.
,,	,,	16	,,	,,	7	,,
,,	,,	17	,,	,,	8	,,
,,	,,	18	,,	,,	10	,,
,,	,,	19	,,	,,	11	,,
,,	,,	20	,,	,,	12	,,

Many people believe that there is some connection between the moon and the weather. From a scientific point of view this is a mere vulgar superstition ; at the same time a long series of observations indicates that certain weather is probable with certain positions of the moon. According to this theory, if the new or full moon takes place between noon and 2 p.m., or between 4 and 6 a.m., rain may be predicted. Fair weather may be expected when either new or full moon takes place between 4 and 6 p.m., or between 10 p.m. and 2 a.m.

Wind Pressure.

The pressure of the wind is, it is generally agreed, expressed with tolerable accuracy, sufficient for all practical purposes, by Hawksley's formula—

Let v = velocity in feet per second ;
h = height through which a body must fall in order to generate a velocity, v ;
w = weight of a cubic foot of air = 0.0765 lb. ;
g = acceleration of gravity.

Then—

$$h = \frac{v^2}{2g}.$$

And since p, the pressure of a fluid striking a plane perpendicularly, and then escaping at right-angles to its original path, is that due to the height h, we have—

$$p = \frac{wv^2}{g}.$$
$$= \frac{.0765\ v^2}{32}.$$
$$= \left(\frac{v}{20}\right)^2 \text{ (nearly).}$$

From this formula is constructed the following table:—

Velocity in feet per second, v.	Velocity in miles per hour.	Pressure in lbs. per square foot.
10	6·8	0·25
40	27·2	4·00
70	47·6	12·25
100	68·0	25·00

If the pressure is applied to an inclined surface, then the effective pressure, p_e, will be—

$$p_e = \left(\frac{v \sin \theta}{20} \right)^2$$

where θ is the internal angle made between the direction of the wind and the plane surface.

The Morse Code.

As all moto-vehicles must be furnished with a sound-producing instrument, either a whistle, horn, or bell, as well as with lamps, automobilists are readily enabled by the Morse code to signal or send a message, either by sound or by flashing signals, a considerable distance. Apart from this, a knowledge of the Morse is invaluable to the traveller, soldier, and seaman.

A · —　　　　J · — — —　　　S · · ·
B — · · ·　　　K — · —　　　　T —
C — · — ·　　　L · — · ·　　　U · · —
D — · ·　　　　M — —　　　　　V · · · —
E ·　　　　　　N — ·　　　　　　W · — —
F · · — ·　　　O — — —　　　　X — · · —
G — — ·　　　　P · — — ·　　　Y — · — —
H · · · ·　　　Q — — · —　　　Z — — · ·
I · ·　　　　　R · — ·

Numerals.

1　　　　　　　4　　　　　　　7
· — — — —　　· · · · —　　— — · · ·

2　　　　　　　5　　　　　　　8
· · — — —　　· · · · ·　　— — — · ·

3　　　　　　　6　　　　　　　9
· · · — —　　— · · · ·　　— — — — ·

0
— — — — —

B 2

THE AUTOMOTOR LOG.

——◆——

Log of the Automotor _____

owned by _____

in charge of _____

while on a journey from _____

to _____

Time of departure _____ *date* _____

State of Roads _____

Weather _____

No. of Persons on board _____

lbs.

Weight of Persons on board ..   ..

    ,,   **Fuel**   ,,   · ..   ..

    ,,   **Stores**   ,, ...

    ,,   **Luggage**   ,, ...

        Total Weight   ..   ..

Total distance traversed _____ *miles.*

Whole time on journey _____*d.* __ ____*h.*_____*m.*

Deduct for stoppages _____*d.* _____*h.*_____*m.*

Net time in motion .. _____*d.*_____*h.* ___ __ _*m.*

Greatest speed attained _____ _____

Average ,, ,, $\left(\frac{miles}{hours}\right)$ _____*miles per hour.*

Power developed by Motor _____ *I.H.P.*

,, ,, ,, _ _ _ _ _ _ _ _ _ _ *B.H.P.*

lbs.

Fuel Consumption .. ..

,, ,, *per mile* .. ..

,, ,, *per B.H.P.*.. .. ..

Water Consumption .. ..

., ,, *per mile* .. ..

Stores ,, *(Oil, Waste, &c.)* .. .. ..

Arrivals at	Times.	Distances.	Speeds.	Remarks on Roads, Gradients, &c.

POSTAL INFORMATION, STAMPS, &c.

Rates of Postage.

To and from all parts of the United Kingdom, including Channel Islands, for Prepaid letters :—

The Inland Letter Rate has been reduced for all weights—under 4 oz. 1d., and for every additional 2 oz. $\frac{1}{2}d$.

Not exceeding 4 oz.	..	1d.	Ex. 10, but not ex. 12 oz.			3d.
Ex. 4, but not ex. 6 oz.	..	1$\frac{1}{2}d$.	„ 12,	„	14 „	3$\frac{1}{2}d$.
„ 6, „ 8 „	..	2d.	„ 14, . „		16 „	4d.
„ 8, „ 10 „	..	2$\frac{1}{2}d$.	And so on, $\frac{1}{2}d$. for every 2 oz.			

A letter posted unpaid is chargeable on delivery with double postage, and a letter posted insufficiently paid is chargeable with double the deficiency. Size not to exceed 24 × 12 inches, by 12 inches in depth.

Post Cards.

Post Cards, bearing a halfpenny impressed stamp, are available for transmission between places in the United Kingdom only, in packets of 10 for 5$\frac{1}{2}d$. "Stout" cards 6d.

Postage on Inland Registered Newspapers.

Prepaid Rate.—On each Registered Newspaper, whether posted singly or in a packet, the postage when prepaid is one halfpenny; but a packet containing two or more Registered Newspapers is one halfpenny for every two ounces. Newspaper Wrappers, 7 for 4d.

No packet of Newspapers to exceed 5 lbs., or 24 × 12 × 12 inches in size. Name of sender should be put on cover to prevent loss.

Inland Book Post.

The Book Post rate is one halfpenny for every 2 oz. or fraction of 2 oz. This rate is now the same as letter rates. See above. No Book Packet to exceed 5 lbs., or 24 inches in length, 12 inches in width, and 12 inches in depth.

Inland Pattern and Sample Post.

Same rates as for Letters. See above.

Registration.

By the prepayment of a fee of 2d., any letter, newspaper, book packet or parcel may be registered to any place in the United Kingdom, British Colonies, or Foreign Countries in Postal Union.

The Post Office will not in any way undertake the safe conveyance of *unregistered* letters containing valuable articles; and all letters found to contain coin, etc., will be charged on delivery with a double registration fee. Money sent by post ought to be enclosed in envelopes sold at Post Offices. A receipt should be obtained. On certain conditions, compensation is given on loss of ordinary registered letter with fee of 2*d*., to £5. Secured with fee of 3*d*., £10; 4*d*., £15; 5*d*., £20; 6*d*., £25; 7*d*., £30; 8*d*., £35; 9*d*., £40; 10*d*., £45; and 11*d*., to £50.

   N.B.—Compensation only allowed on Loss of Money if sent by Letter Post.

   Bank Notes or Postal Orders must be claimed for by production of the number of each.

Inland Parcels Post.

   Parcels not exceeding 11 lbs. are received for transmission between places of the United Kingdom—

Under 1 lb.	3*d*.	Maximum length ..	3 ft. 6 in.	
And for every lb. or part	1*d*.	,, length & girth	} 6 ft.	
Up to 9 lbs. 11*d*., or 11 lbs.	1/0	combined		

Parcels to be marked on left hand corner "Parcels Post," must be prepaid, securely packed and plainly addressed, and not contain anything offensive or explosive.

Compensation given for loss, partial or total, on certain conditions .. .. ..
$\left\{\begin{array}{l} \text{On ordinary Parcels up to £2} \\ \text{With an extra fee of 2}d\text{., £5} \\ \text{,, 3}d\text{., £10} \\ \text{Up to a fee of 11}d\text{., covering £50} \end{array}\right.$

Express Delivery Service.

   Messages, letters, or parcels, and other articles are conveyed the entire distance by special messenger from all offices from which there is a delivery of telegrams, and are delivered in any part of the town or rural district at the following rates, handed in over the counter :—

   Letters, parcels, etc., under 1 lb., 3*d*. for every mile or part.

   Letters, parcels, etc., over 1 lb., are charged 1½*d*. each pound or part over the first, in addition to 3*d*. per mile.

   If distance exceed 2 miles, and if no public conveyance is available in both directions, the cost of a special conveyance must be paid in addition to the above fees—generally 1/- per mile.

   Reply delivered *en route* to offices, or half mile from originating office, at half rates.

   Prepaid letters under 1 oz. can be accepted by the principal railways at their stations to be forwarded by passenger train at a fee of 2*d*. Letters, on arrival at town, to be posted at nearest letter box *to station, to* be delivered in usual manner.

Postal Orders.

(Broken Amounts Affixed in Stamps up to 5d.)

Are issued in the United Kingdom at the following rates :—

Orders for sums, 1/- and 1/6 ..   ..   ½d. each.

    ,,   2/-, 2/6, 3/-, 3/6, 4/-, 4/6, 5/-, 7/6, 10/-, 10/6 1d. ,,.

    ,.   15/-, and 20/-, ·   ..   .. 1½d. ,,

These Orders may be crossed thus⎯& Co., and thus made payable only through a Bank. All Orders must be signed at foot by the party to whom they are payable.

Money Orders for the United Kingdom.

Money Orders are granted in the United Kingdom

For sums under £1   ..   2d. | For £3 and under £4   ..   4d.

,, £1 and under £3 ..   3d. |

Telegraph Money Orders—Inland.

Money may be transmitted by Telegraph Money Order between all head and branch offices in the United Kingdom authorised to transact Telegraph and Money Order business. The commission is—

For sums under £3 -   4d. | For sums from £3 and under £10, 6d.

In addition to the commission a charge is made at the ordinary rate of an Inland Telegram, and reply at the minimum charge of 9d. Telegram to Payee, minimum 6d.

Money Orders payable Abroad.

Money Orders are issued in the United Kingdom, payable abroad in British Possessions, Colonies, and Agencies, and nearly all Foreign Countries, for sums not exceeding £2, 6d.; £6, 1/- ; £10, 1/6.

Foreign Parcels Post

Is now in operation to most of the European States and British Possessions abroad, as per special rates.

Post Office Savings Banks.

No deposit of less than a shilling is received, nor any pence, and not more than £50 in one year. No further deposit is allowed when the amount standing in depositor's name exceeds £200, inclusive of interest. Interest is allowed at the rate of 2½ per cent. (or sixpence in the pound) per annum—that is, at the rate of one halfpenny per pound per month.

Post Office Telegrams, July 1891.

The charge for Telegrams throughout the United Kingdom is 6d. for the first twelve words, and ½d. for each other word, addresses counted. Messages are repeated where necessary at half rates, and repaid if P.O. is in error. Telegrams are now delivered free within 3 miles of the Terminal Office, or within the Town Postal Delivery of the Head Office when that extends beyond 3 miles.

Telegrams to Countries in Europe are charged per word :—

Austria	..	3d.	Greece	..	6½d.	Portugal	..	3½d.
Belgium	..	2d.	Holland	..	2d.	Russia	..	5½d.
Denmark	..	3½d.	Hungary	..	3d.	Spain	..	3½d.
France	..	2d.	Italy ..	..	3d.	Sweden	..	4d.
Germany	..	2d.	Malta	..	6d.	Switzerland ..	..	3d.
Gibraltar	..	3½d.	Norway	..	3½d.	Turkey in Europe	6½d.

New York, U.S.	1/-	California	..	1/6	Canada	..	1/0
Victoria	..	4/10	Hong Kong	..	5/6	India	..	3/8

Signalling Ships at Foreign Semaphore Stations, 10d.

The number of letters allowed to a word in plain language is now 15, and the number of figures allowed to a word in cypher is now 5.

General Postal Union.

Correspondence with all Foreign Countries, with certain exceptions* as to prepayment and registration, is now transmitted at the following uniform rate :—

Letters, 2½d. per half-ounce ; Post Cards, 1d. each.

Newspapers and Printed Papers, ½d. per 2 oz. ; limit, 4 lbs. ; British Colonies and Possessions, 5 lbs.

Patterns of Merchandise, and legal and Commercial Documents, ½d. for every 2 oz. Minimum charge, 1d. ; limit of size, 12 × 8 × 4 ; weight, 12 oz., with exceptions.

Letters not prepaid will be returned to sender. Registration fee 2d., which, in addition to the postage, must be prepaid. No money, jewellery, nor articles of saleable value, may be enclosed. Patterns not to exceed half a pound, nor printed papers 4 lbs.

INLAND BILLS for sums—

Under £5	..	1d.	Under £25	..	3d.	Under £75	..	9d.
„ 10	..	2d.	„ 50	..	6d.	„ 100	..	1/-

And for every £100 or part, in addition, 1/-.

RECEIPT or DISCHARGE for payment of £2 or upwards, 1d.

DRAFT or ORDER for any sum payable to bearer or to order on demand, 1d.

* The postage on letters from this country for India and the under-mentioned British Colonies and Protectorates is 1d. per ½ oz.:—

Aden	Falkland Islands	Niger Coast Protectorate
Ascension	Fiji Islands	Niger Territory
Bahamas	Gambia	St. Helena
Barbados	Gibraltar	Sarawak
Bermuda	Gold Coast Colony	Seychelles
British Central Africa	Hongkong	Sierra Leone
British East Africa	Johore	Straits Settlements
British Guiana	Lagos	Tobago
British Honduras	Leeward Islands	Trinidad
Canada	Malay States	Turks Islands
Ceylon	Natal	Uganda
Cyprus	Newfoundland	Windward Islands

LEGAL.

LOCOMOTIVES ON HIGHWAYS ACT.

59 & 60 V., c. 36.

An Act to amend the Law with respect to the Use of Locomotives on Highways, 1896.

BE it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows :—

1.—(1) The enactments mentioned in the schedule to this Act, and any other enactment restricting the use of locomotives on highways and contained in any public, general, or local and personal Act in force at the passing of this Act, shall not apply to any vehicle propelled by mechanical power if it is under three tons in weight unladen, and is not used for the purpose of drawing more than one vehicle (such vehicle with its locomotive not to exceed in weight unladen four tons), and is so constructed that no smoke or visible vapour is emitted therefrom except from any temporary or accidental cause ; and vehicles so exempted, whether locomotives or drawn by locomotives, are in this Act referred to as light locomotives.

Provided that—

> (a) The council of any county or county borough shall have power to make bye-laws preventing or restricting the use of such locomotives upon any bridge within their area, where such council are satisfied that such use would be attended with damage to the bridge or danger to the public.

> (b) A light locomotive shall be deemed to be a carriage within the meaning of any Act of Parliament, whether public, general, or local, and of any rule, regulation, or bye-law, made under any Act of Parliament, and, if used as a carriage of any particular class, shall be deemed to be a carriage of that class, and the law relating to carriages of that class shall apply accordingly.

(2) In calculating for the purposes of this Act the weight of a vehicle unladen, the weight of any water, fuel, or accumulators, used for the purpose of propulsion, shall not be included.

2. During the period between one hour after sunset and one hour before sunrise, the person in charge of a light locomotive shall carry attached thereto a lamp so constructed and placed as to exhibit a light in accordance with the regulations to be made by the Local Government Board.

3. Every light locomotive shall carry a bell or other instrument capable of giving audible and sufficient warning of the approach or position of the carriage.

4. No light locomotive shall travel along a public highway at a greater speed than fourteen miles an hour, or than any less speed that may be prescribed by regulations of the Local Government Board.

5. The keeping and use of petroleum or of any other inflammable liquid or fuel for the purpose of light locomotives shall be subject to regulations made by a Secretary of State, and regulations so made shall have effect notwithstanding anything in the Petroleum Acts, 1871 to 1881.

6.— (1) The Local Government Board may make regulations with respect to the use of light locomotives on highways, and their construction, and the conditions under which they may be used.

(2) Regulations under this section may, if the Local Government Board deem it necessary, be of a local nature and limited in their application to a particular area, and may, on the application of any local authority, prohibit or restrict the use of locomotives for purposes of traction in crowded streets, or in other places where such use may be attended with danger to the public.

All regulations under this section shall have full effect notwithstanding anything in any other Act, whether general or local, or any bye-laws or regulations made thereunder.

Every regulation purporting to be made in pursuance of this section shall be forthwith laid before both Houses of Parliament.

7. A breach of any bye-law or regulation made under this Act, or of any provision of this Act, may, on summary conviction, be punished by a fine not exceeding ten pounds.

8.—(1) On and after the first day of January next after the passing of this Act there shall be granted, charged, and paid in *Great Britain* for every light locomotive, which is liable to duty

either as a carriage or as a hackney carriage under section four of the Customs and Inland Revenue Act, 1888, an additional duty of excise at the following rate ; namely :—

	£	s.	d.
If the weight of the locomotive exceeds one ton unladen, but does not exceed · two tons unladen	2	2	0
If the weight of the locomotive exceeds two tons unladen	3	3	0

(2) Every such duty shall be paid together with the duty on the licence for the locomotive as a carriage or a hackney carriage, and shall in England be dealt with in manner directed with respect to duties on local taxation licences within the meaning of the Local Government Act, 1888 ; and in Scotland be paid into the Local Taxation (Scotland) Account, and be dealt with as part of the residue within the meaning of section two, subsection (3), of the Local Taxation (Customs and Excise) Act, 1890.

9. The requirements of sub-section (4) of section twenty-eight of the Highways and Locomotives Amendment Act, 1878, may be from time to time varied by order of the Local Government Board.

10. In the application of this Act to Scotland a reference to the Secretary for Scotland shall be substituted for a reference to the Local Government Board, a reference to the road authority of any county or burgh for a reference to the council of a county or county borough, and a reference to sub-section (4) of section three of the Locomotives Amendment (Scotland) Act, 1878, for a reference to sub-section (4) of section twenty-eight of the Highways and Locomotives Amendment Act, 1878.

11. In the application of this Act to Ireland a reference to the Local Government Board for Ireland shall be substituted for a reference to the Local Government Board, and a reference to the council of a county shall be construed in an urban sanitary district under the Public Health (Ireland) Act, 1878, as a reference to the urban sanitary authority, and elsewhere as a reference to the grand jury.

12. This Act may be cited as the Locomotives on Highways Act, 1896, and shall come into operation on the expiration of three months from the passing thereof.

THE REGULATIONS OF THE LOCAL GOVERNMENT BOARD RESPECTING AUTO-MOTOR CARRIAGES.

———◆———

ENGLAND, WALES, AND IRELAND.

THE Local Government Board have issued the following Regulations to the county councils and certain other local authorities in England and Wales with respect to the use of light locomotives on highways, and their construction, and the conditions under which they may be used, and directed that the same should have effect on and after November 14th, 1896 :—

ARTICLE I.

In this Order :—

The expression "carriage" includes a wagon, cart, or other vehicle.

The expression "horse" includes a mule or other beast of draught or burden, and the expression "cattle" includes sheep.

The expression "light locomotive" means a vehicle propelled by mechanical power which is under three tons in weight unladen, and is not used for the purpose of drawing more than one vehicle (such vehicle with its locomotive not exceeding in weight unladen four tons), and is so constructed that no smoke or visible vapour is emitted therefrom except from any temporary or accidental cause.

In calculating for the purposes of this Order the weight of a vehicle unladen, the weight of any water, fuel, or accumulators used for the purpose of propulsion shall not be included.

ARTICLE II.

No person shall cause or permit a light locomotive to be used on any highway, or shall drive or have charge of a light locomotive when so used, unless the conditions hereinafter set forth shall be satisfied, namely :—

(1.) The light locomotive, if it exceeds in weight unladen five hundredweight, shall be capable of being so worked that it may travel either forwards or backwards.

(2.) The light locomotive shall not exceed six and a half feet in width, such width to be measured between its extreme *projecting* points.

(3.) The tyre of each wheel of the light locomotive shall be smooth, and shall, where the same touches the ground, be flat and of the width following, namely :—

(a) If the weight of the light locomotive unladen exceeds fifteen hundredweight, but does not exceed one ton, not less than two and a half inches ;

(b) If such weight exceeds one ton, but does not exceed two tons, not less than three inches ;

(c) If such weight exceeds two tons, not less than four inches

Provided that where a pneumatic tyre, or other tyre of a soft and elastic material is used, the tyre may be round or curved, and there may be upon the same projections or bosses rising above the surface of the tyre if such projections or bosses are of the same material as that of the tyre itself, or of some other soft and elastic material. The width of the tyre shall, for the purpose of this proviso, mean the extreme width of the soft and elastic material on the rim of the wheel when not subject to pressure.

(4.) The light locomotive shall have two independent brakes in good working order, and of such efficiency that the application of either to such locomotive shall cause two of its wheels on the same axle to be so held that the wheels shall be effectually prevented from revolving, or shall have the same effect in stopping the light locomotive as if such wheels were so held.

Provided that in the case of a bicycle this Regulation shall apply as if, instead of two wheels on the same axle, one wheel was therein referred to.

(5.) The light locomotive shall be so constructed as to admit of its being at all times under such control as not to cause undue interference with passenger or other traffic on any highway.

(6.) In the case of a light locomotive drawing or constructed to draw another vehicle or constructed or used for the carriage of goods, the name of the owner and the place of his abode or business, and in every such case and in the case of every light locomotive weighing unladen one ton and a half or upwards, the weight of the light locomotive unladen shall be painted in one or more straight lines upon some conspicuous part of the right or off side of the light locomotive in large legible letters in white upon black or black upon white, not less than one inch in height.

(7.) The light locomotive and all the fittings thereof shall be in such a condition as not to cause, or to be likely to cause, danger to any person on the light locomotive or on any highway.

(8.) There shall be in charge of the light locomotive when used on any highway a person competent to control and direct its use and movement.

(9.) The lamp to be carried attached to the light locomotive in pursuance of Section 2 of the Act shall be so constructed and placed as to exhibit, during the period between one hour after sunset and one hour before sunrise, a white light visible within a reasonable distance in the direction towards which the light locomotive is proceeding or is intended to proceed, and to exhibit a red light so visible in the reverse direction. The lamp shall be placed on the extreme right or off side of the light locomotive in such a position as to be free from all obstruction to the light.

Provided that this Regulation shall not extend to any bicycle, tricycle, or other machine to which Section 85 of the Local Government Act, 1888, applies.

ARTICLE III.

No person shall cause or permit a light locomotive to be used on any highway for the purpose of drawing any vehicle, or shall drive or have charge of a light locomotive when used for such purpose, unless the conditions hereinafter set forth shall be satisfied, namely :—

(1.) Regulations (2), (3), (5), and (7), of Article II of this Order shall apply as if the vehicle drawn by the light locomotive was therein referred to, instead of the light locomotive itself, and Regulation (6) of the Article shall apply as if such vehicle was a light locomotive constructed for the carriage of goods.

(2.) The vehicle drawn by the light locomotive, except where the light locomotive travels at a rate not exceeding four miles an hour, shall have a brake in good working order of such efficiency that its application to the vehicle shall cause two of the wheels of the vehicle on the same axle to be so held that the wheels shall be effectually prevented from revolving, or shall have the same effect in stopping the vehicle as if such wheels were so held.

(3.) The vehicle drawn by the light locomotive shall, when under the last preceding regulation a brake is required to be

attached thereto, carry upon the vehicle a person competent to apply efficiently the brake : Provided that it shall not be necessary to comply with this Regulation if the brakes upon the light locomotive by which the vehicle is drawn are so constructed and arranged that neither of such brakes can be used without bringing into action simultaneously the brake attached to the vehicle drawn, or if the brake of the vehicle drawn can be applied from the light locomotive independently of the brakes of the latter.

ARTICLE IV.

Every person driving or in charge of a light locomotive when used on any highway shall comply with the Regulations hereinafter set forth, namely :—

(1.) He shall not drive the light locomotive at any speed greater than is reasonable and proper, having regard to the traffic on the highway, or so as to endanger the life or limb of any person, or to the common danger of passengers.

(2.) He shall not under any circumstances drive the light locomotive at a greater speed than 12 miles an hour. If the weight unladen of the light locomotive is one ton and a half and does not exceed two tons, he shall not drive the same at a greater speed than eight miles an hour, or if such weight exceeds two tons, at a greater speed than five miles an hour.

Provided that whatever may be the weight of the light locomotive, if it is used on any highway to draw any vehicle, he shall not, under any circumstances, drive it at a greater speed than six miles an hour. No light locomotive may travel along any public highway within the limits of the Dublin Metropolitan District, or of any city, town, or village, at a greater speed than six miles an hour ; or, if its weight unladen exceeds two tons, at a greater speed than five miles an hour.

Provided also that this Regulation shall only have effect during six months from the date of this Order, and thereafter until We otherwise direct.

(3.) He shall not cause the light locomotive to travel backwards for a greater distance or time than may be requisite for purposes of safety.

(4.) He shall not negligently or wilfully cause any hurt or damage to any person, carriage, horse, or cattle, or to any goods conveyed in any carriage on any highway, or, when on the light locomotive, be in such a position that he cannot have control over the same, or quit the light locomotive without having taken due precautions against its being started in his absence

or allow the light locomotive or a vehicle drawn thereby to stand on such highway so as to cause any unnecessary obstruction thereof.

(5.) He shall when meeting any carriage, horse, or cattle keep the light locomotive on the left or near side of the road, and when passing any carriage, horse, or cattle proceeding in the same direction keep the light locomotive on the right or off side of the same.

(6.) He shall not negligently or wilfully prevent, hinder, or interrupt the free passage of any person, carriage, horse, or cattle on any highway, and shall keep the light locomotive and any vehicle drawn thereby on the left or near side of the road for the purpose of allowing such passage.

(7.) He shall, whenever necessary, by sounding the bell or other instrument required by Section 3 of the Act, give audible and sufficient warning of the approach or position of the light locomotive.

(8.) He shall on the request of any police constable, or of any person having charge of a restive horse, or on any such constable or person putting up his hand as a signal for that purpose, cause the light locomotive to stop and to remain stationary so long as may be reasonably necessary.

Article V.

If the light locomotive is one to which Regulation (6) of Article II applies, and the particulars required by that Regulation are not duly painted thereon, or if the light locomotive is one to which that Regulation does not apply, the person driving or in charge thereof shall, on the request of any constable, or on the reasonable request of any other person, truly state his name and place of abode, and the name of the owner, and the place of his abode or business.

This Order may be cited as " The Light Locomotives on Highways Order, 1896."

In a letter addressed to the County Councils Sir Hugh Owen, the Secretary of the Local Government Board, draws attention. to the provisions of the Locomotives on Highways Act, 1896. He refers to the exemption of light locomotives from certain enactments, and points out that the duties imposed by Section 4 of the Customs and Inland Revenue Act, 1888, will be payable *for light* locomotives which are carriages or hackney carriages *as defined by the Act*, and that such light locomotives will pay

on and after January 1st next an additional excise duty at the following rate :—£2 2s. if the weight of the locomotive exceeds 1 ton but does not exceed 2 tons unladen, and £3 3s. if the weight exceeds 2 tons unladen. A summary of the above Order issued by the Local Government Board is given, and on the subject of speed Sir Hugh Owen states :—"Section 4 of the Act directs that no light locomotive shall travel along a public highway at a greater speed than 14 miles an hour, or than any less speed that may be prescribed by regulations of the Board. There is considerable difficulty in laying down definite rules as to the speed of light locomotives at the present time, as no experience has been obtained of their use in this country ; but the Board have been strongly urged to make some general regulations on the subject, and they have dealt with it by Article IV of the Order."

EXPLANATORY CHAPTER ON THE LOCO- MOTIVES ON HIGHWAYS ACT, 1896.

FOR the convenience of our readers we have compiled the following summary and explanation of the effect of the various clauses of the above measure, which governs the manner in which automotor carriages can be em- ployed:—

WEIGHT LIMITS.—Light locomotives—the term by which all descriptions of horseless vehicles affected by the Act are to be hitherto known—must not exceed three tons in weight unladen, and must not draw more than one independent vehicle. When such other vehicle is attached to the locomo- tive the weight of the two together unloaded shall not exceed four tons. In reference to this question of weight, an impor- tant provision is contained in Sub-section 2 of Clause 1, to the effect that the weight unladen shall be calculated without any reference to the weight of any water, fuel, or accumulators which may be used for the purpose of pro- viding motive power. In cases where steam or electricity derived from storage batteries is used as a means of pro- pulsion, the dead weight of the locomotive may be, there- fore, enormously greater than that mentioned in the Act. With regard to oil or gas engines, the words " used for the

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purposes of propulsion," may be safely interpreted to mean that oil carried for the purpose of forming an explosive gas, and water to be used to cool the cylinders, may be properly deducted from the gross weight, as they are as essential to the working of the locomotive as the water used in a boiler, or the coal which is consumed to evaporate it.

SMOKE AND VAPOUR.—No smoke or vapour must be emitted from the engines, except from temporary or accidental causes. This restriction will, doubtless, be construed in conformity with the practice under the Smoke Nuisances Act, and the bye-laws with reference to traction-engines. A reasonable amount of smoke will be permissible on getting up steam, and when firing heavily on a gradient. The onus of proving that such a nuisance was unavoidable, however, rests upon the defendant in these matters, and justices in various parts of the country are apt to widely vary in their opinions on the subject.

DANGEROUS BRIDGES.—By Sub-section (a) the Council of any county or borough have absolute power to prohibit or regulate the use of any such locomotives on any bridge within their jurisdiction, if they are satisfied that the use of such vehicles will be dangerous. As the highest limit allowed in the majority of districts by the Council is four tons, and often falls as low as two, this will automatically have the effect of keeping down vehicular weights in cases where loads are intended to be taken from one county to another, or where streams or rivers intervene.

DUTIES PAYABLE.—The heavy incidence of the dues payable on road vehicles under this Act has been one of its surprises, and there can be no question that an effort will be made at any convenient season to obtain a reduction. By Clause 8 it is provided that after the 1st of January, 1897, an excise duty shall be paid on all light locomotives as follows:—Where the weight exceeds one ton and is under two, £2 2s.; where the weight exceeds two tons, £3 3s. (in both cases the unladen weight is taken). By Sub-section (b), Clause 1, such vehicles are chargeable in

addition with customs duty as carriages when they come within the existing law.

LAMPS AND BELLS.—By Clauses 2 and 3 it is provided that between one hour after sunset and one hour before sunrise a lamp must be carried in accordance with regulations to be made by the Local Government Board; while at all times a bell or other appliance capable of giving sufficient warning to other vehicles or passengers must be carried and presumably sounded at necessary intervals.

RATE OF SPEED.—The maximum rate of speed along a public highway is fixed by the Act at 14 miles per hour, but any less speed may be, as it has in fact been, prescribed by the Local Government Board.

PENALTIES.—Any breach of the Act or of any bye-law made in respect of it will render the offender subject to a fine not exceeding £10, or imprisonment in default of payment thereof.

OPERATIVE DATE.—The Act came into force at the expiration of three months from the date of its passing, viz., on the 14th November, 1896, the Royal Assent having been signified on 14th August, 1896.

MISCELLANEOUS.—The remaining provisions not commented upon at length in the above summary extend the Act to Scotland and Ireland, provide for the disposal of the revenue to be obtained from it, and gives the Central Board power to vary the present stringent regulations which exist as to the construction of wheels of locomotives on roads.

THE CARRIAGE AND STORAGE OF PETROLEUM ON LAND.*

The Home Secretary, in issuing the regulations as to petroleum for motor-cars, states:—

In promulgating the following regulations relating to the keeping, conveyance, and use of petroleum in connection with light locomotives, the Secretary of State for the Home Depart-

* For information relative to the carriage of petroleum at sea, see "Marine Transport of Petroleum." By G. H. Little. (Spon, London.)

ment desires to call public attention to the dangers that may arise from the careless use of those more volatile descriptions of petroleum to which these rules apply, being petroleum to which the Petroleum Act, 1871, applies, and commonly known as " mineral spirit."

Not only is the vapour therefrom, which is given off at ordinary temperature, capable of being easily ignited, but also, when mixed with air, of forming an explosive mixture. Hence the necessity for strict precautions in dealing with and handling the same, and for the employment of thoroughly sound and properly closed vessels to contain the same, the importance of avoiding the use of naked lights in dangerous proximity to the same or to any place where such petroleum may be kept, and generally of taking precautions to prevent contact of the highly inflammable vapour of this very volatile liquid with any form of artificial light.

REGULATIONS.

1. Petroleum shall not be kept, used, or conveyed, except in tanks or cases of metal so made and closed that no leakage, whether of liquid or vapour, can take place therefrom, and so substantially constructed as not to be liable, except under circumstances of gross negligence or extraordinary accident to be broken or become defective or insecure in course of conveyance or use ; and every air-inlet in any such tank or case shall be at all times, except when the valve, if any, is required to be removed for immediate use or repair, protected by securely affixed wire gauze, the openings in which shall not be less in number than 400 to the square inch.

2. Every such tank or case shall be clearly stamped or securely labelled with a legible metallic or enamelled label with the words "mineral spirit, highly inflammable, for use with light locomotives."

3. The amount of petroleum to be in any one such tank or case at one time shall not exceed 20 gallons.

4. There shall not be at the same time on or in any one light locomotive, more than two of such tanks as aforesaid.

5. Before repairs are done to any such tank or case, that tank or case shall, as far as practicable, be cleaned by the removal of all petroleum and of all dangerous vapours derived from the same.

6. When petroleum for use in, or in connection with any light locomotive is not being so used, it shall be kept either in accordance with the provisions of the Petroleum Acts, or in

such tanks or cases as aforesaid ; provided that the amount of petroleum which may be so kept in tanks or cases as aforesaid shall not exceed the amount of petroleum which may be kept on or in any one light locomotive at the same time, and that the tanks or cases shall be kept in the open air, or in some suitably ventilated place.

7. The filling or replenishing of a tank with petroleum shall not be carried on, nor shall the contents of any such tank be exposed by artificial light, except a light of such construction, position, or character as not to be liable to cause danger, and no artificial light shall be brought within dangerous proximity of the place where any tank containing petroleum is being kept.

8. In the case of all petroleum kept or conveyed for the purpose of or in connection with any light locomotive (a) all due precautions shall be taken for the prevention of accidents by fire or explosion, and for the prevention of unauthorised persons having access to any petroleum kept or conveyed, and to the vessels containing or intended to contain, or having actually contained the same ; and (b) every person managing or employed on or in connection with any light locomotive shall abstain from every act whatever which tends to cause fire or explosion, and which is not reasonably necessary, and shall prevent any other person from committing such act.

9. These regulations shall come into operation on the 14th day of November, 1896, and be in force until further notice.

REGULATIONS FOR MOTO-VEHICLES IN SCOTLAND.

THE Secretary for Scotland has issued the general regulations respecting Light Locomotives on Highways applicable to Scotland. It is stated as a preliminary that the expression "carriage" includes a wagon, cart, or other vehicle ; expression "horse" includes a mule or other beast of draught or burden ; and the expression "cattle" includes sheep. The expression "light locomotive" means a vehicle propelled by mechanical power which is under 3 tons in weight, unladen, and is not used for the purpose of drawing more than one vehicle (such vehicle with its locomotive not exceeding in weight, unladen, 4 tons), and is so constructed that no smoke or visible vapour is emitted therefrom, except from any temporary or accidental cause. When calculating the weight of a vehicle, unladen, the weight of water, fuel, or accumulators used for the purpose of propul-

sion shall not be included. No one must drive or allow one to be driven if it exceeds 5 cwt., unless it can travel either forwards or backwards. It shall not exceed six and a half feet in width. The tyre of each wheel shall be smooth and flat where it touches the ground. For a machine, unladen, weighing between 15 cwt. and 1 ton, not less 2½ inches wide ; exceeding 1 ton and not exceeding 2, not less than 3 inches wide ; and if exceeding 2 tons, not less than 4 inches. There must be two independent brakes provided to act on two wheels, but in the case of a bicycle it is provided that one wheel will be enough to be acted upon. The name of the owner and place of abode must be painted on locomotives used for haulage, in letters black upon white or white upon black, not less than 1 inch in height ; and it shall be built so as not to cause danger to any person on it or on the road ; and a competent person must always be in charge. A white light is to be used at night in the front, and a red one exhibited at the rear. The vehicle drawn by the locomotive must have a brake, except where the speed is less than 4 miles an hour, and some one must be on the vehicle to work the brake, unless it can be worked from the locomotive. The speed must not be greater than is reasonable and proper, and must not exceed 10 miles an hour in any case. If the weight unladen is 1½ tons and does not exceed 2 tons, the maximum speed allowed is 8 miles an hour, and if the weight is over 2 tons, the speed shall not be greater than 5 miles an hour. If the locomotive is used to draw a vehicle, no matter what its weight is, the speed shall not be greater than 6 miles an hour. The rules for passing and being passed are also given, but are the same as those already in force.

THE INLAND REVENUE REGULATIONS AS TO MOTO-VEHICLES.

The following is an extract from a General Order issued by the Inland Revenue Department to their Officers with reference to the Licence Duties upon Light Locomotives :—

"Under Section 1 a light locomotive is referred to as ' Any vehicle propelled by mechanical power if it is under three tons in weight unladen, and is not used for the purpose of drawing more than one vehicle (such vehicle with its locomotive not to exceed in weight unladen four tons), and is so constructed that *no smoke or visible* vapour is emitted therefrom except from

any temporary or accidental cause,' and by proviso *b* to that section a light locomotive is to be deemed a carriage, and if used as a carriage of any particular class is to be deemed to be a carriage of that class.

"Under Section 8 it is provided that on and after the first day of January next there shall be paid in Great Britain for every light locomotive which is liable to duty either as a carriage or or as a hackney carriage under Section 4 of the Customs and Inland Revenue Act, 1888, an additional duty of excise at the following rate, namely :—

	£	s.	d.
If the weight of the locomotive exceeds one ton unladen, but does not exceed two tons unladen	2	2	0
If the weight of the locomotive exceeds two tons unladen	3	3	0

"This additional duty is payable at the same time as the ordinary duty on a licence for the locomotive as a carriage or hackney carriage. The full duties payable for light locomotives of the above description are therefore as follows :—

—	Weight, exceeding one ton, but not exceeding two tons.	Weight, exceeding two tons.
Locomotives with four or more wheels—	£ s. d.	£ s. d.
If used as an ordinary carriage	4 4 0	5 5 0
If used as a hackney carriage	2 17 0	3 18 0
Locomotives with less than four wheels—		
If used as an ordinary carriage	2 17 0	3 18 0
If used as a hackney carriage	2 17 0	3 18 0

"The above rates are subject to the reduction of £1 1s. or 7s. 6d. as the case may be if the locomotive be first used on or after the 1st October in any year.

"In calculating for the purposes of the Act the weight of a vehicle unladen, the weight of any water, fuel, or accumulators used for the purpose of propulsion is not to be included.

"It will be observed that there is no additional duty chargeable in respect of a locomotive not exceeding one ton in weight unladen, or in respect of a locomotive of three tons or upwards in weight unladen. These will remain subject to the ordinary provisions as to carriage licence duty."

WEIGHTS AND MEASURES.

British Measures of Weight.

Drams.	Ozs.	Lbs.	Qrs.	Cwts.	Ton.	Grammes.
1	·0625	·0039063	·0001395	·0000349	·00000174	1·771846
16	=1	·0625	·0022321	·000558	·00002790	28·34954
256	16	=1	·0357143	·0089285	·00044643	453·5927
7168	448	28	=1	·25	·0125	12700·59
28672	1792	112	4	=1	·05	50802·38
573440	35840	2240	80	20	=1	1016048

British Lineal Measure.

Inches.	Hands.	Feet.	Yards.	Fathoms.	Chains.	Furlongs.	Mile.
1	—	—	—	—	—	—	—
4	1	—	—	—	—	—	—
12	3	1	—	—	—	—	—
36	9	3	1	—	—	—	—
72	18	6	2	1	—	—	—
792	198	66	22	11	1	—	—
7620	1980	660	220	110	10	1	—
63360	15840	5280	1760	880	80	8	1

The span = 9″.　　The hand = 4″.
The cubit = 18″.　　The military pace = 30″.
The itinerary pace = 5′.

British Square Measure.

Sq. inches.	Sq. feet.	Sq. yards.	Acres.	Sq. mile.
1	·0069	·0007	—	—
144	=1	·11	·00002	—
1296	9	=1	·0062	—
6272640	43560	4840	=1	·00156
4014489600	27878400	3097600	640	=1

Acres × 0·0015625 = Sq. miles.

Apothecaries' or Medical Measures of Weight.

20 grains ..	1 scruple	Drachms.	Ounces.	Pound.
60　,,　..	3　,,	1		
480　,,　..	24　,,	8	1	
5760　,,　..)	288　,,	96	12	1

Apothecaries' or Medical Measures of Capacity.

60 Minims		1 Drachms		Ounces.	Pints.	Gallon.
480	,,	8	,,	1		
9600	,,	160	,,	20	1	
76800	,,	1280	,,	160	8	1

1 Drachm = 1 Tea-spoonful.
2 Drachms = 1 Dessert-spoonful.
4 Drachms = 1 Table-spoonful.
2 Ounces = 1 Wineglassful.
3 Ounces = 1 Teacupful.

Land Measure.

	sq. yds.	sq. ft.
Perch	30¼	272¼
Square chain (10000 sq. links)	484	4357
Rood (40 perches)	1210	10890
Acre (4 roods, or 10 sq. chains)	4840	43560
The Cheshire acre	10240	92160

The Metric System of Measures and their equivalents in British Units.

LINEAL.

	Inches.	Feet.	Yards.	Miles.
Millimètre	0·03937	0·003281	—	—
Centimètre	0·3937	0·03281	—	—
Décimètre	3·937	0·3281	0·10936	—
Mètre	39·37	3·281	1·0936	—
Décamètre	393·0	32·81	10·936	—
Hectomètre	—	328·08	109·36	0·06213
Kilomètre	—	3280·8	1093·6	0·6213
Myriamètre	—	32808·0	10936·0	6·218

The millimètre is roughly ₂₅th inch; the centimètre a full ⅜th; and the mètre 3 feet 3⅜ inches. 1 inch=2·539 centimètres; 1 foot=3·0479 décimètres; 1 yard= 0·91438 mètre; 1 mile=1·6093 kilomètres.

1 Myriametre = 10,000 metres = 6·21382 miles.

1 Kilometre = 1,000 metres = 1093·6 yards = 3280·9 feet.

1 Hectometre = 100 metres = 0·06213 mile = 109·36 yards = 328·0 feet.

1 Decametre = 10 metres = 0·0062 mile = 10·936 yards = 32·809 feet.

1 Metre = 0·00062 mile = 1·0936 yards = 3·2809 feet = 39·37079 inches.

1 Decimetre = 0·1 metre = 0·000062 mile = 0·1093 yard = 0·328 feet = 3·937 inches.

1 Centimetre = 0·01 metre = 0·0109 yard = 0·328 foot = 0·3937 inch.

1 Millimetre = 0·001 metre = 0·00109 yard = 0·00328 foot = 0·03937 inch.

SURFACE.

	Sq. Inches.	Sq. Feet.	Sq. Yards.	Acres.
Sq. Millimètre ...	0·0015	0·00001	0·000001	—
Sq. Centimètre ...	0·155	0·001	0·0001	—
Sq. Décimètre ...	15·5	0·1076	0·01	—
Sq. Mètre ...	1550·0	10·76	1·196	0·0002
Sq. Décamètre ...	155003·0	1076·4	119·6	0·0247
Hectare ...	—	107641·0	11960·0	2·47
Sq. Kilomètre ...	0·3861 ⎫ Sq.	10761101·0	1196011·0	247·1
Sq. Myriamètre...	31·61 ⎭ miles	—	—·	24711·0

1 sq. inch = 6·45137 sq. centimètres; 1 sq. foot = 9·2899 sq. décimètres; 1 sq. yard = 0·83609 sq. mètre; 1 mile = 0·40467 hectare.

1 Hectare = 10,000 square metres = 11,960 square yards.

1 Decare = 1,000 square metres = 0·2471 acre = 1,196 square yards.

1 Are = 100 square metres = 0·0247 acre = 119·6 square yards = 1076·4 square feet.

1 Deciare = 10 square metres = 11·96 square yards = 107·64 square feet = 15,501 square inches.

1 Centiare or 1 Square Metre = 1 square metre = 0·00025 acre = 1·19 square yards = 10·764 square feet = 1,550 square inches.

1 Milliare = 0·1 square metre = 0·119 square yard = 1·076 square *feet = 155 square inches.*

CAPACITY.

	In Cubic Inches.	In Cubic Feet = 1728 Cubic Inches.	In Pints = 34·659 Cubic Inches.	In Gallons = 8 Pints = 277·273 Cubic Inches.	In Bushels = 8 Gallons = 2218·19 Cubic Inches.
Millilitre, or cubic centimètre	0·0610	0·0000353	0·00176	0·0002201	0·0000275
Centilitre, or 10 cubic centimètres	0·6102	0·000353	0·0176	0·0022009	0·0000275
Décilitre, or 100 cubic centimètres	6·1027	0·00353	0·176	0·0220096	0·00275
Litre, or cubic décimètre	61·027	0·0353	1·76	0·220096	0·0275
Décilitre, or centistère	610·27	0·353	17·6	2·20096	0·275
Hectolitre, or décistère	6102·7	3·53	176·07	22·00966	2·751
Kilolitre, or stère, or cubic mètre	61027·05	35·31	1760·77	220·0966	27·512
Myrialitre, or décastère	610270·5	353·16	17607·7	2200·966	275·12

1 cubic inch = 16·3861759 cubic centimètres ; 1 cubic foot = 28·3153119 cubic décimètres ; 1 fluid ounce = 28·4 cubic centimètres ; 1 gallon = 4·5494579694 litres ; 1 quart = 1·136 litres.

1 Hectostere = 100·0 cubic metres = 130·802 cubic yards.
1 Decastere = 10 cubic metres = 13·08 cubic yards.
1 Stere or 1 Cubic Metre = 1·0 cubic metre = 1·308 cubic yards = 35·317 cubic feet = 61,028 cubic inches.
1 Decistere = 0·1 cubic metre = 0·1308 cubic yard = 3·5317 cubic feet = 6102·8 cubic inches.
1 Centistere = 0·01 cubic metre = 0·353 cubic foot = 610·28 cubic inches.
1 Millistere = 0·001 cubic metre = 61·028 cubic inches.

1 Kilolitre or 1 Cubic Metre = 1,000 litres = 27·512 bushels = 220·09 gallons = 35·817 feet.
1 Hectolitre = 100 litres = 2·751 bushels = 22·009 gallons = 3·53 feet.
1 Decalitre = 10 litres = 0·276 bushel = 2·2 gallons = 0·353 foot = 610·28 inches.
1 Litre or 1 Cubic Decimetre = 1 litre = 0·0275 bushel = 0·22 gallon = 0·0353 foot = 61·02 inches.
1 Decilitre = 0·1 litre = 0·0027 bushel = 0·022 gallon = 6·1 inches.
1 Centilitre = 0·01 litre = 0·0022 gallon = 0·61 inch.
1 Millilitre = 0·001 litre = 0·00022 gallon = 0·061 inch.

Liquid and Dry Measures.

1 Myrialitre = 10,000 litres = 275·121 bushels = 1 2200·967 gallons = 353·17 feet.

WEIGHT.

	In English Grains.	In Troy Ounces =480 Grains.	In Avoirdupois Lbs.=7000 Grains.	In Cwts. =112 Lbs. =784,000 Grains.	In Tons =20 Cwts. =16,620,000 Grains.
Milligramme	0·01543	0·000032	0·0000022?	0·00000002	0·000000001
Centigramme	0·1543	0·000322	0·000022	0·00000002	0·000000010
Décigramme	1·543	0·0032	0·00022	0·0000019	0·00000009
Gramme	15·43	0·032	0·0022	0·000019	0·00000098
Décagramme	154·3	0·32	0·022	0·00019	0·0000098
Hectogramme	1543·234	3·215	0·22	0·00196	0·0000984
Kilogramme	15432·348	32·15	2·2	0·01968	0·0009842
Myriagramme	154323·488	321·5	22·046	0·1968	0·009842

1 grain = 0·064798950 gramme ; 1 Troy oz. = 31·103496 grammes ; 1 lb. Avoirdupois = 453·59 grammes = 0·45359265 kilogramme ; 1 cwt. = 50·802437689 kilogrammes.

1 Millier or Bar = 1,000,000 grammes = 0·984206 ton = 19·684 cwts. = 2204·02 lbs. avoirdupois.

1 Quintal = 100,000 grammes = 0·0984 ton = 1·9684 cwts. = 220·46 lbs. avoirdupois.

1 Myriagramme = 10,000 grammes = 0·00984 ton = 0·1968 cwt. = 22·04 lbs. avoirdupois.

1 Kilogramme = 1,000 grammes = 0·00098 ton = 0·019 cwt. = 2·2046 lbs. = 35·2739 ozs. avoirdupois.

1 Hectogramme = 100 grammes = 0·22046 lb. = 3·527 ozs. avoirdupois.

1 Decagramme = 10 grammes = 0·022 lb. = 0·35 oz. avoirdupois.

1 Gramme = 0·0022 lb. = 0·035 oz. avoirdupois = 15·432349 grains Troy.

1 Decigramme = 0·1 gramme = 1·543 grains Troy.

1 Centigramme = 0·01 gramme = 0·154 grain Troy.

1 Milligramme = 0·001 gramme = 0·015 grain Troy.

To convert Metric Units to British, and vice versa.

Hectares.	Acres.		Kilomètres.	Eng. miles.		Square Kilomètres.	Square Eng. miles.		Mètres.	Yards.		Kilogrs.	lbs. Avoir.		Litres.	Gallons.	
0·405	2·471	1	1·609	0·621	1	2·592	0·386	1	0·914	1·094	1	0·457	2·20	1	4·54	0·2	1
0·809	4·942	2	3·219	1·243	2	5·184	0·772	2	1·829	2·187	2	0·907	4·41	2	9·09	0·44	2
1·214	7·413	3	4·828	1·864	3	7·776	1·158	3	2·743	3·281	3	1·361	6·61	3	13·63	0·66	3
1·619	9·885	4	6·438	2·486	4	10·368	1·544	4	3·658	4·374	4	1·814	8·82	4	18·17	0·88	4
2·023	12·356	5	8·047	3·107	5	12·960	1·930	5	4·572	5·468	5	2·268	11·02	5	22·72	1·10	5
2·428	14·827	6	9·656	3·728	6	15·552	2·316	6	5·486	6·562	6	2·722	13·23	6	27·26	1·32	6
2·833	17·298	7	11·265	4·350	7	18·144	2·702	7	6·401	7·655	7	3·175	15·43	7	31·80	1·54	7
3·237	19·769	8	12·879	4·971	8	20·736	3·088	8	7·315	8·749	8	3·629	17·64	8	36·35	1·76	8
3·642	22·240	9	14·484	5·592	9	23·328	3·474	9	8·229	9·843	9	4·082	19·84	9	40·89	1·98	9
4·047	24·711	10	16·093	6·214	10	25·920	3·860	10	9·144	10·936	10	4·536	22·05	10	45·48	2·20	10
8·093	49·423	20	32·186	12·428	20	51·840	7·720	20	18·288	21·873	20	9·072	44·09	20	90·87	4·40	20
12·140	74·134	30	48·279	18·641	30	77·760	11·580	30	27·432	32·809	30	13·608	66·14	30	136·30	6·61	30
16·187	98·846	40	64·373	24·855	40	103·680	15·440	40	36·576	43·745	40	18·144	88·18	40	181·74	8·80	40
20·234	123·557	50	80·466	31·069	50	129·600	19·300	50	45·719	54·682	50	22·679	110·23	50	227·17	11·00	50
24·287	148·268	60	96·559	37·283	60	155·520	23·160	60	54·863	65·618	60	27·215	132·28	60	272·61	13·20	60
28·327	172·980	70	112·652	43·497	70	181·440	27·020	70	64·007	76·554	70	31·752	154·32	70	318·04	15·40	70
32·373	197·692	80	128·746	49·710	80	207·360	30·880	80	73·151	87·491	80	36·288	176·37	80	363·48	17·60	80
36·420	222·903	90	144·839	55·924	90	233·280	34·740	90	82·295	98·427	90	40·823	198·42	90	408·91	19·80	90
40·467	247·114	100	160·932	62·138	100	259·200	38·601	100	91·438	109·363	100	45·359	220·46	100	454·35	22·01	100

Example.—10 miles = 16·093 kilomètres, or 10 kilomètres = 6·214 miles. Similarly 6 lbs. = 2·722 kilogrammes, or 6 kilogrammes = 13·23 lbs. Or this Rule may be employed :—

Grammes to ounces avoirdupois, multiply by 20 and divide by 567.

Kilogrammes to pounds, multiply by 1000 and divide by 454.

Litres to gallons, multiply by 22 and divide by 100.

Litres to pints, multiply by 88 and divide by 50.

Millimètres to inches, multiply by 10 and divide by 254.

Mètres to yards, multiply by 70 and divide by 64.

Inches expressed as Decimals of a Foot.

Ins.	Foot.	Ins.	Foot.	Ins.	Foot.	Ins.	Foot.	Ins.	Foot.	Ins.	Foot.
0	·0000	2	·1667	4	·3333	6	·5000	8	·6667	10	·8333
1/32	·0026	1/32	·1693	1/32	·3359	1 32	·5026	1 32	·6693	1 32	·8359
1/16	·0052	1/16	·1719	1/16	·3385	1,16	·5052	1/16	·6719	1/16	·8385
3 32	·0078	3 32	·1745	3·32	·3411	3:32	·5078	3 32	·6745	3 32	·8411
1/8	·0104	1/8	·1771	1/8	·3438	1 8	·5104	1,8	·6771	1/8	·8438
5/32	·0130	5/32	·1797	5/32	·3464	5/32	·5130	5 32	·6797	5,32	·8464
3/16	·0156	3/16	·1823	3/16	·3490	3/16	·5156	3,16	·6823	3 16	·8490
7/32	·0182	7/32	·1849	7/32	·3516	7 32	·5182	7,32	·6849	7/32	·8516
1/4	·0208	1/4	·1875	1/4	·3542	1,4	·5208	1 4	·6875	1/4	·8542
9/32	·0234	9/32	·1901	9/32	·3568	9 32	·5234	9 32	·6901	9/32	·8568
5/16	·0260	5.16	·1927	5/16	·3594	5.16	·5260	5·16	·6927	5 16	·8594
11/32	·0286	11/32	·1953	11/32	·3620	11 32	·5286	11 32	·6953	11 32	·8620
3/8	·0313	3/8	·1979	3/8	·3646	3 8	·5313	3 8	·6979	3/8	·8646
13/32	·0339	13/32	·2005	13/32	·3672	13,32	·5339	13 32	·7005	13 32	·8672
7/16	·0365	7 16	·2031	7/16	·3698	7 16	·5365	7 16	·7031	7·16	·8698
15/32	·0391	15/32	·2057	15/32	·3724	15.32	·5391	15/32	·7057	15/32	·8724
1/2	·0417	1/2	·2083	1/2	·3750	1,2	·5417	1 2	·7083	1/2	·8750
17/32	·0443	17/32	·2109	17/32	·3776	17/32	·5443	17/32	·7109	17/32	·8776
9/16	·0469	9/16	·2135	9/16	·3802	9/16	·5469	9 16	·7135	9/16	·8802
19/32	·0495	19/32	·2161	19/32	·3828	19,32	·5495	19 32	·7161	19/32	·8828
5/8	·0521	5/8	·2188	5/8	·3854	5,8	·5521	5 8	·7188	5/8	·8854
21/32	·0547	21/32	·2214	21/32	·3880	21,32	·5547	21 32	·7214	21/32	·8880
11/16	·0573	11/16	·2240	11/16	·3906	11/16	·5573	11 16	·7240	11,16	·8906
23/32	·0599	23/32	·2266	23/32	·3932	23/32	·5599	23 32	·7266	23/32	·8932
3/4	·0625	3/4	·2292	3/4	·3958	3/4	·5625	3/4	·7292	3 4	·8958
25/32	·0651	25,32	·2318	25.32	·3984	25 32	·5651	25 32	·7318	25,32	·8984
13/16	·0677	13/16	·2344	13/16	·4010	13 16	·5677	13/16	·7344	13/16	·9010
27/32	·0703	27 32	·2370	27/32	·4036	27,32	·5703	27/32	·7370	27/32	·9036
7/8	·0729	7/8	·2396	7/8	·4063	7 8	·5729	7/8	·7396	7,8	·9063
29/32	·0755	29/32	·2422	29/32	·4089	29 32	·5755	29,32	·7422	29/32	·9089
15/16	·0781	15/16	·2448	15/16	·4115	15/16	·5781	15/16	·7448	15/16	·9115
31/32	·0807	31/32	·2474	31,32	·4141	31 32	·5807	31/32	·7474	31/32	·9141
1	·0833	3	·2500	5	·4167	7	·5833	9	·7500	11	·9167
1/32	·0859	1/32	·2526	1/32	·4193	1,32	·5859	1/32	·7526	1/32	·9193
1/16	·0885	1/16	·2552	1/16	·4219	1/16	·5885	1/16	·7552	1/16	·9219
3/32	·0911	3/32	·2578	3 32	·4245	3 32	·5911	3/32	·7578	3/32	·9245
1/8	·0938	1/8	·2604	1/8	·4271	1/8	·5938	1/8	·7604	1/8	·9271
5/32	·0964	5/32	·2630	5/32	·4297	5/32	·5964	5/32	·7630	5/32	·9297
3/16	·0990	3/16	·2656	3/16	·4323	3/16	·5990	3/16	·7656	3/16	·9323
7/32	·1016	7/32	·2682	7/32	·4349	7 32	·6016	7/32	·7682	7/32	·9349
1/4	·1042	1/4	·2708	1/4	·4375	1/4	·6042	1/4	·7708	1/4	·9375
9/32	·1068	9/32	·2734	9/32	·4401	9 32	·6068	9,32	·7734	9,32	·9401
5/16	·1094	5/16	·2760	5/16	·4427	5/16	·6094	5/16	·7760	5/16	·9427
11/32	·1120	11/32	·2786	11/32	·4453	11 32	·6120	11/32	·7786	11/32	·9453
3/8	·1146	3/8	·2813	3/8	·4479	3 8	·6146	3/8	·7813	3/8	·9479
13/32	·1172	13/32	·2839	13 32	·4505	13,32	·6172	13/32	·7839	13/32	·9505
7/16	·1198	7/16	·2865	7/16	·4531	7/16	·6198	7/16	·7865	7 16	·9531
15/32	·1224	15/32	·2891	15/32	·4557	15/32	·6224	15/32	·7891	15/32	·9557
1/2	·1250	1/2	·2917	1/2	·4583	1/2	·6250	1/2	·7917	1/2	·9583
17/32	·1276	17/32	·2943	17/32	·4609	17/32	·6276	17/32	·7943	17/32	·9609
9/16	·1302	9/16	·2969	9/16	·4635	9/16	·6302	9/16	·7969	9/16	·9635
19/32	·1328	19/32	·2995	19/32	·4661	19/32	·6328	19/32	·7995	19/32	·9661
5/8	·1354	5/8	·3021	5/8	·4688	5/8	·6354	5/8	·8021	5/8	·9688
21/32	·1380	21/32	·3047	21/32	·4714	21/32	·6380	21/32	·8047	21/32	·9714
11/16	·1406	11/16	·3073	11/16	·4740	11/16	·6406	11/16	·8073	11/16	·9740
23/32	·1432	23/32	·3099	23/32	·4766	23/32	·6432	23/32	·8099	23/32	·9766
3/4	·1458	3/4	·3125	3/4	·4792	3/4	·6458	3/4	·8125	3/4	·9792
25/32	·1484	25/32	·3151	25.32	·4818	25/32	·6484	25,32	·8151	25/32	·9818
13/16	·1510	13/16	·3177	13/16	·4844	13/16	·6510	13/16	·8177	13/16	·9844
27/32	·1536	27/32	·3203	27/32	·4870	27/32	·6536	27/32	·8203	27/32	·9870
7/8	·1563	7/8	·3229	7/8	·4896	7/8	·6563	7,8	·8229	7/8	·9896
29/32	·1589	29/32	·3255	29/32	·4922	29/32	·6589	29 32	·8255	29,32	·9922
15/16	·1615	15/16	·3281	15/16	·4948	15/16	·6615	15/16	·8281	15/16	·9948
31/32	·1641	31/32	·3307	31/32	·4974	31/32	·6641	31/32	·8307	31/32	·9974

FRACTIONS OF AN INCH AND THEIR DECIMAL EQUIVALENTS.

Fractions.	Decimals.	Fractions.	Decimals.	Fractions.	Decimals.	Fractions.	Decimals.
1/64	0·015625	17/64	0·265625	33/64	0 515625	49/64	0·765625
1/32	0·03125	9/32	0·28125	17/32	0·53125	25/32	0·78125
3/64	0·046875	19/64	0·296875	35/64	0·546875	51/64	0·796875
1/16	0·0625	5/16	0·3125	9/16	0·5625	13/16	0·8125
5/64	0·078125	21/64	0·328125	37/64	0·578125	53/64	0·828125
3/32	0·09375	11/32	0·34375	19/32	0·59375	27/32	0·84375
7/64	0·109375	23/64	0·359375	39/64	0·609375	55/64	0·859375
1/8	0·125	3/8	0·375	5/8	0·625	7/8	0·875
9/64	0·140625	25/64	0·390625	41/64	0·640625	57/64	0·890625
5/32	0·15625	13/32	0·40625	21/32	0·65625	29/32	0·90625
11/64	0 171875	27/64	0·421875	43/64	0·671875	59/64	0·921875
3/16	0·1875	7/16	0·4375	11/16	0·6875	15/16	0·9375
13/64	0·203125	29/64	0 453125	45/64	0·703125	61/64	0·953125
7/32	0·21875	15/32	0·46875	23/32	0·71875	31/32	0·96875
15/64	0·234375	31/64	0·484375	47/64	0·734375	63/64	0·984375
1/4	0·25	1/2	0·5	3/4	0·75	1	0·1

DECIMAL EQUIVALENTS OF A FOOT.

In.	0	1/16	1/8	3/16	1/4	5/16	3/8	7/16	In.
0	0·0000	0·0052	0·0104	0·0156	0·0208	0·0260	0·0313	0·0365	0
1	0·0833	0·0885	0·0937	0·0990	0·1042	0·1094	0·1146	0·1198	1
2	0·1667	0·1719	0·1771	0·1823	0·1875	0·1927	0·1979	0·2031	2
3	0·2500	0·2552	0·2604	0·2656	0·2708	0·2760	0·2813	0·2865	3
4	0·3343	0·3385	0·3437	0·3490	0·3542	0·3594	0·3646	0·3698	4
5	0·4167	0·4219	0·4271	0·4323	0·4375	0·4427	0·4479	0·4531	5
6	0·5000	0·5052	0·5104	0·5156	0·5208	0·5260	0·5313	0·5365	6
7	0·5833	0·5885	0·5937	0·5990	0·6042	0·6094	0·6146	0·6198	7
8	0·6667	0 6719	0·6771	0·6823	0·6875	0·6927	0·6979	0·7031	8
9	0·7500	0·7552	0·7604	0·7656	0·7708	0·7760	0·7813	0·7865	9
10	0·8333	0·8385	0·8437	0·8490	0·8542	0·8594	0·8646	0·8698	10
11	0·9167	0·9219	0·9271	0·9323	0·9375	0·9427	0·9479	0·9531	11

In.	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	In.
0	0·0417	0·0469	0·0521	0·0573	0·0625	0·0677	0·0729	0·0781	0
1	0·1250	0·1302	0·1354	0·1406	0·1458	0·1510	0·1563	0·1615	1
2	0·2083	0·2135	0·2188	0·2240	0·2292	0·2344	0·2396	0·2448	2
3	0·2917	0·2969	0·3021	0·3073	0·3125	0·3177	0·3229	0·3281	3
4	0·3750	0·3802	0·3854	0·3906	0·3958	0·4010	0·4063	0·4115	4
5	0·4583	0·4635	0·4688	0·4740	0·4792	0·4844	0·4896	0·4948	5
6	0·5417	0·5469	0·5521	0·5573	0·5625	0·5677	0·5729	0·5781	6
7	0·6250	0·6302	0·6354	0·6406	0·6458	0·6510	0·6563	0·6615	7
8	0·7083	0·7135	0·7187	0·7240	0·7292	0·7344	0·7396	0·7448	8
9	0·7917	0·7969	0·8021	0·8073	0·8125	0·8177	0·8229	0·8281	9
10	0·8750	0·8802	0·8854	0·8906	0·8958	·9010	0·9063	0·9115	10
11	0·9583	0·9635	0·9688	0·9740	0·9792	0·9844	0·9896	0·9948	11

British Statute Miles Expressed as Kilomètres.

Ml.	0	1	2	3	4	5	6	7	8	9
	Kilom.	Kilom.	Kilom.	Kilom.	Kilom.	Kilom.	Kilom.	Kilom.	Kilom.	Kilom.
0	·000	1·6093	3·2186	4·8279	6·4372	8·0465	9·6558	11·2652	12·8745	14·4848
10	16·093	17·702	19·321	20·921	22·530	24·139	25·749	27·358	28·967	30·577
20	32·186	33·795	35·405	37·014	38·623	40·232	41·842	43·451	45·060	46·670
30	48·279	49·888	51·498	53·107	54·716	56·325	57·935	59·544	61·153	62·763
40	64·372	65·981	67·591	69·200	70·809	72·419	74·028	75·637	77·246	78·856
50	80·465	82·074	83·684	85·293	86·902	88·511	90·121	91·730	93·339	94·949
60	96·558	98·167	99·777	101·39	102·99	104·60	106·21	107·82	109·43	111·04
70	112·65	114·26	115·87	117·48	119·08	120·69	122·30	123·91	125·52	127·13
80	128·74	130·35	131·96	133·57	135·17	136·78	138·39	140·00	141·61	143·22
90	144·85	146·44	148·05	149·66	151·26	152·87	154·48	156·09	157·70	159·31
100	160·93	162·53	164·14	165·75	167·35	168·96	170·57	172·18	173·79	175·40

Kilomètres Expressed as British Statute Miles.

Kl.	0	1	2	3	4	5	6	7	8	9
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
0	·0000	0·6214	1·2427	1·8641	2·4855	3·1069	3·7282	4·3497	4·9711	5·5924
10	6·2138	6·8352	7·4565	8·0780	8·6994	9·3205	9·9421	10·562	11·185	11·805
20	12·427	13·049	13·670	14·292	14·913	15·534	16·156	16·776	17·399	18·019
30	18·641	19·263	19·884	20·506	21·127	21·748	22·370	22·990	23·613	24·233
40	24·855	25·477	26·098	26·720	27·341	27·962	28·524	29·204	29·827	30·447
50	31·069	31·690	32·311	32·933	33·554	34·175	34·797	35·417	36·040	36·660
60	37·282	37·904	38·525	39·147	39·768	40·389	41·011	41·631	42·254	42·874
70	43·497	44·118	44·739	45·361	45·982	46·603	47·225	47·845	48·468	49·088
80	49·711	50·332	50·953	51·575	52·196	52·817	53·439	54·059	54·682	55·302
90	55·924	56·545	57·166	57·788	58·409	59·030	59·652	60·272	60·895	61·515
100	62·138	62·759	63·380	64·002	64·623	65·244	65·866	66·486	67·109	67·729

British Feet Expressed as Mètres.

Ft.	0	1	2	3	4	5	6	7	8	9
	Mètres.	Mètres.	Mètres.	Mètres.	Mètres.	Mètres.	Mètres.	Mètres.	Mètres.	Mètres.
0	·000	0·3048	0·6096	0·9144	1·2192	1·5239	1·8287	2·1335	2·4383	2·7431
10	3·0479	3·3527	3·6575	3·9623	4·2671	4·5719	4·8767	5·1815	5·4963	5·7911
20	6·0359	6·4006	6·7055	7·0102	7·3150	7·6198	7·9246	8·2294	8·5342	8·8390
30	9·1438	9·4486	9·7534	10·058	10·363	10·668	10·972	11·277	11·582	11·887
40	12·192	12·496	12·801	13·106	13·411	13·716	14·020	14·325	14·630	14·935
50	15·239	15·544	15·849	16·154	16·459	16·763	17·068	17·376	17·678	17·983
60	18·287	18·592	18·897	19·202	19·507	19·811	20·116	20·421	20·726	21·031
70	21·335	21·640	21·945	22·250	22·555	22·859	23·164	23·469	23·774	24·079
80	24·383	24·688	24·993	25·298	25·602	25·907	26·212	26·517	26·822	27·126
90	27·431	27·736	28·041	28·346	28·651	28·955	29·260	29·565	29·870	30·174
100	30·479	30·784	31·089	31·394	31·698	32·003	32·308	32·613	32·918	33·222

Mètres Expressed as British Feet.

Me.	0	1	2	3	4	5	6	7	8	9
	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
0	·000	3·2809	6·5618	9·8427	13·123	16·404	19·685	22·966	26·247	29·528
10	32·809	36·090	39·371	42·651	45·932	49·213	52·494	55·775	59·056	62·337
20	65·618	68·899	72·179	75·461	78·741	82·022	85·303	88·584	91·865	95·146
30	98·427	101·71	104·99	108·27	111·55	114·83	118·11	121·39	124·67	127·96
40	131·24	134·52	137·80	141·08	144·36	147·64	150·92	154·20	157·48	160·76
50	164·04	167·33	170·61	173·89	177·17	180·45	183·73	187·01	190·29	193·57
60	196·85	200·13	203·42	206·70	209·98	213·26	216·54	219·82	223·10	226·38
70	229·66	232·94	236·22	239·51	242·79	246·07	249·35	252·63	255·91	259·19
80	262·47	265·75	269·03	272·31	275·60	278·88	282·16	285·44	288·72	292·00
90	295·28	298·56	301·84	305·12	308·40	311·69	314·97	318·25	321·53	324·81
100	328·09	331·37	334·65	337·93	341·21	344·49	347·78	351·06	354·34	357·62

British Inches expressed as Centimètres.

In.	0	1	2	3	4	5	6	7	8	9
	Cm.	Cm.	Cm.	Cm.	Cm.	Cm.	Cm.	Cm.	Cm.	Cm.
0	·0	2·54	5·08	7·62	10·16	12·7	15·24	17·78	20·32	22·8
10	25·4	27·94	30·48	33·02	35·56	38·1	40·64	43·18	45·72	48·2
20	50·8	53·34	55·88	58·42	60·96	63·5	66·04	68·58	71·12	73·6
30	76·2	78·74	81·28	83·82	86·36	88·9	91·44	93·98	96·52	99·0
40	101·6	104·14	106·68	109·22	111·76	114·3	116·84	119·38	121·92	124·4
50	127·0	129·54	132·08	134·62	137·16	139·7	142·24	144·78	147·32	149·8
60	152·4	154·94	157·48	160·02	162·56	165·1	167·64	170·18	172·72	175·2
70	177·8	180·34	182·88	185·42	187·96	190·5	193·04	195·58	198·12	200·9
80	203·2	205·74	208·28	210·82	213·36	215·9	218·44	220·98	223·52	226·0
90	228·6	231·14	233·68	236·22	238·76	241·3	243·84	246·38	248·92	251·4
100	254·0	256·54	259·08	261·62	264·16	266·7	269·24	271·78	274·32	276·8

4 inches=rather more than 10 centimetres.

Centimètres expressed as British Inches.

Cm.	0	1	2	3	4	5	6	7	8	9
	Inches.	Inches.	Inches.	Inches.	Inches	Inches.	Inches.	Inches.	Inches.	Inche
0	·000	0·394	0·787	1·181	1·575	1·969	2·362	2·756	3·150	3·54
10	3·937	4·331	4·742	5·118	5·512	5·906	6·299	6·693	7·087	7·48
20	7·874	8·268	8·662	9·055	9·449	9·843	10·236	10·630	11·024	11·41
30	11·811	12·205	12·599	12·992	13·386	13·780	14·173	14·567	14·961	15·35
40	15·748	16·142	16·536	16·929	17·323	17·717	18·111	18·504	18·898	19·29
50	19·685	20·079	20·473	20·867	21·260	21·654	22·048	22·441	22·835	23·22
60	23·622	24·016	24·410	24·804	25·197	25·591	25·985	26·378	26·772	27·16
70	27·560	27·953	28·347	28·741	29·134	29·528	29·922	30·316	30·709	31·10
80	31·497	31·890	32·284	32·678	33·071	33·465	33·859	34·253	34·646	35·04
90	35·434	35·827	36·221	36·615	37·009	37·402	37·796	38·190	38·583	38·97
100	39·370	39·764	40·158	40·552	40·945	41·339	41·733	42·126	42·520	42·91

2·5 centimètres or 25 millimètres=nearly 1 inch.

Millimetres and their equivalents in British Inches.

Mm.	Inches.	Mm.	Inches.	Mm.	Inches.	Mm.	Inches.	Mm.	Inches.	Mm.	Inches.
1	·0394	18	·7087	35	1·3780	52	2·0473	69	2·7166	86	3·3859
2	·0787	19	·7480	36	1·4173	53	2·0866	70	2·7559	87	3·4252
3	·1181	20	·7874	37	1·4567	54	2·1260	71	2·7953	88	3·4646
4	·1575	21	·8268	38	1·4961	55	2·1654	72	2·8347	89	3·5040
5	·1968	22	·8661	39	1·5354	56	2·2047	73	2·8740	90	3·5433
6	·2362	23	·9055	40	1·5748	57	2·2441	74	2·9134	91	3·5827
7	·2756	24	·9449	41	1·6142	58	2·2835	75	2·9528	92	3·6221
8	·3150	25	·9843	42	1·6536	59	2·3228	76	2·9922	93	3·6614
9	·3543	26	1·0236	43	1·6929	60	2·3622	77	3·0315	94	3·7008
10	·3937	27	1·0630	44	1·7323	61	2·4016	78	3·0709	95	3·7402
11	·4331	28	1·1024	45	1·7717	62	2·4410	79	3·1103	96	3·7796
12	·4724	29	1·1417	46	1·8110	63	2·4803	80	3·1496	97	3·8189
13	·5118	30	1·1811	47	1·8504	64	2·5197	81	3·1890	98	3·8583
14	·5512	31	1·2205	48	1·8898	65	2·5591	82	3·2284	99	3·8977
15	·5906	32	1·2598	49	1·9291	66	2·5984	83	3·2677	100	3·9370
16	·6299	33	1·2992	50	1·9685	67	2·6378	84	3·3071		
17	·6693	34	1·3386	51	2·0079	68	2·6772	85	3·3465		

Compound Equivalents.

1 Atmosphere (14·7 lbs. per square inch) = 1·0335 kilogrammes per square centimetre.

1 Foot-pound = 0·1382 kilogrammetre.

1 lb. per square inch = 0·0703077 kilogramme per square centimetre = 0·7031 gramme per square millimetre = 5·170 centimetres of mercury at 0 degree Centigrade.

1 Kilogramme per square millimetre = 1422·32 lbs. per square inch = 0·635 ton per square inch.

1 Kilogramme per square centimetre = 14·2232 lbs. per square inch.

1 Gramme per square millimetre = 1·422 lbs. per square inch.

1 Kilogrammetre = 7·233 foot-pounds.

1 Gramme per square centimetre = 0·01422 lb. per square inch.

1 Calorie or French unit of heat = 3·968 English heat-units.

French mechanical equivalent of heat (425 kilogrammetres) = 3,074 foot-pounds per unit.

1 Calorie per square metre = 0·369 heat-unit per square foot.

1 Calorie per kilogramme = 1·800 heat-units per lb.

1 English unit of heat, or heat-unit = 0·252 calorie.

English mechanical equivalent to one heat-unit (772 foot-pounds) = 10·67 kilogrammetres.

1 English heat-unit per square foot = 2·713 calories per square metre.

1 English heat-unit per lb. = ⅝ calorie per kilogramme.

The Law of Footpaths.

By the Highways Act, 1835, it is enacted:—If any person shall wilfully ride upon any footpath or causeway by the side of the road made or set apart for the use and accommodation of foot passengers; or shall wilfully lead or drive any horse, ass, sheep, mule, swine, or cattle or carriage of any description, or any truck or sledge upon any such footpath or causeway; or shall cause any injury or damage to be done to the said highway, or the hedges, posts, rails, walls, or fences thereof; or wilfully destroy the surface of any highway; or shall in any way wilfully obstruct the free passage of any such highway: Every person so offending in any of the cases aforesaid shall for each and every such offence forfeit and pay any sum not exceeding *forty shillings* over and above the damages occasioned thereby.

TABLES OF IMPERIAL STANDARD WIRE GAUGES,

with Equivalents in Decimals of an Inch and in Millimetres.

	SIZE.			SIZE.	
S.W.G.	Decimals of an Inch.	Equivalent in Millimetres.	S.W.G.	Decimals of an Inch.	Equivalent in Millimetres.
No. 1	·300	7 ·620	No. 26	·018	0 ·457
2	·276	7 ·010	27	·0164	0 ·4166
3	·252	6 ·401	28	·0148	0 ·3759
4	·232	5 ·893	29	·0136	0 ·3454
5	·212	5 ·385	30	·0124	0 ·3150
6	·192	4 ·877	31	·0116	0 ·2946
7	·176	4 ·470	32	·0108	0 ·2743
8	·160	4 ·064	33	·0100	0 ·2540
9	·144	3 ·658	34	·0092	0 ·2337
10	·128	3 ·251	35	·0084	0 ·2134
11	·116	2 ·946	36	·0076	0 ·1930
12	·104	2 ·642	37	·0068	0 ·1727
13	·092	2 ·337	38	·0060	0 ·1524
14	·080	2 ·032	39	·0052	0 ·1321
15	·072	1 ·829	40	·0048	0 ·1219
16	·064	1 ·626	41	·0044	0 ·1118
17	·056	1 ·422	42	·0040	0 ·1016
18	·048	1 ·219	43	·0036	0 ·0914
19	·040	1 ·016	44	·0032	0 ·0813
20	·036	0 ·914	45	·0028	0 ·0711
21	·032	0 ·813	46	·0024	0 ·0610
22	·028	0 ·711	47	·0020	0 ·0508
23	·024	0 ·610	48	·0016	0 ·0406
24	·022	0 ·559	49	·0012	0 ·0305
25	·020	0 ·508	50	·0010	0 ·0254

Copying Graphs.—Take 8 oz. of glycerine, 2 oz. best glue; to the glue add 8 oz. of water, and when dissolved, stir in the glycerine, pour the mixture into a zinc dish, and as soon as it sets it is ready for use. If too much glycerine is used, the paper will stick to it; if too much glue, it will not take a good impression. The remedy for this is re-melting, and adding either glue or glycerine till it is right.

Imperial Standard Wire Gauge.

Issued by the Iron and Steel Wire Manufacturers' Association.

Size on Wire Gauge.	Diameter.		Sectional Area in Square Inches.	Weight of		Length of Cwt.	Ultimate Strength.	
	Inch.	Milli-metres.		100 yds.	Mile.		Annealed.	Bright.
				lbs.	lbs.	Yards.	lbs.	lbs.
7/0	·500	12·7	·1963	193·4	3404	58	10470	15700
6/0	·464	11·8	·1691	166·5	2930	67	9017	13525
5/0	·432	11·0	·1466	144·4	2541	78	7814	11725
4/0	·400	10·2	·1257	123·8	2179	91	6702	10052
3/0	·372	9·4	·1087	107·1	1885	105	5796	8694
2/0	·348	8·8	·0951	93·7	1649	120	5072	7608
1/0	·324	8·2	·0824	81·2	1429	138	4397	6595
1	·300	7·6	·0707	69·6	1225	161	3770	5655
2	·276	7·0	·0598	58·9	1037	190	3190	4785
3	·252	6·4	·0499	49·1	864	228	2660	3990
4	·232	5·9	·0423	41·6	732	269	2254	3381
5	·212	5·4	·0365	34·8	612	322	1883	2824
6	·192	4·9	·0290	28·5	502	393	1544	2316
7	·176	4·5	·0243	24·0	422	467	1298	1946
8	·160	4·1	·0201	19·8	348	566	1072	1608
9	·144	3·7	·0162	16·0	282	700	869	1303
10	·128	3·3	·0129	12·7	223	882	687	1030
— 11	·116	3·0	·0106	10·6	188	1077	564	845
12	·104	2·6	·0085	8·4	148	1333	454	680
13	·092	2·3	·0066	6·5	114	1723	355	532
14	·080	2·0	·0050	5·0	88	2240	268	402
15	·072	1·8	·0041	4·0	70	2800	218	326
16	·064	1·6	·0032	3·2	56	3500	172	257
17	·056	1·4	·0025	2·4	42	4667	131	197
18	·048	1·2	·0018	1·8	32	6222	97	145
19	·040	1·0	·0013	1·2	21	9333	67	100
20	·036	0·9	·0010	1·0	18	11200	55	82

The Watch as a Compass.—Due south can be readily ascertained if one possesses a fairly correct watch and the position of the sun is distinguishable. Point the hour hand to the sun, and the south is exactly half-way between the hour and the figure XII on the watch. For instance, suppose that it is 4 o'clock. Point the hand indicating IV to the sun and II on the watch is exactly south. Suppose that it *is 8 o'clock,* point the hand indicating VIII to the sun, and the figure X *on the watch is due south.*

COMPARISON OF DIFFERENT THERMOMETERS.

Centigrade or Celsius.	Réaumur.	Fahrenheit.	Centigrade or Celsius.	Réaumur.	Fahrenheit.	Centigrade or Celsius.	Réaumur.	Fahrenheit.
+260	+208	+500	+215	+172	+419	+170	+136	+338
259	207·20	498·20	214	171·20	417·20	169	135·20	336·20
258	206·40	496·40	213	170·40	415·40	168	134·40	334·40
257	205·60	494·60	212	169·60	413·60	167	133·60	332·60
256	204·80	492·80	211	168·80	411·80	166	132·80	330·80
255	204	491	210	168	410	165	132	329
254	203·20	489·20	209	167·20	408·20	164	131·20	327·20
253	202·40	487·40	208	166·40	406·40	163	130·40	325·40
252	201·60	485·60	207	165·60	404·60	162	129·60	323·60
251	200·80	483·80	206	164·80	402·80	161	128·80	321·80
250	200	482	205	164	401	160	128	320
249	199·20	480·20	204	163·20	399·20	159	127·20	318·20
248	198·40	478·40	203	162·40	397·40	158	126·40	316·40
247	197·60	476·60	202	161·60	395·60	157	125·60	314·60
246	196·80	474·80	201	160·80	393·80	156	124·80	312·80
245	196	473	200	160	392	155	124	311
244	195·20	471·20	199	159·20	390·20	154	123·20	309·20
243	194·40	469·40	198	158·40	388·40	153	122·40	307·40
242	193·60	467·60	197	157·60	386·60	152	121·60	305·60
241	192·80	465·80	196	156·80	384·80	151	120·80	303·80
240	192	464	195	156	383	150	120	302
239	191·20	462·20	194	155·20	381·20	149	119·20	300·20
238	190·40	460·40	193	154·40	379·40	148	118·40	298·40
237	189·60	458·60	192	153·60	377·60	147	117·60	296·60
236	188·80	456·80	191	152·80	375·80	146	116·80	294·80
235	188	455	190	152	374	145	116	293
234	187·20	453·20	189	151·20	372·20	144	115·20	291.20
233	186·40	451·40	188	150·40	370·40	143	114·40	289·40
232	185·60	449·60	187	149·60	368·60	142	113·60	287·60
231	184·80	447·80	186	148·80	366·80	141	112·80	285·80
230	184	446	185	148	365	140	112	284
229	183·20	444·20	184	147·20	363·20	139	111·20	282·20
228	182·40	442·40	183	146·40	361·40	138	110·40	280·40
227	181·60	440·60	182	145·60	359·60	137	109·60	278·60
226	180·80	438·80	181	144·80	357·80	136	108·80	276·80
225	180	437	180	144	356	135	108	275
224	179·20	435·20	179	143·20	354·20	134	107·20	273·20
223	178·40	433·40	178	142·40	352·40	133	106·40	271·40
222	177·60	431·60	177	141·60	350·60	132	105·60	269·60
221	176·80	429·80	176	140·80	348·80	131	104·80	267·80
220	176	428	175	140	347	130	104	266
219	175·20	426·20	174	139·20	345·20	129	103·20	264·20
218	174·40	424·40	173	138·40	343·40	128	102·40	262·40
217	173·60	422·60	172	137·60	341·60	127	101·60	260·60
216	172·80	420·80	171	136·80	339·80	126	100·80	258·80

Comparison of Different Thermometers—*continued*.

Centigrade or Celsius.	Réaumur.	Fahrenheit.	Centigrade or Celsius.	Réaumur.	Fahrenheit.	Centigrade or Celsius.	Réaumur.	Fahrenheit.
+125	+100	+257	+80	+64	+176	+35	+28	+95
124	99·20	255·20	79	63·20	174·20	34	27·20	93·20
123	98·40	253·40	78	62·40	172·40	33	26·40	91·40
122	97·60	251·60	77	61·60	170·60	32	25·60	89·60
121	96·80	249·80	76	60·80	168·80	31	24·80	87·80
120	96	248	75	60	167	30	24	86
119	95·20	246·20	74	59·20	165·20	29	23·20	84·20
118	94·40	244·40	73	58·40	163·40	28	22·40	82·40
117	93·60	242·60	72	57·60	161·60	27	21·60	80·60
116	92·80	240·80	71	56·80	159·80	26	20·80	78·80
115	92	239	70	56	158	25	20	77
114	91·20	237·20	69	55·20	156·20	24	19·20	75·20
113	90·40	235·40	68	54·40	154·40	23	18·40	73·40
112	89·60	233·60	67	53·60	152·60	22	17·60	71·60
111	88·80	231·80	66	52 80	150·80	21	16·80	69·80
110	88	230	65	52	149	20	16	68
109	87·20	228·20	64	51·20	147·20	19	15·20	66·20
108	86·40	226·40	63	50·40	145·40	18	14·40	64·40
107	85·60	224·60	62	49·60	143·60	17	13·60	62·60
106	84·80	222·80	61	48·80	141·80	16	12·80	60·80
105	84	221	60	48	140	15	12	59
104	83·20	219·20	59	47·20	138·20	14	11·20	57·20
103	82·40	217·40	58	46·40	136·40	13	10·40	55·40
102	81·60	215·60	57	45·60	134·60	12	9·60	53·60
101	80·80	213·80	56	44·80	132·80	11	8·80	51·80
100	80	212	55	44	131	10	8	50
99	79·20	210·20	54	43·20	129·20	9	7·20	48·20
98	78·40	208·40	53	42·40	127·40	8	6·40	46·40
97	77·60	206·60	52	41·60	125·60	7	5·60	44·60
96	76·80	204·80	51	40·80	123·80	6	4·80	42·80
95	76	203	50	40	122	5	4	41
94	75·20	201·20	49	39·20	120·20	4	3·20	39·20
93	74·40	199·40	48	38·40	118·40	3	2·40	37·40
92	73·60	197·60	47	37·60	116·60	2	1·60	35·60
91	72·80	195·80	46	36·80	114·80	1	0·80	33·80
90	72	194	45	36	113	0	0	32
89	71·20	192·20	44	35·20	111·20	−1	−0·80	30·20
88	70·40	190·40	43	34·40	109·40	2	1·60	28·40
87	69·60	188·60	42	33·60	107·60	3	2·40	26·60
86	68·80	186·80	41	32·80	105·80	4	3·20	24·80
85	68	185	40	32	104	5	4	23
84	67·20	183·20	39	31·20	102·20	6	4·80	21·20
83	66·40	181·40	38	30·40	100·40	7	5·60	19·40
82	65·60	179·60	37	29·60	98·60	8	6·40	17·60
81	64·80	177·80	36	28·80	96·80	9	7·20	15·80
						10	8	14

ARITHMETICAL.
Properties of the Circle.

A = Area.
D = Diameter.
C = Circumference.

S = Side of Square.

$\dfrac{C}{D}$ = 3·14159 . . . . .

This ratio is denoted by π.

2π = 6·2832.

4π = 12·5664.

36π = 113·0973.

$\dfrac{\pi}{2}$ = 1·57079.

$\dfrac{\pi}{4}$ = 0·7853981.

$\dfrac{\pi}{6}$ = 0·52359.

$\sqrt{2}$ = 1·4142.

$\sqrt{\tfrac{1}{2}}$ = 0·70710.

$\sqrt{\pi}$ = 1·77245.

$\sqrt{\dfrac{1}{\pi}}$ = 0·564189.

$2\sqrt{\pi}$ = 3·5449.

$\dfrac{\pi}{180°}$ = 0·01745.

$\dfrac{180°}{\pi}$ = 57·29578.

$\pi\sqrt{2}$ = 4·4428.

$\dfrac{2}{\pi}$ = 0·6366.

$$C = D\pi = R\,2\pi = \sqrt{A} \times 2\sqrt{\pi}.$$

$$D = C\cdot\frac{1}{\pi} = \sqrt{A} \times 2\sqrt{\frac{1}{\pi}}.$$

$$R = C\cdot\frac{1}{2\pi} = \sqrt{A} \times \sqrt{\frac{1}{\pi}}.$$

$$A = R^2\pi = L^2\frac{\pi}{4}.$$

$$S = R\sqrt{\pi} = D\tfrac{1}{2}\sqrt{\pi} = C\tfrac{1}{2}\sqrt{\frac{1}{\pi}}.$$

The Law of Highways.

By Secs. 78 and 79 of the Act of 1835 it is provided *inter alia* that, in the event of a driver of a vehicle offending against the rule of the road as there laid down, the driver may be apprehended *without any warrant* by *any* person who shall see such offence committed. A refusal by the driver to give his name and address can be punished by three months hard labour. If, however, the driver is known to the local surveyor or assistant surveyor he can only be arrested by an authorised officer of the law. It would thus appear that only in cases where the driver is a stranger to a district can he be arrested by *anyone.* A surveyor or his assistant has power to arrest a person who offends against the provisions of the Act. This Act does not apply to turnpike roads or to roads made under local Acts, or to the Universities or to the City of London.

TABLE OF AREAS AND CIRCUMFERENCES OF CIRCLES.

Diam. In.	Circum. In.	Area. Sq. In.	Diam. In.	Circum. In.	Area. Sq. In.	Diam. In.	Circum. In.	Area. Sq. In.
1/32	0·098175	0·00077	2	6·28319	3·1416	5	15·7080	19·635
3/64	0·147262	0·00173	1/16	6·47953	3·3410	1/16	15·9043	20·129
1/16	0·196350	0·00307	1/8	6·67588	3·5466	1/8	16·1007	20·629
3/32	0·294524	0·00690	3/16	6·87223	3·7583	3/16	16·2970	21·135
1/8	0·392699	0·01227	1/4	7·06858	3·9761	1/4	16·4934	21·648
5/32	0·490874	0·01917	5/16	7·26493	4·2000	5/16	16·6897	22·166
3/16	0·589049	0·02761	3/8	7·46128	4·4301	3/8	16·8861	22·691
7/32	0·687223	0·03758	7/16	7·65763	4·6664	7/16	17·0824	23·221
1/4	0·785398	0·04909	1/2	7·85398	4·9087	1/2	17·2788	23·758
9/32	0·883573	0·06213	9/16	8·05033	5·1572	9/16	17·4751	24·301
5/16	0·981748	0·07670	5/8	8·24668	5·4119	5/8	17·6715	24·850
11/32	1·07992	0·09281	11/16	8·44303	5·6727	11/16	17·8678	25·406
3/8	1·17810	0·11045	3/4	8·63938	5·9396	3/4	18·0642	25·967
13/32	1·27627	0·12962	13/16	8·83573	6·2126	13/16	18·2605	26·535
7/16	1·37445	0·15033	7/8	9·03208	6·4918	7/8	18·4569	27·109
15/32	1·47262	0·17257	15/16	9·22843	6·7771	15/16	18·6532	27·688
1/2	1·57080	0·19635	3	9·42478	7·0686	6	18·8496	28·274
17/32	1·66897	0·22166	1/16	9·62113	7·3662	1/8	19·2423	29·465
9/16	1·76715	0·24850	1/8	9·81748	7·6699	1/4	19·6350	30·680
19/32	1·86532	0·27688	3/16	10·0138	7·9798	3/8	20·0277	31·919
5/8	1·96350	0·30680	1/4	10·2102	8·2958	1/2	20·4204	33·183
21/32	2·06167	0·33824	5/16	10·4065	8·6179	5/8	20·8131	34·472
11/16	2·15984	0·37122	3/8	10·6029	8·9462	3/4	21·2058	35·785
23/32	2·25802	0·40574	7/16	10·7992	9·2806	7/8	21·5984	37·122
3/4	2·35619	0·44179	1/2	10·9956	9·6211	7	21·9911	38·485
25/32	2·45437	0·47937	9/16	11·1919	9·9678	1/8	22·3838	39·871
13/16	2·55254	0·51849	5/8	11·3883	10·321	1/4	22·7765	41·282
27/32	2·65072	0·55914	11/16	11·5846	10·680	3/8	23·1692	42·718
7/8	2·74889	0·60132	3/4	11·7810	11·045	1/2	23·5619	44·179
29/32	2·84707	0·64504	13/16	11·9773	11·416	5/8	23·9546	45·664
15/16	2·94524	0·69029	7/8	12·1737	11·793	3/4	24·3473	47·173
31/32	3·04342	0·73708	15/16	12·3700	12·177	7/8	24·7400	48·707
1	3·14159	0·78540	4	12.5664	12·566	8	25·1327	50·265
1/16	3·31794	0·88664	1/16	12·7627	12·962	1/8	25·5224	51·849
1/8	3·53429	0·99402	1/8	12·9591	13·364	1/4	25·9181	53·456
3/16	3·73064	1·1075	3/16	13·1554	13·772	3/8	26·3108	55·088
1/4	3·92699	1·2272	1/4	13·3518	14·186	1/2	26·7035	56·745
5/16	4·12334	1·3530	5/16	13·5481	14·607	5/8	27·0962	58·462
3/8	4·31969	1·4849	3/8	13·7445	15·033	3/4	27·4889	60·132
7/16	4·51604	1·6230	7/16	13·9408	15·466	7/8	27·8816	61·862
1/2	4·71239	1·7671	1/2	14·1372	15·904	9	28·2743	63·617
9/16	4·90874	1·9175	9/16	14·3335	16·349	1/8	28·6670	65·397
5/8	5·10509	2·0739	5/8	14·5299	16·800	1/4	29·0597	67·201
11/16	5·30144	2·2365	11/16	14·7262	17·257	3/8	29·4524	69·029
3/4	5·49779	2·4053	3/4	14·9226	17·721	1/2	29·8151	70·882
13/16	5·69414	2·5802	13/16	15·1189	18·190	5/8	30·2378	72·760
7/8	5·89049	2·7612	7/8	15·3153	18·665	3/4	30·6305	74·662
15/16	6·08684	2·9438	15/16	15·5116	19·147	7/8	31·0232	76·589

TABLE OF AREAS AND CIRCUMFERENCES OF CIRCLES.

Diam. In.	Circum. In.	Area. Sq. In.	Diam. In.	Cricum. In.	Area. Sq. In.	Diam. In.	Circum. In.	Area. Sq. In.
10	31·4159	78·540	16	50·2655	201·06	22	69·1150	380·13
1/8	31·8086	80·516	1/8	50·6·82	204·22	1/8	69·5077	384·46
1/4	32·2013	82·516	1/4	51·0509	207·39	1/4	69·9004	388·82
3/8	32·5940	84·541	3/8	51·4436	210·60	3/8	70·2931	393·20
1/2	32·9867	86·590	1/2	51·8363	213·82	1/2	70·6858	397·61
5/8	33·3794	88·664	5/8	52·2290	217·08	5/8	71·0785	402·04
3·4	33·7721	90·763	3/4	52·6217	220·35	3/4	71·4712	406·49
7/8	34·1648	92·886	7/8	53·0144	223·65	7/8	71·8639	410·97
11	34·5575	95·033	17	53·4071	226·98	23	72·2566	415·48
1/8	34·9502	97·205	1/8	53·7998	230·33	1/8	72·6493	420·00
1/4	35·3429	99·402	1/4	54·1·25	233·71	1/4	73·0420	424·56
3/8	35·7356	101·62	3/8	54·5852	237·10	3/8	73·4347	429·13
1/2	36·1283	103·87	1/2	54·9779	240·53	1/2	73·8274	433·74
5/8	36·5210	106·14	5/8	55·3706	243·98	5/8	74·2201	438·36
3/4	36·9137	108·43	3 4	55·7733	247·45	3/4	74·6128	443·01
7/8	37·3064	110·75	7/8	56·1560	250·95	7/8	75·0055	447·69
12	37·6991	113·10	18	56·5487	254·47	24	75·3982	452·39
1/8	38·0918	115·47	1/8	56·9414	258·02	1/8	75·7909	457·11
1/4	38·4845	117·86	1/4	57·3341	261·59	1/4	76·1836	461·86
3/8	38·8772	120·28	3/8	57·7268	265·18	3/8	76·5763	466·64
1/2	39·2699	122·72	1/2	58·1195	268·80	1/2	76·9690	471·44
5/8	39·6626	125·19	5/8	58·5122	272·45	5/8	77·3617	476·26
3/4	40·0553	127·68	3/4	58·9049	276·12	3/4	77·7544	481·11
7/8	40·4480	130·19	7/8	59·2976	279·81	7/8	78·1471	485·98
13	40·8307	132·73	19	59·6903	283·53	25	78·5398	490·87
1/8	41·2334	135·30	1/8	60·0830	287·27	1/8	78·9325	495·79
1/4	41·6261	137·89	1,4	60·4757	291·04	1/4	79·3252	500·74
3/8	42·0188	140·50	3/8	60·8684	294·83	3/8	79·7179	505·71
1/2	42·4115	143·14	1/2	61·2611	298·65	1/2	80·1106	510·71
5/8	42·8042	145·80	5/8	61·6538	302·49	5 8	80·5033	515·72
3/4	43·1969	148·49	3/4	62·0465	306·35	3,4	80·8960	520·77
7/8	43·5896	151·20	7/8	62·4392	310·24	7/8	81·2887	525·84
14	43·9823	153·94	20	62·8319	314·16	26	81·6814	530·93
1/8	44·3750	156·70	1/8	63·2246	318·10	1/8	82·0741	536·05
1/4	44·7677	159·48	1/4	63·6173	322·06	1/4	82·4668	541·19
3/8	45·1604	162·30	3/8	64·0100	326·05	3/8	82·8595	546·35
1/2	45·5531	165·13	1/2	64·4026	330·06	1·2	83·2522	551·55
5/8	45·9458	167·99	5/8	64·7953	334·10	5/8	83·6449	556·76
3/4	46·3385	170·87	3/4	65·1880	338·16	3/4	84·0376	562·00
7/8	46·7312	173·78	7/8	65·5807	342·25	7/8	84·4303	567·27
15	47·1239	176·71	21	65·9734	346·36	27	84·8230	572·56
1/8	47·5166	179·67	1/8	66·3661	350·50	1/8	85·2157	577·87
1/4	47·9093	182·65	1/4	66·7588	354·66	1/4	85·6084	583·21
3/8	48·3020	185·66	3/8	67·1515	358·84	3·8	86·0011	588·57
1/2	48·6947	188·69	1/2	67·5442	363·05	1/2	86·3938	593·96
5/8	49·0874	191·75	5/8	67·9369	367·28	5/8	86·7865	599·37
3/4	49·4801	194·83	3/4	68·3296	371·54	3/4	87·1792	604·81
7/8	49·8728	197·93	7/8	68·7223	375·63	7/8	87·5719	610·27

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TABLE OF AREAS AND CIRCUMFERENCES OF CIRCLES.

Diam. In.	Circum. In.	Area. Sq. In.	Diam. In.	Circum. In.	Area. Sq. In.	Diam. In.	Circum. In.	Area. Sq. In.
28	87 9646	615·75	**34**	106·814	907·92	**40**	125·664	1256·6
1/8	88·3·73	621·26	1/8	107·207	914·61	1/8	126·056	1264·5
1/4	88·7500	626·80	1/4	107·600	921·32	1/4	126·449	1272·4
3/8	89·1427	632·36	3/8	107·992	928·06	3/8	126·842	1280·3
1/2	89·5354	637·94	1/2	108·385	934·82	1/2	127·235	1288·2
5/8	89·9281	643·55	5/8	108·788	941·61	5/8	127·627	1296·2
3/4	90·3208	649·18	3/4	109·170	948·42	3/4	128·020	1304·2
7/8	90·7135	654·84	7/8	109·563	955·25	7/8	128·413	1312·2
29	91·1062	660·52	**35**	109·956	962·11	**41**	128·805	1320·3
1/8	91·4989	666·23	1/8	110·348	969·00	1/8	129·198	1328·3
1/4	91·8916	671·96	1/4	110·741	975·91	1/4	129·591	1336·4
3/8	92·2843	677·71	3/8	111·134	982·84	3/8	129·993	1344·5
1/2	92·6770	683·49	1/2	111·527	989·80	1/2	130·376	1352·7
5/8	93·0697	689·30	5/8	111·919	996·78	5/8	130·769	1360·8
3/4	93·4624	695·13	3/4	112·312	1003·8	3/4	131·161	1369·0
7/8	93·8551	700·98	7/8	112·705	1010·8	7/8	131·554	1377·2
30	94·2478	706·96	**36**	113·097	1017·9	**42**	131·947	1385·4
1/8	94·6405	712·76	1/8	113·490	1025·0	1/8	132·340	1393·7
1/4	95·0332	718·69	1/4	113·883	1032·1	1/4	132·732	1402·0
3/8	95·4259	724·64	3/8	114·275	1039·2	3/8	133·125	1410·3
1/2	95·8186	730·62	1/2	114·668	1046·3	1/2	133·518	1418·6
5/8	96·2113	736·62	5/8	115·061	1053·5	5/8	133·910	1427·0
3/4	96·6040	742·64	3/4	115·454	1060·7	3/4	134·303	1435·4
7/8	96·9967	748·69	7/8	115·846	1068·0	7/8	134·696	1443·8
31	97·3894	754·77	**37**	116·239	1075·2	**43**	135·088	1452·2
1/8	97·7821	760·87	1/8	116·632	1082·5	1/8	135·481	1460·7
1/4	98·1748	766·99	1/4	117·024	1089·8	1/4	135·874	1469·1
3/8	98·5675	773·14	3/8	117·417	1097·1	3/8	136·267	1477·6
1/2	98·9602	779·31	1/2	117·810	1104·5	1/2	136·659	1486·2
5/8	99·3529	785·51	5/8	118·202	1111·8	5/8	137·052	1494·7
3/4	99·7456	791·73	3/4	118·596	1119·2	3/4	137·445	1503·3
7/8	100·138	797·98	7/8	118·988	1126·7	7/8	137·837	1511·9
32	100·531	804·25	**38**	119·381	1134·1	**44**	138·230	1520·5
1/8	100·924	810·54	1/8	119·773	1141·6	1/8	138·623	1529·2
1/4	101·316	816·86	1/4	120·166	1149·1	1/4	139·015	1537·9
3/8	101·709	823·21	3/8	120·559	1156·6	3/8	139·408	1546·6
1/2	102·102	829·58	1/2	120·951	1164·2	1/2	139·801	1555·3
5/8	102·494	835·97	5/8	121·344	1171·7	5/8	140·194	1564·0
3/4	102·887	842·39	3/4	121·737	1179·3	3/4	140·586	1572·8
7/8	103·280	848·83	7/8	122·129	1186·9	7/8	140·979	1581·6
33	103·673	855·30	**39**	122·522	1194·6	**45**	141·372	1590·4
1/8	104·065	861·79	1/8	122·915	1202·3	1/8	141·764	1599·3
1/4	104·458	868·31	1/4	123·308	1210·0	1/4	142·157	1608·2
3/8	104·851	874·85	3/8	123·700	1217·7	3/8	142·550	1617·0
1/2	105·243	881·41	1/2	124·093	1225·4	1/2	142·942	1626·0
5/8	105·636	888·00	5/8	124·486	1233·2	5/8	143·335	1684·9
3/4	106·029	894·62	3/4	124·878	1241·0	3/4	143·728	1643·9
7/8	*106·421*	*901·26*	7/8	125·271	1248·8	7/8	144·121	1652·9

TABLE OF AREAS AND CIRCUMFERENCES OF CIRCLES.

Diam. In.	Circum. In.	Area. Sq. In.	Diam. In.	Circum. In.	Area. Sq. In.	Diam. In.	Circum. In.	Area. Sq. In.
46	144·513	1661·9	**52**	163·363	2123·7	**58**	182·212	2642·1
1/8	144·906	1670·9	1/8	163·756	2133·9	1/8	182·605	2653·5
1/4	145·299	1680·0	1/4	164·148	2144·2	1/4	182·998	2664·9
3/8	145·691	1689·1	3/8	164·541	2154·5	3/8	183·390	2676·4
1/2	146·084	1698·2	1/2	164·934	2164·8	1/2	183·783	2687·8
5/8	146·477	1707·4	5/8	165·326	2175·1	5/8	184·176	2699·3
3/4	146·869	1716·5	3/4	165·719	2185·4	3/4	184·569	2710·9
7/8	147·262	1725·7	7/8	166·112	2195·8	7/8	184·961	2722·4
47	147·655	1734·9	**53**	166·504	2206·2	**59**	185·354	2734·0
1/8	148·048	1744·2	1/8	166·897	2216·6	1/8	185·747	2745·6
1/4	148·440	1753·5	1/4	167·290	2227·0	1/4	186·139	2757·2
3/8	148·833	1762·7	3/8	167·683	2237·5	3/8	186·532	2768·8
1/2	149·226	1772·1	1/2	168·075	2248·0	1/2	186 925	2780·5
5/8	149·618	1781·4	5/8	168·46 8	2258·5	5/8	187·317	2792·2
3/4	150·011	1790·8	3/4	168·861	2269·1	3/4	187 710	2803·9
7/8	150·404	1800·1	7/8	169·253	2279·6	7/8	188·103	2815·7
48	150·796	1809·6	**54**	169·646	2290·2	**60**	188·496	2827·4
1/8	151·189	1819·0	1,8	170·039	2300·8	1/8	188·8·8	2839·2
1/4	151·582	1828·5	1/4	170·431	2311·5	1/4	189·281	2851·0
3/8	151·975	1837·9	3/8	170·824	2322·1	3/8	189·674	2862·9
1/2	152·367	1847·5	1/2	171·217	2332·8	1/2	190·066	2874·8
5/8	152·760	1857·0	5/8	171·609	2343·5	5/8	190 459	2886·6
3/4	153·153	1866·5	3/4	172·002	2354·3	3/4	190·852	2898·6
7/8	153·545	1876·1	7/8	172·395	2365·0	7/8	191·244	2910·5
49	153·938	1885·7	**55**	172·788	2375·8	**61**	191·637	2922·5
1/8	154·331	1895·4	1/8	173·180	2386·6	1/8	192·030	2934·5
1/4	154·723	1905·0	1/4	173·573	2397·5	1/4	192·423	2946·5
3/8	155·116	1914·7	3/8	173·966	2408·3	3/8	192·815	2958·5
1.2	155·509	1924·2	1/2	174·358	2419·2	1/2	193·208	2970·6
5/8	155·509	1934·2	5/8	174·751	2430·1	5 8	193·601	2982·7
3/4	156·294	1943·9	3/4	175·144	2441·1	3/4	193·993	2994·8
7/8	156·687	1953·7	7/8	175·536	2452·0	7/8	194·386	3006·9
50	157·080	1963·5	**56**	175·929	2463·0	**62**	194·779	3019·1
1/8	157·472	1973·3	1/8	176·322	2474·0	1/8	195·171	3031·3
1/4	157·865	1983·2	1/4	176·715	2485·0	1/4	195·564	3043·5
3/8	158·258	1993·1	3/8	177·107	2496·1	3/8	195·957	3055·7
1/2	158·650	2003·0	1/2	177·500	2507·2	1/2	196·350	3068·0
5/8	159·043	2012·9	5/8	177·893	2518·3	5/8	196·742	3080·3
3/4	159·436	2022·8	3/4	178·285	2529·4	3/4	197·135	3092·6
7/8	159·829	2032·8	7/8	178·678	2540·6	7/8	197·528	3104·9
51	160·221	2042·8	**57**	179·071	2551·8	**63**	197·920	3117·2
1/8	160·614	2052·8	1/8	179·463	2563·0	1/8	198·313	3129·6
1/4	161·007	2062 9	1/4	179·856	2574·2	1/4	198·706	3142·0
3/8	161·399	2073·0	3/8	180·249	2585·4	3/8	199·098	3154·5
1/2	161·792	2083·1	1/2	180·642	2596·7	1/2	199·491	3166·9
5/8	162·185	2093·2	5/8	181·034	2608·0	5/8	199·884	3179·4
3/4	162·577	2103·3	3/4	181·427	2619·4	3/4	200·277	3191·9
7/8	162·970	2113·5	7/8	181·820	2630·7	7/8	200·669	3204·4

TABLE OF AREAS AND CIRCUMFERENCES OF CIRCLES.

Diam. In.	Circumf. In.	Area. Sq. In.	Diam. In.	Circumf. In.	Area. Sq. In.	Diam. In.	Circumf. In.	Area. Sq. In.
64	201·062	3217·0	70	219·911	3848·5	76	238 761	4536·5
1/8	201·455	3229·6	1/8	220·304	3862·2	1/8	239·154	4551·4
1/4	201·847	3242·2	1/4	220·697	3876·0	1/4	239·546	4566·4
3/8	202·210	3254·8	3/8	221·090	3889·8	3/8	239·939	4581·3
1/2	202 633	3267·5	1/2	221·482	3903·6	1/2	240 332	4596·3
5/8	203·025	3290·1	5/8	221·875	3917·5	5/8	240·725	4611·4
3/4	203·418	3292·8	3/4	222 268	3931·4	3/4	241·117	4626·4
7/8	203·811	3305·6	7/8	222·660	3945·3	7/8	241 510	4641·5
65	204·204	3318·3	71	223·053	3959·2	77	241·903	4656·6
1/8	204·596	3331·1	1/8	223·446	3973·1	1/8	242·295	4671·8
1/4	204·989	3343·9	1/4	223·838	3987·1	1/4	242 688	4686·9
3/8	205·382	3356·7	3/8	224·231	4001·1	3/8	243·081	4702·1
1/2	205·774	3369·6	1/2	224 624	4015·2	1/2	243·473	4717·3
5/8	206·167	3382·4	5/8	225·017	4029·2	5/8	243 866	4732·5
3/4	206·560	3395·3	3/4	225·409	4043·3	3/4	244·259	4747·8
7/8	206·952	3408·2	7/8	225·802	4057·4	7/8	244·652	4763·1
66	207·345	3421·2	72	226·195	4071·5	78	245·044	4778·4
1/8	207·738	3434·3	1/8	226·587	4085·7	1/8	245·437	4793·7
1/4	208·131	3447·2	1/4	226·980	4099·8	1/4	245·830	4809·0
3/8	208·523	3460·2	3/8	227·373	4114·0	3/8	246 222	4824·4
1/2	208·916	3473·2	1/2	227·765	4128·2	1/2	246·615	4839·8
5/8	209 309	3486·3	5/8	228·158	4142·5	5/8	247·008	4855·2
3/4	209 701	3499·4	3/4	228 551	4156·8	3/4	247 400	4870·7
7/8	210·094	3512·5	7/8	228·944	4171·1	7/8	247·793	4886·2
67	210·487	3525·7	73	229·336	4185·4	79	248·186	4901·7
1/8	210·879	3538·8	1/8	229·729	4199·7	1/8	248·579	4917·2
1/4	211·272	3552·0	1/4	230·122	4214·1	1/4	248·971	4932·7
3/8	211·665	3565·2	3/8	230 514	4228·5	3/8	249·364	4948·3
1/2	212·058	3578·5	1/2	230·907	4242·9	1/2	249·757	4963·9
5/8	212·450	3591·7	5/8	231·300	4257·4	5/8	250·149	4979·5
3/4	212·843	3605·0	3 4	231·692	4271·8	3/4	250·542	4995·2
7/8	213·236	3618·3	7/8	232·085	4286·3	7/8	250·935	5010·9
68	213·628	3631·7	74	232·478	4300·8	80	251·327	5026·5
1/8	214 021	3645·0	1/8	232 871	4315·4	1/8	251·720	5042 3
1/4	214·414	3658·4	1/4	233·263	4329·9	1/4	252·113	5058·0
3/8	214·806	3671·8	3/8	233·656	4844·5	3/8	252·506	5073·8
1/2	215·199	3685·3	1/2	234·059	4359·2	1/2	252·898	5089 6
5/8	215·592	3698·7	5/8	234·441	4373 8	5/8	253·291	5105·4
3/4	215·984	3712·2	3/4	234·834	4388·5	3/4	253 684	5121·2
7/8	216·377	3725·7	7/8	235·227	4403·1	7/8	254·076	5137·1
69	216·770	3739·3	75	235·619	4417·9	81	254·469	5153·0
1/8	217·163	3752·8	1/8	236·012	4432·6	1/8	254·862	5168·9
1/4	217·555	3766·4	1/4	236·405	4447·4	1/4	255·254	5184·9
3/8	217 948	3780·0	3/8	236·798	4462·2	3/8	255·647	5200·8
1/2	218·341	3793·7	1/2	237·190	4477·0	1/2	256·040	5216·8
5/8	218·733	3807·3	5/8	237·583	4491·8	5/8	256·433	5232·8
3/4	219·126	3821·0	3/4	237·976	4506·7	3/4	256·825	5 48·9
7/8	219·519	3834·7	7/8	238·368	4521·5	7/8	257·218	5264·9

TABLE OF AREAS AND CIRCUMFERENCES OF CIRCLES.

Diam. In.	Circumf. In.	Area. Sq. In.	Diam. In.	Circumf. In.	Area. Sq. In.	Diam. In.	Circumf. In.	Area. Sq. In.
82	257·611	5281·0	**88**	276·460	6082·1	**94**	295·310	6939·8
1/8	258·003	5297·1	1/8	276·853	6099·4	1/8	295·702	6958·2
1/4	258·396	5313·3	1/4	277·246	6116·7	1/4	295·095	6976·7
3/8	258·789	5329·4	3/8	277·638	6134·1	3/8	296·488	6995·3
1/2	259·181	5345·6	1/2	278·031	6151·4	1/2	296·881	7013·8
5/8	259·574	5361·8	5/8	278·424	6168·8	5/8	297·273	7032·4
3/4	259·967	5378·1	3/4	278·816	6186·2	3/4	297·666	7051·0
7/8	260·359	5394·3	7/8	279·209	6203·7	7/8	298·059	7069·6
83	260·752	5410·6	**89**	279·602	6221·1	**95**	298·451	7088·2
1/8	261·145	5426·9	1/8	279·994	6238·6	1/8	298·844	7106·9
1/4	261·538	5443·3	1/4	280·387	6256·1	1/4	299·237	7125·6
3/8	261·930	5459·6	3/8	280·780	6273·7	3/8	299·629	7144·3
1/2	262·323	5476·0	1/2	281·173	6291·2	1/2	300·022	7163·0
5/8	262·716	5492·4	5/8	281·565	6308·8	5/8	300·415	7181·9
3/4	263·108	5508·8	3/4	281·958	6326·4	3/4	300·807	7200·6
7/8	263·501	5525·3	7/8	282·351	6344·1	7/8	301·200	7219·4
84	263·894	5541·8	**90**	282·743	6361·7	**96**	301·593	7238·2
1/8	264·286	5558·3	1/8	283·136	6379·4	1/8	301·986	7257·1
1/4	264·679	5574·8	1/4	283·529	6397·1	1/4	302·378	7276·0
3/8	265·072	5591·4	3/8	283·921	6414·9	3/8	302·771	7294·9
1/2	265·465	5607·9	1/2	284·314	6432·6	1/2	303·164	7313·8
5/8	265·857	5624·5	5/8	284·707	6450·4	5/8	303·556	7332·8
3/4	266·250	5641·2	3/4	285·100	6468·2	3/4	303·949	7351·8
7/8	266·643	5657·8	7/8	285·492	6486·0	7/8	304·342	7370·8
85	267·035	5674·5	**91**	285·885	6503·9	**97**	304·734	7389·8
1/8	267·428	5691·2	1/8	286·278	6521·8	1/8	305·127	7408·9
1/4	267·821	5707·9	1/4	286·670	6539·7	1/4	305·520	7428·0
3/8	268·213	5724·7	3/8	287·063	6557·6	3/8	305·913	7447·1
1/2	268·606	5741·5	1/2	287·456	6575·5	1/2	306·305	7466·2
5/8	268·999	5758·3	5/8	287·848	6593·5	5/8	306·698	7485·3
3/4	269·392	5775·1	3/4	288·241	6611·5	3/4	307·091	7504·5
7/8	269·784	5791·9	7/8	288·634	6629·6	7/8	307·483	7523·7
86	270·177	5808·8	**92**	289·027	6647·6	**98**	307·876	7543·0
1/8	270·570	5825·7	1/8	289·419	6665·7	1/8	308·269	7562·2
1/4	270·962	5842·6	1/4	289·812	6683·8	1/4	308·661	7581·5
3/8	271·355	5859·6	3/8	290·205	6701·9	3/8	309·054	7600·8
1/2	271·748	5876·5	1/2	290·597	6720·1	1/2	309·447	7620·1
5/8	272·140	5893·5	5/8	290·990	6738·2	5/8	309·840	7639·5
3/4	272·533	5910·6	3/4	291·383	6756·4	3/4	310·232	7658·9
7/8	272·926	5927·6	7/8	291·775	6774·7	7/8	310·625	7678·3
87	273·319	5944·7	**93**	292·168	6792·9	**99**	311·018	7697·7
1/8	273·711	5961·8	1/8	292·561	6811·2	1/8	311·410	7717·1
1/4	274·104	5978·9	1/4	232·954	6829·5	1/4	311·803	7636·6
3/8	274·497	5996·0	3/8	293·346	6847·8	3/8	312·196	7756·1
1/2	274·889	6013·2	1/2	293·739	6866·1	1/2	312·588	7775·6
5/8	275·282	6030·4	5/8	294·132	6884·5	5/8	312·981	7795·2
3/4	275·675	6047·6	3/4	294·524	6902·9	3/4	313·374	7814·8
7/8	276·067	6064·9	7/8	294·917	6921·3	7/8	313·767	7834·4
						100	314·159	7854·0

SQUARES, CUBES, SQUARE ROOTS, AND CUBE ROOTS.

No.	Square.	Cube.	Square Root. √	Cube Root. ³√	No.	Square.	Cube.	Square Root. √	Cube Root. ³√
1	1	1	1·000	1·000	51	2601	132651	7·141	3·708
2	4	8	1·414	1·259	52	2704	140608	7·211	3·732
3	9	27	1·732	1·442	53	2809	148877	7·280	3·756
4	16	64	2·000	1·587	54	2916	157464	7·348	3·779
5	25	125	2·236	1·709	55	3025	166375	7·416	3·802
6	36	216	2·449	1·817	56	3136	175616	7·483	3·825
7	49	343	2·645	1·912	57	3249	185193	7·549	3·848
8	64	512	2·828	2·000	58	3364	195112	7·615	3·870
9	81	729	3·000	2·080	59	3481	205379	7·681	3·892
10	100	1000	3·162	2·154	60	3600	216000	7·745	3·914
11	121	1331	3·316	2·223	61	3721	226981	7·810	3·936
12	144	1728	3·464	2·289	62	3844	238328	7·874	3·957
13	169	2197	3·605	2·351	63	3969	250047	7·937	3·979
14	196	2744	3·741	2·410	64	4096	262144	8·000	4·000
15	225	3375	3·872	2·466	65	4225	274625	8·062	4·020
16	256	4096	4·000	2·519	66	4356	287496	8·124	4·041
17	289	4913	4·123	2·571	67	4489	300763	8·185	4·061
18	324	5832	4·242	2·620	68	4624	314432	8·246	4·081
19	361	6859	4·358	2·668	69	4761	328509	8·306	4·101
20	400	8000	4·472	2·714	70	4900	343000	8·366	4·121
21	441	9261	4·582	2·758	71	5041	357911	8·426	4·140
22	484	10648	4·690	2·802	72	5184	373248	8·485	4·160
23	529	12167	4·795	2·843	73	5329	389017	8·544	4·179
24	576	13824	4·898	2·884	74	5476	405224	8·602	4·198
25	625	15625	5·000	2·924	75	5625	421875	8·660	4·217
26	676	17576	5·099	2·962	76	5776	438976	8·717	4·235
27	729	19683	5·196	3·000	77	5929	456333	8·774	4·254
28	784	21952	5·291	3·036	78	6084	474552	8·831	4·272
29	841	24389	5·385	3·072	79	6241	493039	8·888	4·290
30	900	27000	5·477	3·107	80	6400	512000	8·944	4·308
31	961	29791	5·567	3·141	81	6561	531441	9·000	4·326
32	1024	32768	5·656	3·174	82	6724	551368	9·055	4·344
33	1089	35937	5·744	3·207	83	6889	571787	9·110	4·362
34	1156	39304	5·830	3·239	84	7056	592704	9·165	4·379
35	1225	42875	5·916	3·271	85	7225	614125	9·219	4·396
36	1296	46656	6·000	3·301	86	7396	636056	9·273	4·414
37	1369	50653	6·082	3·332	87	7569	658503	9·327	4·431
38	1444	54872	6·164	3·361	88	7744	681472	9·380	4·447
39	1521	59319	6·244	3·391	89	7921	704969	9·433	4·464
40	1600	64000	6·324	3·420	90	8100	729000	9·486	4·480
41	1681	68921	6·403	3·448	91	8281	753571	9·539	4·497
42	1764	74088	6·480	3·476	92	8464	778688	9·591	4·514 ·
43	1849	79507	6·557	3·503	93	8649	804357	9·643	4·530
44	1936	85184	6·633	3·530	94	8836	830584	9·695	4·546
45	2025	91125	6·708	3·556	95	9025	857375	9·746	4·560
46	2116	97336	6·782	3·583	96	9216	884736	9·797	4·578
47	2209	103823	6·855	3·608	97	9409	912673	9·848	4·594
48	2304	110592	6·928	3·634	98	9604	941192	9·899	4·610
49	2401	117649	7·000	3·659	99	9801	970299	9·949	4·626
50	2500	125000	7·071	3·684	100	10000	1000000	10·000	4·641

SQUARES, CUBES, SQUARE ROOTS, AND CUBE ROOTS.

No.	Square.	Cube.	Square Root. √	Cube Root. ³√	No.	Square.	Cube.	Square Root. √	Cube Root. ³√
105	11025	1157625	10·24	4·717	360	129600	46656000	18·97	7·115
110	12100	1331000	10·48	4·791	365	133225	48627125	19·10	7·146
115	13225	1520875	10·72	4·862	370	136900	50653000	19·23	7·179
120	14400	1728000	10·95	4·932	375	140625	52734375	19·36	7·211
125	15625	1953125	11·18	5·000	380	144400	54872000	19·49	7·243
130	16900	2197000	11·40	5·065	385	148225	57066625	19·62	7·274
135	18225	2460375	11·61	5·129	390	152100	59319000	19·74	7·306
140	19600	2744000	11·83	5·192	395	156025	61629875	19·87	7·337
145	21025	3048625	12·04	5·253	400	160000	64·00000	20·00	7·368
150	22500	3375000	12·24	5·313	405	164025	66430125	20·12	7·398
155	24025	3723875	12·44	5·371	410	168100	68921000	20·24	7·428
160	25600	4096000	12·64	5·428	415	172225	71473375	20·37	7·459
165	27225	4492125	12·84	5·484	420	176400	74088000	20·49	7·488
170	28900	4913000	13·03	5·539	425	180625	76765625	20·61	7·518
175	30625	5359375	13·22	5·593	430	184900	79507000	20·736	7·547
180	32400	5832000	13·41	5·646	435	189225	82312875	20·856	7·576
185	34225	6331625	13·60	5·698	440	193600	85184000	20·976	7·605
190	36100	6859000	13·78	5·748	445	198025	88121125	21·095	7·634
195	38025	7414875	13·96	5·798	450	202500	91125000	21·213	7·663
200	40000	8000000	14·14	5·848	455	207025	94196375	21·330	7·691
205	42025	8615125	14·31	5·896	460	211600	97336000	21·447	7·719
210	44100	9261000	14·49	5·943	465	216225	100544625	21·563	7·747
215	46225	9938875	14·66	5·990	470	220900	103823000	21·679	7·774
220	48400	10648000	14·83	6·036	475	225625	107171875	21·794	7·802
225	50625	11390625	15·00	6·082	480	230400	110592000	21·909	7·829
230	52900	12167000	15·16	6·126	485	235225	114084125	22·022	7·856
235	55225	12977875	15·32	6·171	490	240100	117649000	22·135	7·883
240	57600	13824000	15·49	6·214	495	245025	121287375	22·248	7·910
245	60025	14706125	15·65	6·257	500	250000	125000000	22·360	7·937
250	62500	15625000	15·81	6·299	510	260100	132651000	22·583	7·989
255	65025	16581375	15·96	6·341	520	270400	140608000	22·803	8·041
260	67600	17576000	16·12	6·382	540	291600	157464000	23·237	8·143
265	70225	18609625	16·27	6·423	560	313600	175616000	23·664	8·247
270	72900	19683000	16·43	6·463	580	336400	195112000	24·083	8·339
275	75625	20796875	16·58	6·502	600	360000	216000000	24·494	8·434
280	78400	21952000	16·73	6·542	625	390625	244140625	25·000	8·549
285	81225	23149125	16·88	6·580	650	422500	274625000	25·495	8·662
290	84100	24389000	17·02	6·619	675	455625	307546875	25·980	8·772
295	87025	25672375	17·17	6·656	700	490000	343000000	26·457	8·879
300	90000	27000000	17·32	6·694	725	525625	381078125	26·925	8·983
305	93025	28372625	17·46	6·731	750	562500	421875000	27·386	9·085
310	96100	29791000	17·60	6·767	775	600625	465484375	27·838	9·185
315	99225	31255875	17·74	6·804	800	640000	512000000	28·284	9·283
320	102400	32768000	17·88	6·839	825	680625	561515625	28·722	9·378
325	105625	34328125	18·02	6·875	850	722500	614125000	29·154	9·472
330	108900	35937000	18·16	6·910	875	765625	669921875	29·580	9·564
335	112225	37595375	18·30	6·945	900	810000	729000000	30·000	9·654
340	115600	39304000	18·43	6·979	925	855625	791453125	30·413	9·743
345	119025	41063625	18·57	7·013	950	902500	857375000	30·822	9·830
350	122500	42875000	18·70	7·047	975	950625	926859375	31·224	9·915
355	126025	44738875	18·84	7·080	1000	1000000	1000000000	31·622	10·000

E.

TABLE OF FOURTH POWERS OF NUMBERS.

N	N⁴	N	N⁴	N	N⁴	N	N⁴
1	1·00	3¼	112	5½	915	7¾	3607
1⅛	1·60	3⅜	130	5⅝	1000	7⅞	3846
1¼	2·44	3½	150	5¾	1093	8	4096
1⅜	3·57	3⅝	173	5⅞	1191	8⅛	4358
1½	5·06	3¾	198	6	1296	8¼	4632
1⅝	6·97	3⅞	228	6⅛	1408	8⅜	4920
1¾	9·38	4	256	6¼	1526	8½	5293
1⅞	12·4	4⅛	289	6⅜	1652	8⅝	5534
2	16·0	4¼	326	6½	1785	8¾	5861
2⅛	20·4	4⅜	366	6⅝	1926	8⅞	6204
2¼	25·6	4½	410	6¾	2076	9	6561
2⅜	31·8	4⅝	458	6⅞	2140	9⅛	6933
2½	39·1	4¾	509	7	2401	9¼	7321
2⅝	47·5	4⅞	565	7⅛	2577	9⅜	7725
2¾	57·2	5	625	7¼	2763	9½	8145
2⅞	68·3	5⅛	690	7⅜	2959	9⅝	8582
3	81·0	5¼	760	7½	3164	9¾	9036
3⅛	95·4	5⅜	835	7⅝	3380	9⅞	9509

Logarithms.—The logarithm of a number to a given base is the index of the power to which the base must be raised to give the number; thus if $m = a^x$, x is the log. of m to base a. In the common system of logs. the base is 10, or the successive values of x, which satisfy the equation $m = 10^x$, that is, x is the log. of m to base 10. In the Napierian or natural system of logs., also called hyperbolic logs., the base is denoted by the symbol ε and is the sum of the series

$$2 + \frac{1}{2} + \frac{1}{2.3} + \frac{1}{2.3.4} \cdot \cdot \cdot \cdot \cdot ;$$

its value is 2·718 . . . . . the log. of which to the base ε is 2·3025 . . . . . ; hence the modulus of common logs. is

$$\frac{1}{\log. \varepsilon \, 10} = \frac{1}{2·3025 \ldots} = 0·43429 \ldots ;$$

that is, to find the common log. of a number, multiply its Napierian or hyperbolic log. by 0·43429 . . . . . Conversely, to find the Napierian or hyperbolic log. of a number, multiply its common log. by 2·3025 . . . . .

DYNAMICS.

Absolute Units of Force.—The "absolute unit of force" is a term used to denote the force which, acting on a unit of mass for a unit of time, produces a unit of velocity.

The unit of time employed is always a second.

The unit of velocity is, in Britain, one foot per second; in France, one metre per second.

The unit of mass is the mass of so much matter as weighs one unit of weight near the level of the sea, and in some definite latitude.

In Britain the latitude chosen is that of London; in France, that of Paris.

In Britain the unit of weight chosen is a pound avoirdupois, and is equal to 32·187 of the corresponding absolute units of force.

In France the unit of weight chosen is a gramme, and it is equal to 9·8087 of the corresponding absolute units of force.

The proportions borne to each other by the absolute units of force in different countries are nearly the same as those of the units of work, and would be exactly the same but for the variation of the force of gravity in the latitude. Gravity is about 1·00017 times greater in London than in Paris.

Power is expressed in units of work in unit of time as foot-pounds per second or per minute.

1 horse-power	= 550 foot-pounds per second.	
	= 33,000 foot-pounds per minute.	
	= 1,980,000 foot-pounds per hour.	
1 horse-power	= 1·0139 cheval-vapeur.	
1 cheval-vapeur	= 75 kilogrammetres per second.	
	= 542·5 foot-pounds per second.	
	= 0·9863 horse-power.	

Work.—1 kilogrammetre = 7·23314 foot-pounds.

1 foot-pound = 0·138253 kilogrammetres.

Energy.—It is known that energy manifests itself under different forms, and that one form of energy is quantitatively convertible into another form, without loss. It is also known that each form of energy is expressible as the product of two factors, one of which has been termed the "intensity factor," and the other the "capacity factor." Prof. Ostwald, in the last edition of his "Allgemeine Chemie," classified some of these forms of energy as follows :—

Kinetic energy is the product of mass into the square of velocity.

Linear	„	„	length into force.
Surface	„	,,	surface into surface tension.
Volume	„	„	volume into pressure.

E 2

Heat energy is the product of heat capacity (entropy) into temperature.

| Electrical | ,, | ,, | electric capacity into potential. |
| Chemical | ,, | ,, | " atomic weight " into affinity. |

Let t = time (seconds).

s = space in feet.

V = initial velocity in feet per second.

v = final   ,,   ,,   ,,

U = average   ,,   ,,   ,,

Then $s = v\,t$, $v = s/t$.

$$U - \tfrac{1}{2}(v + V).$$

$$s = U\,t = \tfrac{1}{2}(v + V)\,t.$$

If velocity increases or diminishes uniformly from V to v foot seconds, then the acceleration or retardation f is given by $f = (v - V)\,t$ foot seconds per second.

$$v = V + f\,t.$$

$$U = V + \tfrac{1}{2} f\,t.$$

$$s = V\,t + \tfrac{1}{2} f\,t^2.$$

Again, since $v - V = f\,t$,—

$$\tfrac{1}{2}(v + V) = U = s/t.$$

Multiplying we get—

$$\tfrac{1}{2} v^2 - \tfrac{1}{2} V^2 = f\,s.$$

If a force of P pounds acts on a weight of W lbs., it produces an acceleration given by—

$$\frac{f}{g} = \frac{P}{W} \quad (g = 32 \cdot 2)$$

If the force P pounds acts through s feet for t seconds, and produces a velocity of v foot seconds,—

then since $\tfrac{1}{2} v^2 = f\,s$, $v = f\,t$—

$$\therefore \ \tfrac{1}{2} W\,v^2/g = P\,s, \text{ and } W\,v/g = P\,t.$$

The expression $\tfrac{1}{2} W\,v^2/g$ denotes the "kinetic energy" of a body in foot-pounds.

A force of P pounds acting for t seconds is called the "impulse" in second pounds, and, since $W\,v/g = P\,t$, $W\,v/g$ is called the "momentum" or quantity of motion that a body of W lbs. weight *possesses, and is measured* in second pounds.

Thus, a body starting from rest, the energy developed is—

$$P s = \tfrac{1}{2} W v^2/g \text{ (foot pounds)},$$

the momentum— $P t = W v/g$ (second pounds),

but if a body already has a motion of V foot seconds, the energy is—

$$\tfrac{1}{2} W v^2/g - \tfrac{1}{2} W V^2/g = P s,$$

and the momentum—

$$W v/g - W V/g = P t \text{ (second pounds)}.$$

Thus, if a body such as a truck on a railway is acted on by a horizontal force of P pounds for t seconds, the velocity acquired will be—

$$\frac{P}{W} g t \text{ (foot seconds)},$$

the energy acquired will be—

$$\tfrac{1}{2} \frac{P^2}{W} g t^2 \text{ (foot pounds)},$$

the momentum acquired will be—

$$P t \text{ (second pounds)},$$

and the distance gone will be—

$$\tfrac{1}{2} \frac{P}{W} g t^2 \text{ (feet)}.$$

If the body is on an incline making an angle of $a°$ with the horizon, it slides with an acceleration given by—

$$\frac{f}{g} = \frac{W \sin. a°}{W}$$

$$f = g \sin. a°$$

Formulæ of Falling Bodies in Air.

$g = 32 \cdot 2.$ $v =$ Velocity in ft. secs.
$s =$ Space in feet. $t =$ Time in secs.

$$s = \tfrac{1}{2} g t^2 = \frac{v^2}{2 g}$$

$$v = g t = \sqrt{2 g s} = \frac{2 s}{t}$$

$$t = \frac{v}{g} = \frac{2 s}{v} = \sqrt{\frac{2 s}{g}}$$

When a body is thrown upwards with an initial velocity of V ft. secs., if T is the time taken to reach the height S feet, these formulæ become—

$$s = V t - \tfrac{1}{2} g t^2 = \frac{V^2}{2 g} \qquad\qquad S = \frac{V^2}{2 g}$$

$$v = V - \sqrt{2 g s} = V - g t \qquad\qquad V = \sqrt{2 g S}$$

$$t = \frac{2 g s + V^2 + V v}{v g} \qquad\qquad T = \frac{V}{g}$$

If the body is thrown downwards—

$$s = V t + \tfrac{1}{2} g t^2$$
$$v = V + \sqrt{2 g s} = V + g t$$
$$t = \frac{2 g s + V^2 - V v}{g v}$$

$g = 32 \cdot 2$	$\dfrac{g}{2} = 16 \cdot 1$
$\dfrac{g}{4} = 8 \cdot 05$	$\dfrac{1}{g} = 0 \cdot 03106$
$\dfrac{1}{2 g} = 0 \cdot 01553$	$2 g = 64 \cdot 4$

$$\sqrt{2 g} = 8 \cdot 025$$

Circular Measure.

Angular and Linear Velocity of Wheels.

Unit of circular measure that angle whose arc equals radius, usually called a radian, and is $\dfrac{180}{\pi} = 57° \cdot 3$. It is denoted by ω. If r be the radius of a circle, and v the linear velocity of any point on its circumference—

$$v = \omega r \quad \text{and} \quad \omega = \frac{v}{r} .$$

1 revolution per min. $= 2 \pi$ units of circular measure per min.

Circular measure $=$ degrees $\times$ $0 \cdot 01745$.

Centrifugal Force.

W = Weight of body.
r = Radius of circle it describes.
A* = Angular velocity in the circle in radians.
Cf. = Centrifugal force.

$$\text{Cf.} = \frac{W A^2 r}{g} = \frac{W}{g} \cdot \frac{V^2}{r}$$

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* If the *linear* velocity is given, V, $A = \dfrac{V}{r}$ and $V = A r$.

THE PENDULUM GOVERNOR.
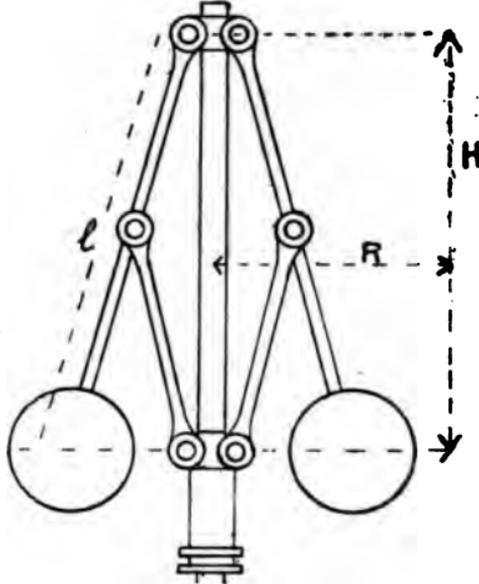
SIMPLE WATT GOVERNOR.
(Foot-lb.-second units.)

Let W = Weight of each ball in lbs.
    R = Radius of system in feet.
    H = Height   „   „   „
    v = Velocity of rotation in feet per second.
    n = Revolutions per second.
    g = Acceleration due to gravity = 32·2.

Each ball as the system revolves is under the action of three forces: A deflecting force, which produces a circular instead of a rectilinear motion, given by $\dfrac{Wv^2}{gR}$; the tension in the rod, e ; and the weight, w.

$$\frac{H}{R} = \frac{W}{\dfrac{Wv^2}{gR}} \qquad\qquad \text{That is---} \qquad H = \frac{gR^2}{v^2}$$

$$v = 2\pi Rn = \frac{2\pi RN}{60}$$

If h be the height in inches—

$$h = \frac{gR^2}{v^2}\,.\,12 = \frac{g\,.\,R^2\,.\,60^2\,.\,12}{4\pi^2R^2N^2} = \frac{35,200}{N^2} \text{ inches.}$$

$$N = \sqrt{\frac{35,200}{h}} = \frac{187\cdot6}{\sqrt{h}} \text{ Revolutions per min.}$$

Speed and Revolutions.

Let M be the speed in miles per hour,
R the revolutions of driving wheel per minute,
C the circumference of driving wheel in inches, then—

$$R = \frac{1056\ M}{C}$$

$$C = \frac{1056\ M}{R}$$

$$M = \frac{R.C}{1056}$$

SPEED TABLE.

Specially Computed for the "Automotor" by G. H. Little, C.E.

1 Statute Mile = 1,760 yards.

Miles per hour.	Yards per minute.	Yards per second.	Time in seconds for 100 yards.
1	29·33	·49	204·57
2	58·66	·98	102·28
3	88·00	1·47	68·19
4	117·33	1·95	51·14
5	146·66	2·44	40·91
6	176·00	2·93	34·09
7	205·33	3·42	29·22
8	234·66	3·91	25·57
9	264·00	4·40	22·73
10	293·33	4·89	20·46
11	322·66	5·37	18·60
12	352·00	5·87	17·05
13	381·33	6·35	15·74
14	410·66	6·84	14·61
15	440·00	7·33	13·64
16	469·33	7·82	12·78
17	498·66	8·31	12·03
18	528·00	8·80	11·36
19	557·33	9·28	10·77
20	586·66	9·78	10·23
21	616·00	10·26	9·74
22	645·33	10·75	9·30
23	674·66	11·24	8·75
24	704·00	11·73	8·52
25	733·33	12·22	8·18

Railway Speed Table.

Speed per hour.	Time of performing			Speed per hour.	Time of performing			Speed per hour.	Time of performing		
	¼ mi.	½ mi.	1 mi.		¼ mi.	½ mi.	1 mi.		¼ mi.	½ mi.	1 mi.
miles.	m. s.	m. s	m. s.	miles.	m. s.	m. s.	m. s.	miles.	m. s.	m. s.	m. s.
5	3 0	6 0	12 0	24	0 37	1 15	2 30	43	0 20	0 41	1 23
6	2 30	5 0	10 0	25	0 36	1 12	2 24	44	0 20	0 40	1 21
7	2 8	4 17	8 34	26	0 34	1 9	2 18	45	0 20	0 40	1 20
8	1 52	3 45	7 30	27	0 33	1 6	2 13	46	0 19	0 39	1 18
9	1 40	3 20	6 40	28	0 32	1 4	2 8	47	0 19	0 38	1 16
10	1 30	3 0	6 0	29	0 31	1 2	2 4	48	0 18	0 37	1 15
11	1 21	2 43	5 27	30	0 30	1 0	2 0	49	0 18	0 36	1 13
12	1 15	2 30	5 0	31	0 29	0 58	1 56	50	0 18	0 36	1 12
13	1 9	2 18	4 37	32	9 28	0 56	1 52	51	0 17	0 35	1 10
14	1 4	2 8	4 17	33	0 27	0 54	1 49	52	0 17	0 34	1 9
15	1 0	2 0	4 0	34	0 26	0 53	1 46	53	0 17	0 34	1 7
16	0 56	1 52	3 45	35	0 25	0 51	1 43	54	0 16	0 33	1 6
17	0 53	1 46	3 31	36	0 25	0 50	1 40	55	0 16	0 32	1 5
18	0 50	1 40	3 20	37	0 24	0 48	1 37	56	0 16	0 32	1 4
19	0 47	1 34	3 9	38	0 23	0 47	1 34	57	0 15	0 31	1 3
20	0 45	1 30	3 0	39	0 23	0 46	1 32	58	0 15	0 31	1 2
21	0 42	1 25	2 51	40	0 22	0 45	1 30	59	0 15	0 30	1 1
22	0 40	1 21	2 43	41	0 21	0 43	1 27	60	0 15	0 30	1 0
23	0 39	1 18	2 36	42	0 21	0 42	1 25				

Speed of Steamships.

Let V = Speed in knots.

D = Displacement in tons.

I.H.P = Indicated horse-power.

C be a constant, or displacement co-efficient,—

Then $$\frac{V^3 \times \sqrt[3]{D^2}}{C} = \text{I.H.P.} \qquad \frac{C \times \text{I.H.P.}}{V^3} = \sqrt[3]{D^2}$$

$$\frac{C \times \text{I.H.P.}}{\sqrt[3]{D^2}} = V^3 \qquad \frac{V^3 \times \sqrt[3]{D^2}}{\text{I.H.P.}} = C$$

Up to speeds of 12 knots, these formulæ may be relied upon to give fairly accurate results.

Co-efficient of Merit for Steamships.

$$\text{Co-efficient} = \frac{D^{\frac{2}{3}} \times V^3}{K}.$$

Where D is displacement in tons, V is speed in knots, and K is the consumption in tons of coal in 24 hours.

Nautical Speed Table.

The Minutes and Seconds of Time in which a Vessel passes over the Measured Knot being known, look for the Corresponding Number in this Table, which will be the rate of the Vessel in Knots.

Sec.	2m.	3m.	4m.	5m.	6m.	7m.	8m.	9m.	10m.	11m.	12m.	13m.	14m.
0	30·000	20·000	15·000	12·000	10·000	8·571	7·500	6·666	6·000	5·454	5·000	4·616	4·285
1	29·752	19·890	14·938	11·960	9·972	8·551	7·484	6·654	5·990	5·446	4·993	4·609	4·280
2	29·508	19·780	14·876	11·920	9·944	8·530	7·468	6·642	5·980	5·438	4·986	4·603	4·275
3	29·268	19·672	14·815	11·880	9·917	8·510	7·453	6·629	5·970	5·429	4·979	4·597	4·270
4	29·032	19·564	14·754	11·841	9·890	8·490	7·438	6·617	5·960	5·421	4·972	4·591	4·265
5	28·800	19·460	14·694	11·803	9·863	8·470	7·422	6·605	5·950	5·413	4·965	4·585	4·260
6	28·571	19·355	14·634	11·764	9·836	8·450	7·407	6·593	5·940	5·405	4·958	4·580	4·255
7	28·346	19·251	14·575	11·726	9·809	8·430	7·392	6·581	5·930	5·397	4·951	4·574	4·250
8	28·125	19·150	14·516	11·688	9·783	8·410	7·377	6·569	5·921	5·389	4·945	4·568	4·245
9	27·907	19·047	14·457	11·650	9·756	8·391	7·362	6·557	5·911	5·381	4·938	4·562	4·240
10	27·692	18·947	14·400	11·613	9·729	8·372	7·346	6·545	5·901	5·373	4·931	4·556	4·235
11	27·481	18·848	14·342	11·575	9·703	8·352	7·331	6·533	5·891	5·365	4·924	4·551	4·230
12	27·273	18·750	14·285	11·538	9·677	8·333	7·317	6·521	5·882	5·357	4·918	4·545	4·225
13	27·068	18·652	14·229	11·501	9·651	8·314	7·302	6·509	5·872	5·349	4·911	4·539	4·220
14	26·866	18·556	14·173	11·465	9·625	8·295	7·287	6·498	5·863	5·341	4·904	4·534	4·215
15	26·667	18·461	14·118	11·428	9·600	8·275	7·272	6·486	5·853	5·333	4·897	4·528	4·210
16	26·471	18·367	14·063	11·392	9·574	8·256	7·258	6·474	5·844	5·325	4·891	4·522	4·206
17	26·277	18·274	14·008	11·356	9·549	8·238	7·243	6·463	5·834	5·317	4·884	4·516	4·201
18	26·087	18·181	13·953	11·320	9·524	8·219	7·229	6·451	5·825	5·309	4·878	4·511	4·196
19	25·900	18·090	13·900	11·285	9·498	8·200	7·214	6·440	5·815	5·301	4·871	4·505	4·191
20	25·714	18·000	13·846	11·250	9·473	8·181	7·200	6·428	5·806	5·294	4·864	4·500	4·186
21	25·532	17·910	13·793	11·214	9·448	8·163	7·185	6·417	5·797	5·286	4·858	4·494	4·181
22	25·352	17·823	13·740	11·180	9·424	8·144	7·171	6·405	5·787	5·278	4·851	4·488	4·176
23	25·175	17·734	13·688	11·145	9·399	8·127	7·157	6·394	5·778	5·270	4·845	4·483	4·171

24	4·166	4·477	4·838	5·263	5·769	6·383	7·142	8·108	9·375	11·111	13·636	17·647	25·000
25	4·161	4·472	4·832	5·256	5·760	6·371	7·128	8·090	9·350	11·077	13·584	17·560	24·828
26	4·157	4·466	4·826	5·247	5·750	6·360	7·114	8·071	9·326	11·043	13·533	17·475	24·658
27	4·152	4·460	4·819	5·240	5·741	6·349	7·100	8·053	9·302	11·009	13·483	17·391	24·490
28	4·147	4·455	4·812	5·232	5·732	6·327	7·086	8·035	9·278	10·975	13·432	17·307	24·324
29	4·142	4·449	4·806	5·224	5·723	6·315	7·072	8·017	9·254	10·942	13·383	17·225	24·161
30	4·137	4·444	4·800	5·217	5·714	6·304	7·059	8·000	9·230	10·909	13·333	17·143	24·000
31	4·133	4·438	4·793	5·210	5·705	6·293	7·045	7·982	9·207	10·876	13·284	17·061	23·841
32	4·128	4·433	4·787	5·202	5·696	6·282	7·031	7·964	9·183	10·843	13·235	16·981	23·684
33	4·123	4·428	4·780	5·195	5·687	6·271	7·017	7·947	9·160	10·810	13·186	16·901	23·529
34	4·118	4·422	4·774	5·187	5·678	6·260	7·004	7·929	9·137	10·778	13·138	16·822	23·377
35	4·114	4·417	4·769	5·179	5·669	6·250	6·990	7·912	9·113	10·746	13·092	16·744	23·226
36	4·110	4·411	4·761	5·172	5·660	6·239	6·977	7·895	9·090	10·714	13·043	16·667	23·077
37	4·105	4·406	4·755	5·164	5·651	6·228	6·963	7·877	9·068	10·682	12·996	16·590	22·930
38	4·100	4·400	4·749	5·157	5·642	6·217	6·950	7·860	9·044	10·651	12·950	16·514	22·785
39	4·095	4·395	4·743	5·150	5·633	6·207	6·936	7·843	9·022	10·619	12·903	16·438	22·642
40	4·090	4·390	4·738	5·142	5·625	6·196	6·923	7·826	9·000	10·588	12·857	16·363	22·500
41	4·085	4·384	4·730	5·135	5·616	6·186	6·909	7·809	8·977	10·557	12·811	16·289	22·360
42	4·081	4·379	4·724	5·128	5·607	6·174	6·896	7·792	8·955	10·526	12·766	16·216	22·222
43	4·077	4·374	4·718	5·121	5·598	6·164	6·883	7·775	8·933	10·495	12·721	16·143	22·096
44	4·072	4·368	4·712	5·114	5·590	6·153	6·870	7·758	8·911	10·465	12·676	16·071	21·951
45	4·068	4·363	4·706	5·106	5·581	6·143	6·857	7·741	8·889	10·434	12·631	16·000	21·818
46	4·063	4·358	4·700	5·099	5·572	6·132	6·844	7·725	8·867	10·404	12·587	15·951	21·687
47	4·058	4·353	4·693	5·091	5·564	6·122	6·831	7·709	8·845	10·375	12·543	15·889	21·557
48	4·054	4·347	4·687	5·084	5·555	6·112	6·818	7·692	8·823	10·345	12·500	15·789	21·429
49	4·049	4·342	4·681	5·077	5·547	6·101	6·805	7·675	8·801	10·315	12·456	15·721	21·302
50	4·044	4·337	4·675	5·070	5·538	6·091	6·792	7·659	8·780	10·286	12·418	15·684	21·177
51	4·040	4·332	4·669	5·063	5·530	6·081	6·779	7·643	8·759	10·256	12·371	15·652	21·053
52	4·035	4·326	4·663	5·056	5·521	6·071	6·766	7·627	8·737	10·227	12·329	15·584	20·930
53	4·031	4·321	4·657	5·049	5·513	6·060	6·754	7·611	8·716	10·198	12·287	15·517	20·809
54	4·026	4·316	4·651	5·042	5·504	6·050	6·741	7·595	8·695	10·169	12·245	15·450	20·690
55	4·022	4·311	4·645	5·035	5·496	6·040	6·728	7·579	8·675	10·140	12·203	15·384	20·571
56	4·017	4·306	4·639	5·028	5·487	6·030	6·716	7·563	8·654	10·112	12·162	15·319	20·454
57	4·013	4·301	4·633	5·020	5·479	6·020	6·704	7·547	8·633	10·084	12·121	15·254	20·339
58	4·008	4·295	4·627	5·013	5·471	6·020	6·691	7·531	8·612	10·055	12·080	15·190	20·225
59	4·004	4·290	4·621	5·006	5·463	6·010	6·679	7·515	8·591	10·027	12·040	15·125	20·112

To determine Speed of Steamships.

A knot is frequently, but very erroneously, used as expressing the *length* of a nautical or sea mile. A knot is a *speed* of one nautical mile, or mean minute of latitude per hour, and it is a speed of 101·4 feet per minute, the nautical mile being taken as 6,080 feet.

Let T be the time in minutes occupied in "running the mile" with the tide.

    t be the time in minutes occupied in "running the mile" against the tide.

    V be the speed of ship in knots (nautical miles per hour).

$$V = \frac{30\ T + t}{T\ t}$$

Table for Converting Knots into Miles.

(The Admiralty Knot = 6,080 feet. 1 statute mile = 5,280 feet.)

Knots.	Miles.	Knots.	Miles.	Knots.	Miles.
1·00	1·152	8·75	10·076	16·50	19·000
1·25	1·439	9·00	10·364	16·75	19·288
1·50	1·727	9·25	10·652	17·00	19·576
1·75	2·015	9·50	10·939	17·25	19·864
2·00	2·303	9·75	11·227	17·50	20·152
2·25	2·591	10·00	11·515	17·75	20·439
2·50	2·879	10·25	11·803	18·00	20·727
2·75	3·167	10·50	12·091	18·25	21·015
3·00	3·455	10·75	12·379	18·50	21·303
3·25	3·742	11·00	12·667	18·75	21·591
3·50	4·030	11·25	12·955	19·00	21·879
3·75	4·318	11·50	13·242	19·25	22·167
4·00	4·606	11·75	13·530	19·50	22·455
4·25	4·894	12·00	13·818	19·75	22·742
4·50	5·182	12·25	14·106	20·00	23·030
4·75	5·470	12·50	14·394	20·25	23·318
5·00	5·758	12·75	14·632	20·50	23·606
5·25	6·045	13·00	14·970	20·75	23·894
5·50	6·333	13·25	15·258	21·00	24·182
5·75	6·621	13·50	15·545	21·25	24·470
6·00	6·909	13·75	15·833	21·50	24·758
6·25	7·197	14·00	16·121	21·75	25·045
6·50	7·485	14·25	16·409	22·00	25·333
6·75	7·773	14·50	16·697	22·25	25·621
7·08	8·061	14·75	16·985	22·50	25·909
7·25	8·349	15·00	17·273	22·75	26·197
7·50	8·636	15·25	17·561	23·00	26·485
7·75	8·924	15·50	17·848	23·50	27·061
8·00	9·212	15·75	18·136	24·00	27·636
8·25	9·500	16·00	18·424	24·50	28·212
8·50	9·788	16·25	18·712	25·00	28·788

TRACTION.

Resistance of Road.

This is usually expressed as being r lbs. per ton of vehicle, but r is a curve the equation of which is—

$$r = A + B\,v^2,$$

where A is the resistance at starting and B a term which increases with the square of the speed.

A and B are determined as follows :—On a given road the gradient of 1 in m is measured, and the speed at wh'ch the vehicle first begins to move is observed ; and on another and steeper gradient of 1 in n, the speed of the vehicle is observed, then

$$A = \frac{2240}{m}, \text{ and } A + B\,v^2 = \frac{2240}{n},$$

equations which enable us to determine A and B.

Lbs. per Ton.

Curve Showing Resistance
to Traction
on Various Roads
from Telford & Babage's data.

Sand if dry & loose 560 lbs.

Fresh Earth
Ordinary Cobble Stones.
Ordinary Road & Gravel.
Cobble Stones.
Hard Dry Clay.
Dry Meadow
Ordinary Macadam and Stone Blocks.
do.   do.
Paris Streets
Best Macadam
Well laid Stone
Tram Rails
Asphalte
Tramway
Iron
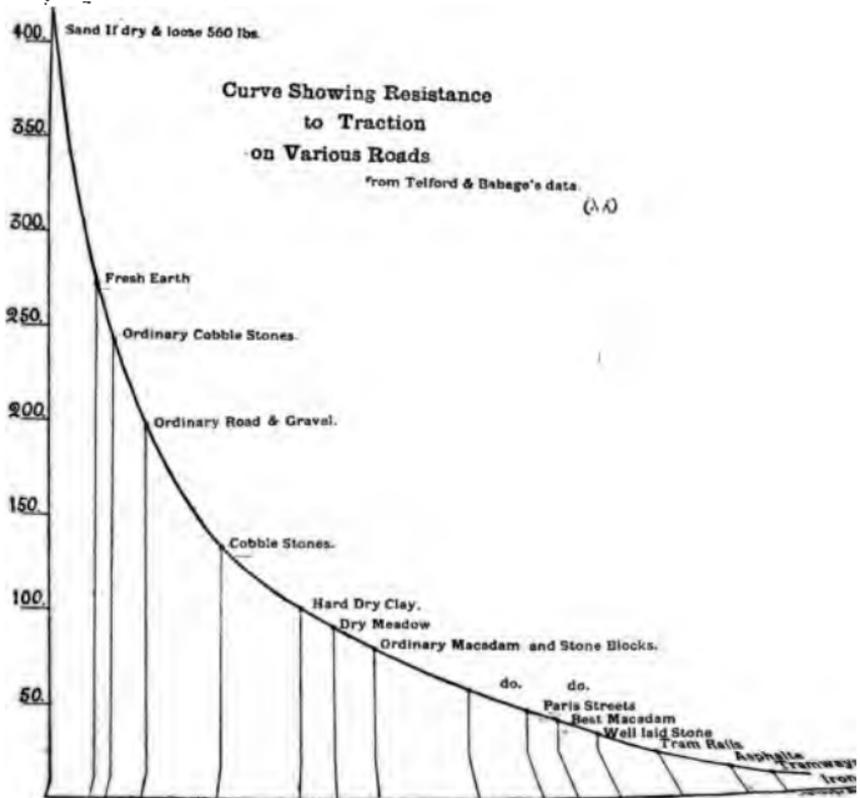
According to data obtained recently by the United States Agricultural Bureau, the resistance to traction is as follows, per ton of 2,000 lbs. :—

Asphalte level, poor condition	..	..	..	26 lbs.
Macadam „ good „	..	..	..	38 „
Dirt Road „ „ „	..	..	..	96 „
Macadam, 10 per cent. up grade	..	..	..	236 „
Average result for Good Macadam Road on the level	.. ..	..	41 „

Influence of Roads and Weather on Traction.

According to tests made by E. Whyte-Smith, and communicated to the Institute of Electrical Engineers, the pull required per ton of vehicle for various roads and for three different conditions of weather is given in the following table :—

	Pull in lbs. per ton.		
Asphalte	22	23	22
Wood	22	31	36
Macadam (good) ..	52	50	49
Macadam..	60	51	50
Macadam (soft)	97	51	52

Gradient.

If a road makes an angle of $a°$ with the horizon, or rises vertically by m feet, the grade is usually expressed as 1 in m, and tan. $a° = \dfrac{1}{m}$.

The friction is estimated by the resistance, r, in lbs. per ton of vehicle, so that on the level the co-efficient of friction $\mu = \dfrac{r}{2240}$.

The acceleration or retardation, f, of a vehicle on an incline is given by—

$$f = g \left(\frac{1}{m} - \mu \right)$$

$$= g \left(\frac{1}{m} - \frac{r}{2240} \right)$$

Influence of Grade on Traction.

$$P = F^a + a\,W,$$

where P is pull in lbs. as shown by a dynamometer; F^a is the pull in lbs. required to draw the vehicle on the level; a is the inclination of the grade expressed as a fraction; and W is the weight in lbs. of the vehicle.

More accurately

$$P = W \sin. a + \mu \cos. a,$$

where μ is the co-efficient of traction. If P for any grade is known then

$$\mu = \frac{P}{W} - \text{per cent. of grade.}$$

Values of μ for trams :—

12	lbs. per ton at a speed of	1 mile per hour.
13	„ „ „	10 „
14	„ „ „	15 „
15½	„ „ „	20 „

(DAWSON.)

Table of Gradients.

Grade in—		Equal to Angle of—	Rise or Fall in 1 Mile.	Load considered as unity, proportion that horse can draw.
Per Cent.	Units.			
20	1 in 5	11° 19′	1056	
17	1 „ 6	9° 26′	880	
14	1 „ 7	8° 09′	754	
12½	1 „ 8	7° 08′	635	
11	1 „ 9	6° 17′	586	
10	1 „ 10	5° 43′	528	·25
9	1 „ 11	5° 11′	480	·265
8	1 „ 12	4° 46′	440	·28
7¾	1 „ 13	4° 24′	406	·295
7	1 „ 14	4° 05′	337	·31
6½	1 „ 15	3° 49′	352	·325
6¼	1 „ 16	3° 35′	330	·34
6	1 „ 17	3° 22′	310	·355
5½	1 „ 18	3° 11′	293	·37
5	1 „ 19	3° 00′	277	·385
5	1 „ 20	2° 52′	204	·4
4	1 „ 25	2° 18′	218	·52
3·3	1 „ 30	1° 55′	155	·64
2·8	1 „ 35	1° 38′	151	·73
2½	1 „ 40	1° 26′	132	·85

Horse-power required to propel a Vehicle on an Incline.

Let W = Total weight to be moved.
  a = Angle of grade.
  v = Speed in miles per hour.
  R = Resistance to traction in lbs. per ton.

$$H.P. = \frac{(R \, Cos. \, a \pm 2240 \, Sin \, a) \, W \, v}{375}$$

If the gradient be expressed as 1 in m the formula may be written—

$$\left(R \pm \frac{2240}{m} \right) \frac{W v}{375}$$

A locomotive exerting a pull of P tons and hauling a train of W tons up an incline of 1 in m, and the resistance of the road being r lbs. per ton, will in a time of t seconds generate a velocity—

$$v = \left(\frac{P}{W} - \frac{1}{m} - \frac{r}{2240} \right) g \, t \text{ (foot seconds)},$$

in the distance—

$$s = \left(\frac{P}{W} - \frac{1}{m} - \frac{r}{2240} \right) \tfrac{1}{2} g \, t^2 \text{ (feet)},$$

and will develop a kinetic energy, K E, of—

$$K E = W \left(\frac{P}{W} - \frac{1}{m} - \frac{r}{2240} \right)^2 \tfrac{1}{2} g \, t^2 \text{ (foot tons)}.$$

(GREENHILL.)

Tractive Power of Locomotives.

For simple engines

$$F = \frac{D^2 . P^m . L}{d}$$

For compound engines

$$F = \frac{D_{\prime}^2 . P^m . L}{2d},$$

where D is diameter of H.P. cylinder, D, diameter of L.P. cylinder, L length of stroke, P is the mean pressure of steam in simple engines, but in compounds P is the sum of the mean pressures in the H.P. and L.P. cylinders divided by ratio of cylinders, and d is diameter of driving wheels.

Tractive Resistance on Tramways.

The average pull required per ton of load to keep a car moving is 30 lbs. With exceptionally clean rails, as during a heavy rainfall, and with the rail grooves void of dirt, the pull may be as low as 20 lbs. per ton, or below this figure, approximating to the 10 or 12 lbs. of railway work. Again, a very dirty, clogged rail, may demand more than the 30 lbs. Multiplying the pull by the speed in feet per minute gives the power in foot-pounds, so that the horse-power is simply H.P. $= \dfrac{P \times W \times V}{33,000}$, where T is the pull in lbs. per ton necessary, W is the load in tons, and V is the speed in feet per minute. This rule gives the horse-power on the level. To find the power on a grade, the vertical rise of the car is found by dividing the speed of the car in feet per minute by the length of road in which there is a rise of 1 foot. The number of feet of vertical lift multiplied by the total weight in pounds is the measure of the work done against gravity, or $\dfrac{V \times W}{D}$, where W is the load, V is the speed, and D is the distance in which the road rises 1 foot. Thus on a 1 in 30 grade, D = 30. The addition of the two results gives the total horse-power.

Friction in Vehicles.
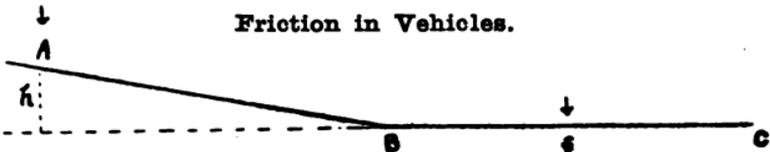
In order to determine the friction in a vehicle, a convenient smooth road is selected, which has one portion level and the other on a known grade. Let A B C be such a road, and let the distances A B, B C be measured. The vehicle is placed at A, and allowed to run down the slope A B and along the level portion B C.

Let W be the weight of the vehicle in lbs.

  h the vertical drop.
  v the mean speed in feet per second, while passing the point s.
  s the distance from the starting point A to middle of B C.
  f the friction of the vehicle in lbs. per lb. of W, then—

  W h = The foot-lbs. of work due to gravity.

  $\dfrac{W v^2}{2g}$ = The kinetic energy of the vehicle while passing s.

  f W s = The work expended in friction in foot-lbs.

  $f\, W\, s = W\, h - \dfrac{W v^2}{2g}$

  $\therefore f = \dfrac{h - \dfrac{V^2}{2g}}{s}$ The friction of the vehicle in lbs. per ton is 2,240 f.

The Prony as the Unit of Power for Moto-Vehicles.

The poncelet is 100 kilogrammetres per second, and the horse-power is 75 kilogrammetres per second. The kilogrammetre per second is too long a name, and is also an unscientific derivation. The prony is a unit of 10 kilogrammetres per second, or the tenth of a poncelet, and almost equal to the hectowatt or one tenth of a kilowatt in electrical nomenclature. The prony is exactly 98·1 watts, or practically 100 watts.

The advantage of the use of the prony as a unit in the calculation of powers for motor vehicles is its simplicity. The calculation is as follows :—

Let P be the power in pronys.
 F be the weight of the vehicle in tons.
 k be the coefficient of traction in centimes ; tan a the gradient in centimes.
 v be the speed in metres per second.
Then—

$$P = F (k \times \text{Tan } a) \, v \text{ (pronys)}.$$

Example.—A vehicle weighing 1,500 kilogrammes is required to ascend a gradient of 2 per cent. at a speed of 4 metres per second ; the coefficient of traction being 3 per cent.

The power necessary to apply to the periphery of the wheel will be :—

$$P = 1\cdot5 \, (3 \times 2) \, 4 = 30 \text{ pronys.}$$

If the efficiency of the system is 80 per cent. the power of the motor to give the speed must be :—

$$P' = \frac{30}{\cdot8} = 37\cdot5 \text{ pronys.}$$

If an electric motor is in question it should furnish 37 hectowatts or 3,700 watts.

Now that the horse is so rapidly losing his importance as a motor it is reasonable to search for a substitute for him by creating a unit more suitable for the actual requirements of the cycle and automobile industries. The prony seems to fill the greater number *of the required conditions.*

ANIMAL POWER.

Average power of a man working to the best advantage is lifting 70 lbs. 1 ft. in 1 second for 10 hours per day, or 4200 ft. lbs. per minute, = 0·127 horse-power.

The average work of a horse in a day of 8 hours is 22,500 lbs. raised 1 ft. in 1 minute, or 0·68 of the theoretical horse-power.

A horse can only exert a theoretical horse-power for 6 hours per day. 1 indicated horse-power = 1·4 times the average power of a horse. The strength of a horse is equivalent to that of 6 men.

Average Work of Horses.

Miles per hour.	Time of Working.	Useful effect for 1 day, drawing for 1 mile.		
		On a Canal.	On a Railroad.	On Turnpike.
	Hours.	Tons.	Tons.	Tons.
2½	11·5	520	115	14·0
3	8·0	243	92	12·0
4	4·5	102	72	9·0
5	2·9	52	57	7·2
6	2·0	30	48	6·0
7	1·5	19	41	5·1
8	1·125	12·8	36	4·5
10	0·750	6·6	28·8	3·6

(KEMPE.)

Pull of a Horse at Various Speeds.
From Trautwine's Experiments.
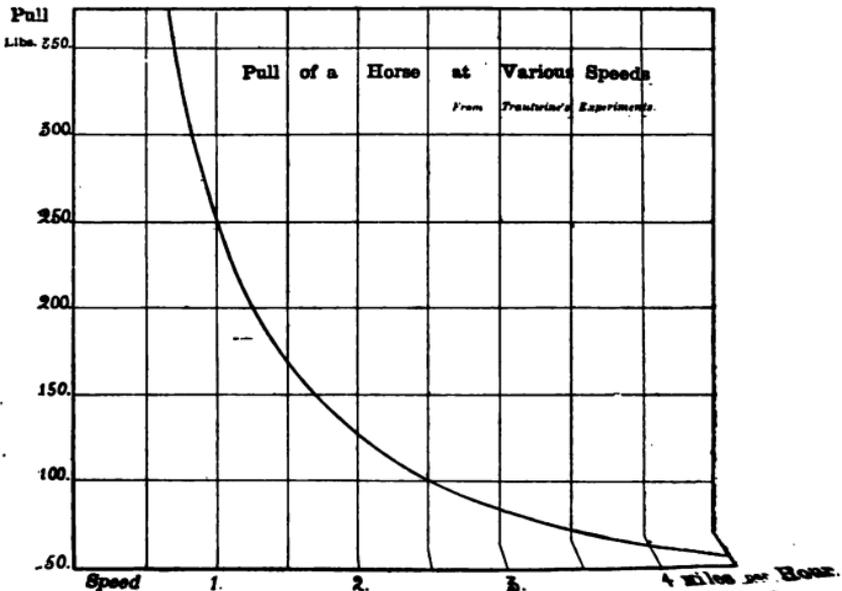
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MECHANICAL DATA.

WEIGHTS, &c., OF MATERIALS.

Specific Gravity—Weight and Strength of Metals.

Metals.	Specific Gravity.	Weight of 1 cubic foot.	Weight of 1 cubic inch.	Tensile.	Crushing.	Transverse.
		lbs.	lbs.	tons.	tons.	tons.
Platinum	21·531	1343·9	·775	—	—	—
,, sheet	23·0	1435·6	·828	—	—	—
Gold, pure	18·417	1150·0	·665	9·1	—	—
Mercury	13·596	848·75	·49117	—	—	—
Silver	10·474	653·8	·377	18·2	—	—
Lead, cast	11·36	708·5	·408	·8	3·1	—
,, sheet	11·4	711·6	·41	1·5	—	—
Bismuth	9·822	613·1	·353	1·45	—	—
Copper, bolts	8·85	552·4	·318	17·0	—	—
,, cast	8·607	537·3	·31	8·4	—	—
,, sheet	8·78	548·1	·316	13·4	—	—
,, wire	8·9	555·0	·32	26·0	—	—
Tin, cast	7·291	455·1	·262	2·0	6·7	—
Zinc, cast...	7·0	437·0	·252	3·3	—	—
Iron, cast, from	7·0	437·0	·252	6·0	36·0	2·0
,, ,, to	7·6	474·4	·273	13·0	64·0	3·4
,, ,, average ...	7·23	451·0	·26	7·3	48·0	2·6
Iron, wrought, from ...	7·5	474·4	·273	16·0	16·0	3·0
,, ,, to ...	7·8	486·9	·281	29·0	18·0	5·5
,, ,, average ...	7·78	485·6	·28	22·0	16·9	3·8
Iron Wire	—	—	—	40·0	—	—
Steel	8·0	499·0	·288	52·0	150·0	—
,, Plates	·	—	—	35·0	90·0	—
Antimony, cast	6·72	419·5	·242	·47	—	—
Aluminium, sheet	2·67	166·6	·096	—	—	—
,, cast ...	2·56	159·3	·092	—	—	—
Aluminium } 20 to 95% of Bronze } copper	7·68	478·4	·276	32·0	58·0	—
Gun-Metal, 10 copper, 1 tin ...	8·464	528·36	·306	16·1	—	—
,, ,, 7 ., 1 ,, ...	8·456	527·89	·305	13·6	—	—
Brass, cast, 3 copper, 1 zinc ...	8·397	524·18	·3	13·1	—	—
White Metal (Babbit's)... ...	7·31	456·32	·263	—	—	—

Useful Numbers for Weight of Iron.—The following are useful numbers to carry in the memory :—

¾ inch dia. = 1 lb. per ft. run.   1½ inch dia. = 4 lbs. per ft. run.
⅞ inch dia. = 2 lbs. per ft. run.   1¾ inch dia. = 8 lbs. per ft. run.

1 inch square of iron weighs 10 lbs. per yard, or 3·33 lbs. per foot.
1 square foot of iron 1 inch thick weighs 40 lbs.
1 cubic inch of wrought iron weighs 0·28 lb.
1 cubic inch of cast iron weighs 0·26 lb.
400 cubic inches of wrought iron weigh 1 cwt.
425 cubic inches of cast iron weigh 1 cwt.

Specific Gravity and Strength of Timber.

Name.	Specific gravity.	Tenacity per square inch.	Crushing stress per square inch.
		lbs.	lbs.
Ebony	1·19	—	18,000
Greenheart	1·05	8,000	12,000
Teak..........................	·98	15,000	12,000
Lancewood	·95	20,000	7,000
Oak, Dantzic	·93	14,500	7,700
„ English	·93	15,000	8,250
Mahogany	·85	15,000	8,200
Hornbeam	·76	15,000	8,500
Ash	·75	17,700	9,000
Pitch-pine	·70	12,000	6,000
Beech	·68	17,000	8,500
Elm........ ·	·55	14,000	10,300
Red Pine....................	·54	10,500	5,000
Fir, Larch	·53	11,000	5,500
„ Riga....................	·53	12,500	5,300

Decimal Equivalents of inches and feet or pence and shillings.

Inches or Pence.		Feet or Shillings.	Inches or Pence.		Feet or Shillings.
½	=	0 ·04166	6½	=	0 ·54166
1	=	0 ·08333	7	=	0 ·58333
1½	=	0 ·125	7½	=	0 ·6250
2	=	0 ·16666	8	=	0 ·66666
2½	=	0 ·20832	8½	=	0 ·70832
3	=	0 ·25	9	=	0 ·75
3½	=	0 ·29166	9½	=	0 ·79166
4	=	0 ·33333	10	=	0 ·83333
4½	=	0 ·3750	10½	=	0 ·8750
5	=	0 ·41666	11	=	0 ·91666
5½	=	0 ·45833	11½	=	0 ·95833
6	=	0 ·5	12	=	1 ·0000

Weight of Iron.

Cubic inches × 0·28 lb.

Thickness of plates in inches × 40 = lbs. per square foot.

      „   „   eighths × 5 =   „   „

      „   „   tenths × 4 =   „   „

Weight of Plate Iron per Square Foot.

Inch.	Lbs.	Inch.	Lbs.	Inch.	Lbs.
$\frac{1}{16}$	2·517	$\frac{5}{8}$	25·176	$1\frac{3}{8}$	55·387
$\frac{1}{8}$	5·035	$\frac{11}{16}$	27·694	$1\frac{1}{2}$	60·422
$\frac{3}{16}$	7·552	$\frac{3}{4}$	30·211	$1\frac{5}{8}$	65·458
$\frac{1}{4}$	10·070	$\frac{13}{16}$	32·729	$1\frac{3}{4}$	70·493
$\frac{5}{16}$	12·588	$\frac{7}{8}$	35·247	$1\frac{7}{8}$	75·528
$\frac{3}{8}$	15·106	$\frac{15}{16}$	37·764	2	80·563
$\frac{7}{16}$	17·623	1	40·282	$2\frac{1}{8}$	85·604
$\frac{1}{2}$	20·141	$1\frac{1}{8}$	45·317	$2\frac{1}{4}$	90·639
$\frac{9}{16}$	22·659	$1\frac{1}{4}$	50·352	$2\frac{1}{2}$	100·709

Weight of Flat Bar Iron per Lineal Foot.

Width.	Thickness in Fractions of Inches.								
	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1
1	·84	1·05	1·26	1·48	1·69	2·11	2·53	2·95	3·38
$1\frac{1}{8}$	·95	1·18	1·42	1·66	1·90	2·37	2·85	3·32	3·80
$1\frac{1}{4}$	1·05	1·32	1·58	1·85	2·11	2·64	3·17	3·69	4·22
$1\frac{3}{8}$	1·16	1·45	1·74	2·03	2·32	2·90	3·48	4·06	4·64
$1\frac{1}{2}$	1·26	1·58	1·90	2·22	2·53	3·17	3·80	4·43	5·07
$1\frac{5}{8}$	1·37	1·71	2·06	2·40	2 74	3·43	4·12	4·80	5 49
$1\frac{3}{4}$	1·48	1·85	2·22	2·59	2 95	3·69	4·43	5·17	5·91
$1\frac{7}{8}$	1·58	1·98	2·37	2·77	3·17	3·96	4 75	5·54	6·33
2	1·69	2·11	2·53	2·96	3 38	4·22	5·07	5·91	6·76
$2\frac{1}{4}$	1·90	2·37	2·85	3·33	3·80	4·75	5·70	6·65	7·60
$2\frac{1}{2}$	2·11	2·64	3·17	3·69	4·22	5·28	6·33	7·39	8·45
$2\frac{3}{4}$	2·32	2·90	3·48	4·07	4·65	5·81	6·97	8·13	9·29
3	2·53	3·17	3·80	4·43	5·07	6·34	7·60	8·87	10·14
$3\frac{1}{4}$	2·74	3·43	4·12	4·80	5·49	6·86	8·24	9·61	10·98
$3\frac{1}{2}$	2·96	3·69	4·43	5·17	5·91	7·39	8·87	10·35	11·83
$3\frac{3}{4}$	3·17	3·96	4·75	5·54	6·33	7·92	9·50	11·09	12·67
4	3·38	4·22	5·07	5·91	6·76	8·45	10·14	11·83	13·52

Weight per Foot of Round and Square Bar Iron.

Inch.	Round.	Square.	Inch.	Round.	Square.
¼	·165	·211	2	10·616	13·520
⅜	·373	·475	2¼	13·440	17·112
½	·663	·845	2½	16·588	21·120
⅝	1·043	1·320	2¾	20·076	25·560
¾	1·493	1·901	3	23·888	30·416
⅞	2·032	2·588	3¼	28·040	35·704
1	2·654	3·380	3½	32·512	41·408
1⅛	3·360	4·278	3¾	37·332	47·534
1¼	4·147	5·280	4	42·464	54·084
1⅜	5·019	6·390	4¼	47·952	61·055
1½	5·972	7·604	4½	53·760	68·448
1⅝	7·010	8·926	4¾	59·900	72·264
1¾	8·128	10·352	5	66·350	84·480
1⅞	9·333	11·883			

Weight of Steel or Iron Angles.

Let S be the sum of the flanges in inches.
,, t ,, thickness of the flanges in inches.
,, W ,, weight in lbs. per foot run. Then—
$$W = t (S - t) K.$$
For iron, K = 3·333. For steel, K = 3·40.
The weights of channel and Z bars can be found from this rule by regarding them as made up of two angles.

Weight of Pipes.

D = Outside diameter in inches.
d = Inside ,, ,,
K = A constant.
W = Weight in lbs. per foot run.
$$W = (D^2 - d^2) K.$$
For brass, K = 2·906. For iron, wrot., K = 2·618.
,, copper, K = 2·994. ,, lead, K = 3·88.
,, iron, cast, K = 2·428. ,, steel, K = 2·87.

WHITWORTH STANDARD BOLTS AND NUTS.
TABLE OF SAFE LOAD IN LBS.

Diam. of Bolt.	Diam. at Bottom of Thread.	Area at Bottom of Thread.	Approximate Safe Load in lbs.			
			At 4,000 lbs. per sq. inch.	At 6,000 lbs. per sq. inch.	At 8,000 lbs. per sq. inch.	At 9,000 lbs. per sq. inch.
in.	in.	sq. in.	lbs.	lbs.	lbs.	lbs.
3/16	0·13	0·01	56	84	112	126
1/4	0·18	0·02	108	162	216	243
5/16	0·24	0·04	184	276	378	414
3/8	0·29	0·06	272	408	546	614
7/16	0·34	0·09	376	504	752	846
1/2	0·39	0·12	484	726	970	1,090
9/16	0·45	0·15	620	930	1,240	1,395
5/8	0·50	0·20	816	1,224	1,620	1,824
11/16	0·57	0·25	1,024	1,536	2,048	2,304
3/4	0·62	0·30	1,216	1,824	2,430	2,734
13/16	0·68	0·36	1,468	2,202	2,936	3,303
7/8	0·73	0·42	1,688	2,532	3,376	3,800
15/16	0·79	0·496	1,984	2,976	3,968	4,464
1	0·84	0·554	2,216	3,324	4,430	4,990
1 1/8	0·94	0·697	2,788	4,182	5,575	6,270
1 1/4	1·06	0·894	3,576	5,364	7,145	8,035
1 3/8	1·16	1·058	4,232	6,348	8,455	9,510
1 1/2	1·28	1·299	5,196	7,794	10,320	11.610
1 5/8	1·36	1·472	5,888	8,832	11,760	13,230
1 3/4	1·49	1·753	7,012	10,518	13,950	15.700
1 7/8	1·59	1·986	7,944	11,916	15,890	17,875
2	1·72	2·311	9,244	13,866	18,480	20,790
2 1/4	1·93	2·926	11,704	17,556	23,400	26,325
2 1/2	2·18	3·733	14,932	22,398	29,855	33,590
2 3/4	2·384	4·464	17,856	26,784	35,680	40,140
3	2·634	5·450	21,800	32,700	43,520	48,960
3 1/4	2·856	6·402	25,608	38,412	51,216	57,618
3 1/2	3·105	7·563	30,252	45,378	60,504	68,065
3 3/4	3·320	8·673	34,692	52,038	69,384	78,057
4	3·573	10·027	40,108	60,162	80,216	90,240
4 1/4	3·804	11·365	45,480	68,190	90,960	102,305
4 1/2	4·054	12·908	51,632	77,448	103,264	116,172
4 3/4	4·284	14·404	57,616	86,424	115,232	129,636
5	4·534	16·146	64,584	96,876	129,168	145,314
5 1/2	5·012	19·720	78,880	118,320	157,760	177,480
6	5·487	23·640	94,560	141,840	189,120	212,760

N.B.—Small bolts less than ¾″ dia. should not be stressed above 4,000 lbs. per square inch of section.

WHITWORTH STANDARD BOLTS AND NUTS.

Size of bolt and thickness of nut.	No. of threads per inch.	Diameter at bottom of thread.	Area at bottom of thread.	Thickness of bolt head.	Nut across flats.	Nut across corners.
1/8	40	·09	·006	·10	·33	·39
3/16	24	·13	·014	·16	·44	·51
1/4	20	·18	·027	·21	·52	·60
5/16	18	·24	·045	·27	·60	·69
3/8	16	·29	·068	·32	·70	·81
7/16	14	·34	·094	·38	·82	·94
1/2	12	·39	·12	·43	·91	1·06
9/16	12	·45	·16	·49	1·01	1·16
5/8	11	·50	·20	·54	1·10	1·27
11/16	11	·57	·25	·60	1·20	1·38
3/4	10	·62	·30	·65	1·30	1·50
13/16	10	·68	·36	·71	1·39	1 60
7/8	9	·73	·42	·76	1·47	1·71
15/16	9	·79	·49	·82	1·57	1·82
1	8	·84	·55	·87	1·67	1·95
1 1/8	7	·94	·69	·98	1·86	2·15
1 1/4	7	1·06	·89	1·09	2·04	2·36
1 3/8	6	1·16	1·05	1·20	2·21	2·55
1 1/2	6	1·28	1·29	1·31	2·41	2·78
1 5/8	5	1·36	1·47	1·42	2·57	2·97
1 3/4	5	1·49	1·74	1·53	2·75	3·18
1 7/8	4 1/2	1·59	1·99	1·64	3·01	3·48
2	4 1/2	1·71	2·31	1·75	3·14	3·63
2 1/8	4 1/2	1 84	2·66	1·85	3·33	3·85
2 1/4	4	1·93	2·92	1·96	3·54	4·09
2 3/8	4	2·05	3·31	2·07	3·75	4·33
2 1/2	4	2·18	3·73	2·18	3·89	4·49
2 5/8	4	2·30	4·17	2·29	4·64	4·67
2 3/4	3 1/2	2·38	4·46	2·40	4·18	4·82
2 7/8	3 1/2	2·50	4·92	2·51	4·34	5·02
3	3 1/2	2·63	5·44	2·62	4·53	5·23

DIAMETER OF WHITWORTH GAS TAPS.

Size. In.	Diameter.	Diameter at bottom of thread.	No. of threads per inch.	Size. In.	Diameter.	Diameter at bottom of thread.	No. of threads per inch.
1/8	0·38	0·33	28	1 1/8	2·02	1·90	11
3/16	0·51	0·45	19	1 1/4	2·04	1·93	11
1/4	0·65	0·58	19	1 1/2	2·24	2·12	11
3/8	0·82	0·73	14	2	2·34	2·23	11
1/2	0·90	0·81	14	2 1/4	2·58	2·47	11
5/8	1·04	0·94	14	2 1/2	3·00	2·88	11
3/4	1·18	1·09	14	2 3/4	3·24	3·13	11
7/8	1·30	1·19	11	3	3·48	3·36	11
1	1·41	1·37	11	3 1/4	3·69	3·58	11
1 1/4	1·65	1·53	11	3 1/2	3·91	3·79	11
1 1/2	1·74	1·62	11	3 3/4	4·12	4·00	11
1 3/4	1·88	1·76	11	4	4·43	4·22	11

WEIGHTS IN LBS. OF BLACK BOLTS AND NUTS

(HEXAGON HEAD AND NUT AND ROUND NECK).

Diameters in Inches.	LENGTH OF BOLTS IN INCHES FROM UNDER HEAD.										For each Additional Inch in Length ADD
	1	1¼	1½	1¾	2	2¼	2½	3	3½	4	
¼	·031	·035	·038	·042	·046	·049	·053	·060	·067	·074	·014
5⁄16	·056	·061	·068	·073	·078	·085	·090	·101	·112	·123	·022
⅜	·092	·100	·108	·116	·124	·132	·140	·156	·173	·189	·081
7⁄16	·139	·150	·161	·172	·183	·194	·205	·227	·248	·270	·042
½	·200	·214	·228	·243	·257	·271	·286	·315	·343	·372	·055
9⁄16	·276	·295	·312	·330	·349	·367	·385	·422	·458	·494	·069
⅝	·369	·391	·414	·436	·458	·481	·504	·549	·592	·638	·0854
¾	·613	·644	·677	·709	·742	·773	·806	·871	·935	1·000	·1230
⅞		·989	1·033	1·077	1·121	1·165	1·209	1·296	1·384	1·473	·1676
1			1·489	1·546	1·604	1·661	1·718	1·833	1·928	2·062	·2183
1⅛				2·118	2·214	2·286	2·359	2·463	2·650	2·795	·2766
1¼					2·951	3·041	3·131	3·309	3·489	3·687	·3408
1⅜					3·851	3·959	4·067	4·285	4·502	4·718	·4133
1½						5·032	5·161	5·420	5·678	5·936	·4916
1¾							7·904	8·255	8·606	8·957	·6691
2							11·473	11·932	12·391	12·819	·8741

Weight of 1 cubic inch of various Metals.

	Weight in lbs.	Weight in ounces.
Steel	0·2833	4·533
Cast iron	0·263	4·208
Wrought iron	0·2777	4·444
Copper	0·3225	5·159
Brass	0·308	5·333

Weight of Fuels.

COKE.	COAL.
4 bushels = 1 sack.	A bushel of coal = 74¾ lbs.
12 sacks = 1 chaldron.	A sack of ,, = 224 ,,
	A chaldron of coal = 2688 ,,
PETROLEUM.	A Newcastle chaldron = 5208 ,,
1 ton = 275 Imperial gallons.	A keel of coal = 41664 ,,

Weight of Animals.

A dense crowd of people, 85 lbs. per square foot.
Average weight of a man, 140 lbs.

,,	,,	,,	cart-horse,	14 cwt.
,,	,,	,,	riding ,,	11 ,,
,,	,,	,,	ox,	7–8 ,,
,,	,,	,,	cow,	6½–8 ,,
,,	,,	,,	pig,	1–1½ ,,
,,	,,	,,	sheep,	1 ,,

Space in cubic feet occupied by 1 ton of various Goods.

	Cub. ft. to 1 ton.		Cub. ft. to 1 ton.
Ballast	22	Gravel	23
Coal, Newcastle	45	Hay, compressed	105
,, Welsh	40	Rice in bags	45
Coffee in bags	61	Sand	21–22
Cotton, compressed	50	Sugar in bags	39
Earth	33	Tea in boxes	111
Flour in barrels	50	Timber	40–50
Granite	14		

Alloys and Bronzes.

The addition of ¼ to 1 % of aluminium to the ordinary brass and bronze mixtures effects a great improvement. The metal runs better and is more durable and tough. A higher percentage of aluminium will produce brittleness.

Aluminium Bronze consists of copper 90 %, aluminium 10 %; or copper 95 %, aluminium 5 %. The former alloy has a tensile strength of 80,000 lbs. It is largely used for bearings, gearing, chain belting, and for all purposes where great strength and toughness are required.

Silicon Bronze—copper 95 %, silicon 5 %—is, as regards strength, equal to aluminium bronze. but does not resist corrosion so well; it however, casts better.

Manganese Bronze, as now made, consists of—

Copper	..	..	..	per cent.	53
Zinc	..	..	..	,,	42
Manganese	..	..		,,	3·75
Aluminium	..	..		,,	1·25

}100·00

This is perhaps the best material to employ for heavy or light gearing wheels.

Imitation German Silver—

Copper	..	..	..	per cent.	67·25
Manganese	..	..		,,	18·50
Zinc	..	..	..	,,	13·00
Aluminium	..	..		,,	1·25

}100·00

This takes a good polish, and is besides very strong. May be usefully employed for motor-car purposes.

Aluminium Solder—

Aluminium	..	..		per cent.	2·38
Zinc	..	..	..	,,	26·19
Tin	..	..	..	,,	71·19
Phosphorus	..	..		,,	0·24

}100·00

Another solder for aluminium is known as Green's; it is stated to be composed of—

Zinc	..	..	..	per cent.	50·03
Tin	..	..	..	,,	47·99
Aluminium	..	..		,,	1·76
Phosphorus	..	..		,,	0·22

}100·00

No flux is required, but the faces of the joint are cleaned and coated *with solder, and a hot bit is* used to make the joint.

THE DESIGN OF BALL BEARINGS.
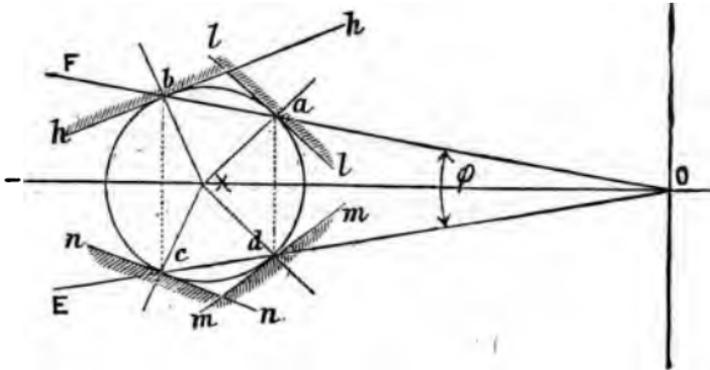
"A properly constructed ball bearing should be laid out on the lines of a cone bearing. Thus if O be the centre of revolution, draw OF, OE, at equal angles, cutting the ball at points a, b, c, d. Then will the cone a, b, c, d be the equivalent cone which would run truly on surfaces FO and EO, and to get true rolling results with ball bearings instead of cones there must be drawn tangents to these four points, viz., the tangents hh, ll, mm, nn. Then will these tangents represent the surfaces of the cones in which the ball will roll truly without grinding, the length of path rolled on being exactly proportioned to the spherical sections through the contact points. Thus the line ad bears the same ratio to the line bc as does the radius of revolution Oa to the radius Ob. We have hatched the lines showing the bearing cones to render our diagram more clear. The dimensions of the angle ϕ relative to the ball determine the shape of the bearing surfaces. When OE and OF become tangents to the balls, these roll on one section only, and would be extruded by the pressure. With a flat angle, ϕ, the bearing cones become acute, as may at once be seen by a rough sketch. It is doubtful if the angle at the apex of the bearing cones, that is, between the tangents ll and hh, should be less than 90°. At smaller angles the destructive effects of the balls is intensified, and the speed of rotation of the balls is much increased by reason of their rolling on a smaller circle. Even when used for rectilinearly moving pieces, we would prefer the surfaces to be slightly coned in order to secure two bearing circles. Between two flat surfaces the balls can only run on one circle. Cones, however flat, give two paths on the ball, and only half the load on any one point. Balls must not run in a curved groove, for then they grind all over their area of contact.

"The narrowness of path in a ball bearing demands that pressures shall not be too heavy, and, for heavy machinery, cones and cylinders,

which substitute lines for points, secure a practical advantage, though if materials were quite unyielding, balls would touch on mathematical points, and would have exactly the same bearing surface as cylinders, where theoretical area of contact is a line or the trace of a mathematical point, and, therefore, no greater than a point. The smallest amount of yield in materials of construction puts, however, quite a different complexion on affairs, and makes a cylinder bearing superior to a ball bearing where loads are heavy." — *Electrical Review*.

BALL BEARINGS.

The balls should be of high quality steel, truly spherical in shape, and without any surface flaws. They should run in accurately cut V-shaped races, and all dust, &c., should be prevented from entering.

Diameter of Ball..	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$
Working load per ball (in lbs.) ..	125	280	500	780	1125	1530	2000	2530	3125

ROLLER BEARINGS: "MOSSBERG" SYSTEM.

These bearings are extensively used for railway wagon and carriage axles, and are eminently suitable for use in moto-vehicles. The rollers are made of a very hard steel, and are supported in a gun-metal or phosphor-bronze cage.

THE MOSSBERG ROLLER BEARING.

Roller *v.* Plain Bearings.

The economy in tractive effort obtained by the use of well-designed roller bearings is shown in the following table, which relates to a test made on a railway car fitted with ordinary plain bearings, and then *fitted with roller bearings* on the Mossberg system.

Style of Bearing.	Area in sq. inches.	Total load in pounds.	Load in pounds per sq. in.	Starting pull in lbs. 10½" lever.	Friction co-effi-cient.
Plain	76·58	8,000	104·5	400	·05
Roller.. ..	76·58	8,000	104·5	20	·0025

It will be seen from this that the friction co-efficient decreases greatly by the use of these roller bearings.

BELT DRIVING.

Let T = Tension in driving part of belt in lbs.

  t = Tension in slack part of belt in lbs.

  V = Speed of belt in feet per minute.

  R = Radius in feet of pulley.

  N = Number of revolutions per minute of pulley.

  l = Length of arc in inches embraced by belt.

  r = Radius of pulley in inches.

  μ = Co-efficient of friction: for leather belting on iron this is from 0·3 to 0·4, but 0·15 if oily. Then—

$$\text{Log.} \left(\frac{T}{t} \right) = 0.43 \; \mu \; \frac{l}{r}$$

$$\text{Driving pull} = (T - t).$$

$$\text{Horse-power transmitted} = \frac{(T - t) \, V}{33,000}$$

$$\text{But V} = 2 \, \pi \, RN$$

$$\therefore \quad \text{H.-P.} = \frac{(T - t) \, 2 \, \pi \, RN}{33,000}$$

In calculating the strength of belting the allowable stress should be 320 lbs. per square inch.

CRANE CHAINS (Iron).

Short link; quality B.B.B.   Length = 5 diameters; width 3½.

STRENGTH AND WEIGHT OF IRON CRANE CHAINS.

Diam.	Safe load.		Breaking load.		Weight per fathom (6 ft.).	Diam.	Safe load.		Breaking load.		Weight per fathom (6 ft.).
inches.	tons.	cwts.	tons.	cwts.	lbs.	inches.	tons.	cwts.	tons.	cwts.	lbs.
³⁄₁₆	0	6	1	5	3	¹³⁄₁₆	5	0	20	0	42
¼	0	11	2	5	4½	⅞	5	11	22	5	48
⁵⁄₁₆	0	17	3	7	6¼	¹⁵⁄₁₆	6	7	25	10	53
⅜	1	4	4	15	9	1	7	2	28	10	60
⁷⁄₁₆	1	12	6	10	12	1¹⁄₁₆	7	17	31	10	72
½	2	1	8	5	16	1⅛	8	12	34	10	90
⁹⁄₁₆	2	11	10	5	20	1¼	13	4	42	15	105
⅝	3	1	12	5	25	1½	14	7	57	10	120
¹¹⁄₁₆	3	12	14	10	31	1¾	19	7	79	10	160
	4	7	17	10	37	2	26	0	104	10	220

CYCLE MECHANISM.

To find the pull exerted on the chain, and the tangential force at rim of driving wheel.

Let p = Mean pressure on pedals in lbs.

r = Radius of crank in inches.

S =   ,,   large sprocket wheel in inches.

s =   ,,   small   ,,   ,,   ,,

R =   ,,   driving wheel in inches.

T = Tangential force in lbs. at rim.

P = Pull on chain.

$$T = \frac{P.r.s}{S\,R}, \quad \text{and} \quad P = \frac{p\,r}{S}.$$

CYCLE GEARING.

The number denoting the "gear" of a cycle is the diameter of a wheel which bears the same ratio to the driving wheel as the crank wheel bears to the hub wheel.

Let n be the number of teeth on hub wheel.

N ,,   ,,   ,,   crank wheel.

d ,,   diameter of driving wheel.

D ,,   ,,   wheel bearing the same ratio to the driver as crank wheel does to hub wheel : then—

$$\frac{D}{d} = \frac{N}{n} ; \quad \text{whence,} \quad D = \frac{d\,N}{n}.$$

If D so found be multiplied by π (3·14) it gives the distance *traversed* during one revolution of the crank.

CHAIN GEARING.

In cases where a considerable amount of work has to be transmitted between two shafts at a slow speed, the tension in a flexible transmitter may easily be much greater than ordinary belts can sustain. In such cases metal chains may be used, so formed that the links fit into the projections of toothed wheels on the shafts. There can then be no slipping of the belt on the toothed wheels, and, as the chains may have almost any strength, an extremely great force can be exerted through the chain. Such chains forming a class of transmitting organ intermediate between belting and gearing are termed gearing chains, or pitch chains. The chief objection to their use is that, however well they fit the toothed wheels at first, they are liable from stretching and wear to become of slightly greater pitch than the toothed wheel, and they then work very badly. To obviate this as far as possible the links should be short. A high velocity ratio is obtained by the use of chain gearing more simply than by any other method, except worm gear. (UNWIN.)

To Design Chain Gear.

Let 2 T be the total tension on the loaded span of the chain.

2 i the number of links in the width of the chain—*i.e.*, the number of plates on each side of a single link.

δ the thickness of plate of ⎫
b the breadth of plate of ⎬ link.
d the diameter of pin of ⎭

The tension in each half of the chain having i links is T

If n T is the greatest tension in any one link, then the stress f_t on a section through the link eye is given by—
$$n\ \mathrm{T} = (b - d)\ \delta f_t$$

Usually $b = 2\cdot 5\ d$, then—
$$n\ \mathrm{T} = 1\cdot 5\ d\ \delta f_t \ldots \ldots \ldots 1$$

The average bearing pressure of the pin in the link eye f_c is—
$$n\ \mathrm{T} = d\ \delta f_c \ \ldots \ldots \ldots 2$$

The pins are subjected to bending action, which will increase with the total stress T, and with the thickness δ of the links. Hence whatever the distribution of the tension T among the links, the greatest bending moment in the pin will be—
$$\mathrm{M} = m\ \mathrm{T}\ \delta$$
and the stress due to bending will be—
$$\mathrm{M} = m\ \mathrm{T}\ \delta = \frac{\pi}{32}\ d^3 f \ \ldots \ldots 3$$

where f is the greatest intensity of the bending stress, and m a co-efficient depending on the distribution of the tension in the link.

Supposing the tension in each link to act at the centre of the link, the greatest bending moment—
$$\mathrm{M} = \mathrm{T}\ \delta \ \ldots \ldots \ldots \ldots 4$$

Hence equations 1, 3, and 4 give—

$$1.5 \, d \, \delta \, i f_t = \frac{\pi}{32} \cdot \frac{d}{\delta} \cdot f$$

and, supposing the stress in the link and pin equal, and taken at $f = 10{,}000$ lbs. per square inch, we get—

$$\frac{\delta}{d} = \frac{0.256}{\sqrt{i}}$$

$$d = 0.01614 \sqrt{\frac{T}{\sqrt{i}}} \quad \ldots \ldots 5$$

and if $f = 14{,}000$ lbs.

$$d = 0.01365 \sqrt{\frac{T}{\sqrt{i}}} \quad \ldots \ldots 6$$

(UNWIN.)

Professor Keller's Proportions for Chain Gearing.

Breadth of link, $b = 2.5 \, d$.
Thickness of middle part of pin, $d_1 = 1.2 \, d$.
Width of thickened part of pin, $w = 1.7 \, d + 0.2$.
Width of eye of link between hole and end of link $= 0.85 \, d$.
Length of link, centre to centre of pins $= 2.9 \, d$.

d is diameter of pin.

TABLE OF PROPORTIONS OF FLAT LINK GEARING CHAINS (KELLER).
ALL DIMENSIONS IN INCHES.

Load on Chain, 2 T lbs.	No. of Links, 2 i.	Pin Diameter at Ends, d.	Pin Diameter at Centre, d_1.	Length of Middle Part of Pin, w.	Thickness of Link, δ.	Breadth of Link, b.	Length of Link, l.	Total Thickness, $a = l - d_1 = 1.7\,d$.
220	2	0·16	0·20	0·43	0·060	0·39	0·55	0·35
550	2	0·26	0·32	0·67	0·098	0·65	0·83	0·51
1100	2	0·37	0·47	0·83	0·118	0·93	1·10	0·65
1650	2	0·45	0·55	0·94	0·158	1·12	1·42	0·75
2200	4	0·49	0·59	1·02	0·158	1·24	1·42	0·83
3300	4	0·61	0·75	1·22	0·177	1·52	1·77	1·04
4400	4	0·69	0·83	1·38	0·216	1·79	2·01	1·18
5500	4	0·85	1·02	1·61	0·256	2·11	2·44	1·42
8820	6	0·85	1·02	1·61	0·177	2·11	2·44	1·42
12100	6	0·94	1·14	1·81	0·197	2·36	2·76	1·61
16500	6	1·08	1·30	2·05	0·216	2·70	3·15	1·85
20050	*6*	*1·26*	*1·54*	*2·32*	0·256	3·15	3·66	2·14

POWER TRANSMITTED BY GEARING.

If p = Circumferential pitch in inches.
    B = Breadth of wheel in inches.
    V = Velocity of pitch line in feet per minute.
H.P. = Horse-power transmitted.

Then

$$\text{H.P.} = p^2 \times B \times V \div 1000 \text{ for cast-iron.}$$
$$= p^2 \times B \times V \div 625 \text{ for cast-steel.}$$

(MUSGRAVE & SONS, BOLTON.)

Number of Teeth and Revolutions of Wheels.

N = Number of teeth in driving wheel.
R = Revolutions of driving wheel.
n = Number of teeth in driven wheel.
r = Revolutions of driven wheel.

$$n = \frac{N\,R}{r} \qquad r = \frac{N\,R}{n}$$

$$N = \frac{n\,r}{R} \qquad R = \frac{n\,r}{N}$$

Strength of Wheel Gearing.

To find the least number of teeth in either wheel of a pair which will ensure sufficient strength :—

    Let T be the least number of teeth.
        H the horse-power transmitted.
        p the pitch in inches.
        N the number of revolutions per minute, then—

$$T = 791 \, \frac{H}{p^3 N}$$

Velocities of Wheels in Chain and Belt Gearing.

Let V = The velocity of chain or belt.
    D = The diameter of driving pulley.
    d = The diameter of driven pulley.
    N = The revolutions of driving pulley.
    n = The revolutions of driven pulley.

        Then $\pi \, D \, N = V$,
        and $\pi \, d \, n = V$;

$$\therefore \quad \frac{D}{d} = \frac{n}{N}$$

G 2

POSITION OF CENTRE OF GRAVITY IN 4-WHEELED AUTOMOTOR VEHICLES.

w = Load on front wheels.
w' = Load on rear wheels.
B = Length of wheel base.
W = Total weight of vehicle.
D = Distance of C.G.

If $w > w'$, D from rear axle is $\dfrac{w\,\text{B}}{\text{W}}$.

But if $w' > w$, then D from front axle = $\dfrac{w'\,\text{B}}{\text{W}}$.

When $w = w'$ the C.G. is midway between them. (The C.G. should be in front of driving wheels.)

STRENGTH OF SHAFTING.

If a force P lbs. is applied to a crank of length R inches, and tending to rotate the shaft, the twisting moment T = R P inch lbs.

If the shaft make n revolutions per minute, the twisting moment will be T $2 \pi n$.

If the shaft is transmitting H.P., then the work per minute is $\times$ 33,000 $\times$ H.P. inch pounds;

that is—
$$\text{T } 2 \pi n = 12 \times 33{,}000 \times \text{H.P.}$$
$$\therefore \text{T} = 63{,}024\ \frac{\text{H.P.}}{n}\ \text{inch lbs.}$$

If Z be the modulus of the section with regard to torsion, the shaft will be sufficiently strong when T = f Z.

If D be the diameter of the shaft,

$$\text{Z} = \frac{\pi\,\text{D}^3}{16} = 0{\cdot}196\ \text{D}^3,$$

hence, by substitution,

$$\text{D} = \sqrt[3]{\frac{\text{T}}{f\,.\,196}}.$$

For steel shafting, f has the following values :—

Stress not changing	f = 13,500.
Stress reversing at each revolution ..	f = 9,000.
Stress constantly changing	f = 4,500.

Hollow v. Solid Shafts.

In order that a hollow or annular shaft may be of the same strength as a solid shaft, the moduli of the sections must be equal; that is, if D be the diameter of a solid (circular) shaft, and d and d_1 the outside and inside diameters of an annular shaft, then for them to be of the same strength to resist torsion, this equation must hold—

$$\frac{\pi D^3}{16} = \frac{\pi}{16} \cdot \frac{d^4 - d_1^4}{d} \ ;$$

that is, $D^3 = \dfrac{d^4 - d_1^4}{d}$.

Let $d_1 = n\ d$, then

$$d = \sqrt[3]{\frac{D^3}{1 - n^4}}.$$

Crankshafts.

Let P = Indicated horse-power.

    n = Number of revs. per min.

    d = Diameter of shaft.

$$d = 4\cdot55 \sqrt[3]{\frac{P}{n}}$$

Proportions of Cranks.

If b is the thickness of crank web, h the width of crank face, and d the diameter of shaft, and c a constant = 0·9 to 1·0, then $b\ h^2 = c\ d^3$.

Torque in Shafting.

H.P. = Horse-power transmitted.

    n = Revolutions per second.

    N = Revolutions per minute.

    T = Torque in inch lbs.

$$T = \frac{550}{2\ \pi\ n}$$

$$= 1050\cdot4\ \frac{\text{H.P.}}{n}\ \text{inch lbs., or}$$

$$T = 63{,}024\ \frac{\text{H.P.}}{N}\ \text{inch lbs.}$$

DIMENSIONS OF SHAFTING TO TRANSMIT A GIVEN HORSE-POWER.

To find the diameter of a shaft, capable, within good working limits, of transmitting a given horse-power :—Multiply the horse-power by 190 for wrought-iron, or by 92 for steel, and divide by the revolutions per minute. The cube-root of the quotient is the diameter in inches. To find the maximum horse-power of a shaft, within good working limits :—Multiply the cube of the diameter in inches by the revolutions per minute, and divide by 190 for wrought-iron, or by 92 for steel. The quotient is the horse-power.

HORSE-POWER TRANSMITTED AT VARIOUS SPEEDS BY STEEL SHAFTING.

Revolutions per Minute.	DIAMETER OF SHAFTS.												
	1¼	1¾	2	2¼	2½	2¾	3	3½	4	4½	5	5½	6
	HORSE-POWERS THEY WILL TRANSMIT.												
50	3·3	5·3	8·0	10·9	15·6	20·8	27	43	64	91	125	166	216
60	4·0	6·4	9·6	13·1	18·8	25·0	32	51	77	109	150	200	259
70	4·7	7·5	11·2	15·2	21·9	29·1	37	60	89	128	175	233	302
80	5·4	8·5	12·8	17·4	25·0	33·3	43	69	102	146	200	266	346
90	6·0	9·6	14·4	19·6	28·1	37·4	49	77	115	164	225	299	389
100	6·7	10·7	16·0	21·8	31·2	41·6	54	86	128	182	250	333	432
110	7·4	11·8	17·6	23·9	34·4	45·8	59	94	141	200	275	366	475
120	8·1	12·9	19·2	26·1	37·5	49·9	65	103	154	219	300	399	518
130	8·7	13·9	20·8	28·3	40·6	54·1	70	111	166	237	325	433	562
140	9·4	15·0	22·4	30·5	43·8	58·2	76	120	179	255	350	466	605
150	10·1	16·1	24·0	32·6	46·9	62·4	81	129	192	273	375	499	648
160	10·8	17·1	25·6	34·8	50·0	66·5	86	137	205	292	400	532	691
170	11·5	18·2	27·2	37·0	53·1	70·7	92	146	218	310	425	566	734
180	12·2	19·3	28·8	39·2	56·3	74·9	97	154	230	328	450	599	778
190	12·8	20·4	30·4	41·3	59·4	79·0	103	163	243	346	475	632	821
200	13·5	21·4	32·0	43·5	62·5	83·2	108	172	256	365	500	665	864
225	15·2	24·1	36·6	49·0	70·3	93·6	122	193	288	410	563	749	972
250	16·9	26·8	40·0	54·4	78·1	104·0	135	214	320	456	625	832	1080
275	18·6	29·5	44·0	59·8	85·9	114·4	149	236	352	501	688	915	1188
300	20·8	32·2	48·0	65·3	93·7	124·8	162	257	384	547	750	998	1296
325	21·9	34·8	52·0	70·7	101·6	135·2	176	279	416	592	813	1081	1404
350	23·6	37·5	56·0	76·2	109·4	145·6	189	300	448	638	875	1165	1512
375	25·3	40·2	60·0	81·6	117·2	156·0	203	322	480	683	938	1243	1620
400	27·0	42·9	64·0	87·0	125·0	166·4	216	343	512	729	1000	1331	1728
425	28·7	45·6	68·0	92·5	132·8	176·8	230	364	544	775	1063	1414	1836
450	30·4	48·2	72·0	97·9	140·6	187·2	243	386	576	820	1125	1497	1944
475	32·1	50·9	71·0	103·4	148·4	197·6	257	407	603	866	1188	1580	2052
500	33·7	53·6	80·0	108·8	156·2	208·0	270	429	640	911	1250	1664	2160

For power of wrought-iron shafts take 70 per cent. of steel shafting of the same size.

(MUSGRAVE & SONS, BOLTON.)

STEEL JOISTS.

Table giving the Weights, Sizes, Moments of Resistance and Inertia of Steel Joists suitable for Railway and Road Vehicle Construction, from the catalogue of Messrs. DORMAN, LONG & Co., Middlesbrough.

Number of Section.	Weight per Foot in lbs.	Sizes in inches.	Web Thickness.	Mean Thickness of Flange.	Moments of Resistance in sq. inches.	Vertical or Greatest Moments of Inertia.
G. 17a	16	7 × 3¾	·25	·375	10 ·28	35 ·98
G. 18	18	6¼ × 3¼	·339	·5	10 ·58	33 ·09
G. 19	25	6 × 5	·423	·52	14 ·48	43 ·46
G. 19a	20	6 × 4½	·434	·4	11 ·11	33 ·35
G. 20	16	6 × 3	·39	·45	8 ·38	25 ·14
G. 20a	13	6 × 3	·322	·35	6 ·92	20 ·77
G. 21	12	6 × 2	·381	·38	5 ·52	16 ·58
G. 22	10 ·5	5½ × 2	·329	·38	4 ·69	12 ·9
G. 22a	9	5½ × 1½	·368	·312	3 ·34	8 ·77
G. 23	24	5 × 5	·371	·56	11 ·82	29 ·55
G. 24	22	5 × 4½	·342	·57	10 ·77	26 ·94
G. 24a	19	5 × 4³⁄₁₆	·44	·45	8 ·83	22 ·09
G. 25	15	5 × 3	·4	·44	6 ·43	16 ·09
G. 25a	11	5 × 3	·23	·38	5 ·46	13 ·65
G. 26	10	4¾ × 1¾	·4	·38	3 ·57	8 ·48
G. 26a	6 ·5	4¾ × 1¾	·1875	·3125	2 ·73	6 ·5
G. 27	14	4⅛ × 3	·2	·43	5 ·68	13 ·17
G. 28	12	4 × 3	·299	·43	4 ·51	9 ·03
G. 28a	9 ·5	4 × 3	·225	·34	3 ·769	7 ·538
G. 29	8	4 × 1¾	·331	·36	2 ·58	5 ·16
G. 29a	5	4 × 1¾	·18	·24	1 ·814	3 ·628
G. 30	10 ·9	3¼ × 3	·35	·35	3 ·35	5 ·87
G. 31	6	3¼ × 1½	·296	·3	1 ·66	2 ·91
G. 32	10	3 × 3	·29	·38	2 ·8	4 ·21
G. 33	4	3 × 1¼	·218	·25	·98	1 ·41

Table of Safe Distributed Loads in Tons on Joists of Varying Spans.
Calculated at One-Third the Breaking Weight.

Section.	Normal Sizes in Inches.	Weight per Ft. in Lbs.	\-	\-	\-	\-	\-	\-	\-	\-	\-	\-
			\-				Clear Spans in Feet between Supports.					
			2	4	6	8	10	12	14	16	18	20
G. 17a	7 × 3¾	16				9·1	7·3	6·1	5·2	4·5	4·1	3·6
G. 18	6¼ × 3½	18			12	9	7	6·8	5·3	4·6	4·1	
G. 19	6 × 5	25			17	12	10	8·5	7·2	6·4	5·7	
G. 19a	6 × 4½	20			13	10	7·9	6·6	5·6	4·9	4·4	
G. 20	6 × 3	16			9·9	7·4	5·9	5	4·2	3·7	3·3	
G. 20a	6 × 3	13		12	8·2	6·1	4·8	4	3·5	3·0	2·7	
G. 21	6 × 2	12		9·8	6·5	4·9	3·9	3·2	2·8	2·4	2·1	
G. 22	5½ × 2	10½		8·3	5·5	4·1	3·3	2·7	2·3	2·0	1·8	
G. 22a	5½ × 1½	9		6	4	3	2·4	2·0	1·7	1·5		
G. 23	5 × 5	24			14	10·5	8·4	7	6	5·2		
G. 24	5 × 4½	22			12	9·6	7·6	6·4	5·5	4·8		
G. 24a	5 × 4 3/16	19			10	7·9	6·3	5·2	4·5	3·9		
G. 25	5 × 3	15			7·6	5·7	4·5	3·8	3·2	2·8		
G. 25a	5 × 3	11			6·5	4·9	3·9	3·2	2·8	2·4		
G. 26	4½ × 1½	10		6·3	4·2	3·1	2·5	2·1	1·8			
G. 26a	4½ × 1¾	6¼		4·8	3·2	2·4	1·9	1·6	1·3			
G. 27	4½ × 3	14		10	6·7	5	4·0	3·3	2·8			
G. 28	4 × 3	12½		8	5·3	4·0	3·2	2·6	2·2			
G. 28a	4 × 3	9½		6·7	4·4	3·3	2·6	2·2	1·9			
G. 30	4 × 1¾	8		4·7	3·2	2·4	1·9	1·5	1·3			
G. 29a	4 × 1¾	5	6	3·2	2·1	1·6	1·3	1				
G. 30	3½ × 3	10½		4·9	4	3	2·4	2	·92			
G. 31	3½ × 1½	6		3	3	1·5	1·2					
G. 32	3 × 3	10		5·1	2·3	2·5	2·0	1·6				
G. 33	3 × 1¼	4	3·4	1·7	1·1	·87	·7	·58				

Strength of Mannesmann Steel Tubes.

TENSILE.

Class of Tube.	Quality.	°/₀ Contraction in Area.	°/₀ Elongation in 8 inches.	Ultimate Strength in tons.	Remarks.
Cycle ..	1st qual.	49·9	17·5	36·71	
,, ..	1st ,,	46·95	16·25	37·5	
,, ..	2nd ,,	53·08	18·625	33·3	
,, ..	2nd ,,	56·17	18·75	32·75	
Boiler tubes	1st ,,	54·17	28·8	24·4)	Mean of 5
,, ,, {	Medium Steel }	69·68	28·75	25·5	{ Admiralty
Steam ,,	2nd qual.	38·73	19·4	28·73	Mean of 3
Hollow Shafting	Medium Steel }	53·92	22·5	31·49	

BEARING STRESS.

Class of Tube.	Span.	Ultimate Strength in lbs.	Elastic Stress in lbs.	Ratio: Elastic Stress, Ultimate Stress.	Deflection in inches, Load Removed.
Mannesmann 1	50″	4,731	3,500	84·7 °/₀	3″
,, 2	50″	4,379	3,400	77·6 °/₀	4″
,, 3	50″	4,186	3,300	78·8 °/₀	4·5″

Approximate Weight of Leather Belting in Lbs.

Per 100 feet in Length.

Width in Inches ..	3	4	5	6	7	8	9	10	12
Single Belts—Strong..	31	43	55	67	79	94	109	125	160
Medium	29	41	52	64	75	89	103	118	150
Double Belts—Strong..	59	83	100	120	145	172	200	230	280
Medium	53	76	92	110	135	160	186	215	265

COLD - DRAWN STEEL TUBE.

Weight of a Lineal Foot.

Thickness. Imperial Standard Wire Gauge.

External Diam.	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lrs.	lbs.	lbs.	lbs.	lbs.
⅜	·080	·090	·105	·120	·130	·145	·160	·194	·210	·234	·251	·277	·300	·320	·337
½	·110	·122	·142	·162	·175	·193	·232	·268	·296	·330	·358	·40	·439	·475	·508
⅝	·140	·154	·179	·204	·224	·251	·296	·342	·382	·426	·465	·523	·578	·639	·679
¾	·170	·186	·216	·246	·273	·304	·360	·416	·463	·522	·572	·646	·717	·765	·850
⅞	·200	·218	·253	·288	·322	·357	·424	·490	·554	·618	·679	·769	·856	·940	1·02
1	·230	·250	·290	·330	·371	·410	·489	·564	·640	·714	·786	·892	·995	1·095	1·19
1⅛	·260	·282	·327	·372	·420	·463	·552	·638	·726	·810	·893	1·015	1·134	1·25	1·363
1¼	·290	·314	·364	·414	·469	·516	·616	·712	·812	·906	1·00	1·138	1·273	1·40	1·534
1⅜	·320	·346	·401	·456	·518	·569	·680	·786	·898	1·00	1·107	1·26	1·412	1·56	1·705
1½	·350	·378	·438	·498	·567	·622	·744	·860	·984	1·098	1·214	1·384	1·55	1·715	1·876

Spiral Springs.

E = Modulus of transverse elasticity = from 10,500,000 to 12,500,000 for Swedish spring steel.

L = Load in lbs.

R = Mean radius of coil in inches.

d = Diameter of circular wire in inches.

s = Side of square wire in inches.

N = Number of free coils.

δ = Deflection of spring in inches.

$$\delta = \frac{64\ N\ L\ R^3}{E\ d^4} \text{ for circular section.}$$

$$\delta = \frac{48\ N\ L\ R^3}{E\ s^4} \text{ for square section.}$$

Taking 11,500,000 lbs. as the value of E, these formulæ become—

$$\delta = \frac{N\ L\ R^3}{180,000\ d^4} \text{ for steel of circular section,}$$

and—

$$\delta = \frac{N\ L\ R^3}{240,000\ s^4} \text{ for steel of square section.}$$

By substitution, we obtain—

$$L = \frac{3\cdot 43\ d^3}{2\ R} \text{ for circular section,}$$

and—

$$L = \frac{3\cdot 638\ s^3}{2\ R} \text{ for square section ;}$$

and finally—

$$d = \sqrt[3]{\frac{L\ 2\ R}{3\cdot 43}} \text{ , and } s = \sqrt[3]{\frac{L\ 2\ R}{3\cdot 638}}$$

Plate Springs.

W = Total load in tons.

E = Modulus of elasticity for spring steel = 36,000,000 lbs., or 16,000 tons.

f = Stress in tons per square inch = 40.

L = Half length of spring.

b = Breadth of plates in inches.

n = Number of plates.

t = Thickness of plates in inches.

δ = Deflection of spring in inches per ton of load, then—

Safe working load on spring in tons is $= \dfrac{f\ b\ t\ n^2}{3\ L} = \dfrac{13\cdot 3\ b\ t^2\ n}{L}$

$$\delta = \frac{L^3}{4000\ b\ t^3\ n} \ ; \ n = \frac{L\ W}{13\cdot 3\ b\ t^2}$$

(MOLESWORTH.)

Tests of Springs.

Single Spiral Spring of Rectangular Section.

Automolor Journal

Dimensions :—

7½ inches high.	8 coils, tip to tip of steel.
4½ inches diameter.	Section of steel, $1\frac{3}{16}''\times\frac{1}{2}'$
2⅓-inch hole.	Weight, 15¼ lbs.

The following results have been obtained by actual test :—

	Free.	1	2	3	4 tons.	Ho
Inches	7¼	6⅞	6 3/16	5½	4⅞	4

A similar spring gave the following results :—
    Dimensions :
        6⅜ inches high.
        5 inches diameter.
        2⅛-inch hole.
        6 coils.
        Steel, 1¾″ × ⅝″
        Resistance, 1 ton 12 cwt. for each 1 inch of deflection.
        Ultimate resistance, 5 tons.
        Weight of spring, 22 lbs.

Single Spiral Spring of Round Steel.

Dimensions :—

6 inches high.	6 coils, tip to tip of steel.
4¼ inches outside diameter.	Steel, ¾-inch round.
2¼-inch hole.	Weight, 6¾ lbs.

	Free.	1	2 tons.	48 cwts.	Home.
Inches	6	5	4⅛	4	3¹¹⁄₁₆
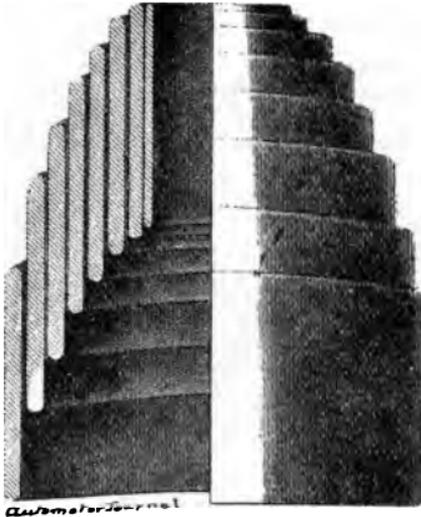
Conical Spring.

Dimensions :—

6 inches high.	Oval section, 1⅝″ × ⁹⁄₁₆″
7¼-inch base.	Weight, 13¼ lbs.
1⅗-inch hole.	

	Free.	1	2	3	4 tons.	Home.
Inches	6	4	3	2⅜	1¾	1⅞

Pneumatic and Iron Tyres.

The relative advantages of these have formed the subject of an investigation by M. Michelin.

The first experiments were made with iron and pneumatic tyres of the following diameters and weights :—

Kind.	Diameter of Wheels.		Weight of Wheels.		Weight of Empty Vehicle.
	Front. ft.	Back. ft.	Front. lbs.	Back. lbs.	lbs.
Iron tyres ..	3·02	3·67	127·6	158·4	1269·4
Pneumatic tyres	2·95	3·93	85·8	123·2	1192·4

To the weight of the empty vehicle the weight of the driver must be added ; and to make this feature comparable the same driver was used in both cases. These experiments were made over various soils, over different lengths of road, with varying loads, and at different speeds. The results of the trials are summed up in the following table :—

Experiments in Snow.

	Iron Tyres. lbs.	Pneumatic Tyres. lbs.
Carriage at a walk, empty	34·89	25·23
Carriage at a walk, load of 330 lbs. ..	39·22	27·96
Carriage at a trot, load of 330 lbs. ..	65·12	33·59
Carriage at a trot, load of 660 lbs. ..	68·57	39·51

Experiments in Mud.

	Iron Tyres. lbs.	Pneumatic Tyres. lbs.
Carriage at a walk, empty	35·20	23·10
Carriage at a walk, load of 330 lbs. ..	38·06	27·34
Carriage at a trot, load of 330 lbs. ..	43·01	28·53
Carriage at a trot, load of 660 lbs. ..	50·73	31·15

Mean of Trials upon Macadam ; Dry, New, Dusty, and Well-paved, with Grades varying from 1·2 to 5·8 per cent.

	Iron Tyres. lbs.	Pneumatic Tyres. lbs.
Carriage at a walk, empty	38·32	30·91
Carriage at a trot, empty	44·90	35·09
Carriage at a walk, load of 660 lbs. ..	45·65	35·51
Carriage at a trot, load of 660 lbs... ..	65·34	36·08

These figures show that under all the conditions given the use of the pneumatic tyre diminishes the tractive effort ; and this economy is greater upon a bad than upon a good road, and it also increases with the speed and the load.

FLY-WHEELS FOR GAS AND OIL MOTORS.

W = Weight of fly-wheel rim in tons.

I.H.P. = Indicated horse-power.

n = Number of strokes during which the fly-wheel receives no impulse + 1 to allow for compression.

N = Maximum number of revs. per min.

C = Ratio of minimum to maximum speed per cent.

D = Mean diameter of wheel in feet.

$$W = 171956 \; \frac{(\text{I.H.P.})n}{D^2 \, N^3 \, (1 - C^2)}$$

Usually $n = 8$ and $C = 0.95$, and the formula becomes

$$W = \frac{\text{I.H.P.}}{D^2 \, N^3} \times 14,109,209.$$

(PRACTICAL ENGINEER.)

WHEEL GEARING.

Let p = the circular pitch.

Let s = the diametral pitch.

Let d = the diameter of the pitch line.

Let T = the number of teeth, then circumference of pitch line = T p.

$$d = \frac{p}{\pi} \, T \;=\; 0.3183 \, p \, T.$$

$$T = \frac{\pi}{p} \;\;=\; d \, 3.1416 \frac{d}{p}.$$

$$s = \frac{p}{\pi} \;\;=\; 0.3183 \, p.$$

$$d = T \, s.$$

$$T = \frac{d}{s}. \qquad\qquad \text{(UNWIN.)}$$

INDIA-RUBBER, TESTS FOR.

India-rubber should not give the slightest sign of superficial cracks on being bent to an angle of 180 deg. after five hours' exposure in a closed air bath to a temperature of 125 deg. Cent. The test-pieces should be about 6 centimetres thick.

Rubber containing not more than 50 per cent. by weight of metallic oxides should stretch to five times its length without breaking. Pure caoutchouc free from all foreign matter, except the sulphur necessary for its vulcanisation, should stretch seven times its length without breaking. The extension measured immediately after rupture should not exceed 12 per cent. of the original length of the test-piece. The test-pieces should be from 3 to 12 millimetres wide, and not more than 6 millimetres thick and 3 centimetres long. The percentage of ash gives a certain indication of the degree of softness, and may form a basis for the choice between different qualities for certain purposes. Any excess of sulphur over that required for vulcanisation should be removed at the works, and should not appear on the surface of any object. (VLADIMIROFF.)

VULCANIZED INDIA-RUBBER.

Vulcanized india-rubber made as tyres should float in water. If it does not, it shows adulteration. To effect proper vulcanization a little more than 3 per cent. of sulphur is required. Vulcanized indiarubber is adversely affected by light and air.

Composition for Uniting India-rubber.

Dissolve 10 parts of finely shredded India-rubber in bisulphide of carbon; add 1½ parts resin, and 1 part of shellac.

WATER AND PUMPS.

Water.

Pure fresh water or hydric oxide H_2O.
Composition of 1 kilo. of ordinary spring water :—

Water	998 ·5
Calcic carbonate	0 ·8
Calcic sulphate	0 ·4
Other salts ..	0 ·3
	1000 ·0

1 cub. ft.	=	0 ·0279 ton	=	62 ·39 lbs.
1 gallon	=	0 ·0045 „	=	10 ·00 „
1 ton	=	35 ·905 cub. ft.	=	223 ·76 galls.

Freezing point at sea level	32° F.
Point of maximum density ., ...	39·1° F.
British standard for specific gravity	62° F.
Boiling point at sea level	212° F.

	Weight per cub. ft.		per cub. in,
32° F.	62·418 lbs.	..	0·03612 lb.
39·1° F.	62·425 lbs.	..	0·036125 lb.
62° F.	62·355 lbs...	..	0·03608 lb.
212° F.	59·760 lbs.	..	0·03458 lb.

Sea-Water.

Composition of 1 kilo. of sea-water :—

Water	962·5
Sodic chloride	29·0
Magnesic chloride	4·0
Calcic sulphate	1·5
Other salts (bromides, iodides, &c.)	3·0
	1000·0

1 cub. ft. = 0·0286 ton = 64·05 lbs.
1 gallon = 0·0046 „ = 10·276 „
1 ton = 34·973 cub. ft. = 217·95 galls.

Expansion of Metals.

Metals expand by heat, and contract by cold ; and in almost all mechanical operations, unless the tendency to expand is allowed to act, very great stresses are brought to bear upon the material. The following table shows the amount of expansion for different materials per foot :—

	Expansion per Degree Fahr.	Expansion from 32° to 212°.
Iron	·0000067	·00122
Steel	·0000069	·00124
Copper	·0000090	·00171
Zinc	·0000160	·00294
Tin	·0000120	·00217

Almost all solid bodies expand equally for each degree between freezing and boiling, or from 32° to 212° of Fahrenheit's thermometer. A bar of iron, therefore, which is 12 feet long, by an increase of 50° of temperature becomes 50 × 12 × ·0000067 = 12·0048 feet in length.

H

Pressure of Water.

The pressure of water in pounds per square inch for every foot in height to 270 feet. By this table, from the pounds pressure per square inch the feet head is readily obtained, and *vice versâ*.

Feet Head.	Pressure per Square Inch.	Feet Head.	Pressure per Square Inch.	Feet Head.	Pressure per Square Inch.	Feet Head.	Pressure per Square Inch.	Feet Head.	Pressure per Square Inch.	Feet Head.	Pressure per Square Inch.
1	0·43	46	19·92	91	39·42	136	58·91	181	78·40	226	97·10
2	0·86	47	20·35	92	39·85	137	59·34	182	78·84	227	98·33
3	1·30	48	20·79	93	40·28	138	59·77	183	79·27	228	98·76
4	1·73	49	21·22	94	40·72	139	60·21	184	79·70	229	99·20
5	2·16	50	21·65	95	41·15	140	60·64	185	80·14	230	99·63
6	2·59	51	22·09	96	41·58	141	61·07	186	80·57	231	100·06
7	3·03	52	22·52	97	42·01	142	61·51	187	81·00	232	100·49
8	3·46	53	22·95	98	42·45	143	61·94	188	81·43	233	100·93
9	3·89	54	23·39	99	42·58	144	62·37	189	81·87	234	101·36
10	4·33	55	23·82	100	43·31	145	62·81	190	82·30	235	101·79
11	4·75	56	24·26	101	43·75	146	63·24	191	82·73	236	102·23
12	5·20	57	24·69	102	44·18	147	63·67	192	83·17	237	102·66
13	5·63	58	25·12	103	44·61	148	64·10	193	83·60	238	103·09
14	6·06	59	25·55	104	45·05	149	64·54	194	84·03	239	103·53
15	6·49	60	25·99	105	45·48	150	64·97	195	84·47	240	103·96
16	6·93	61	26·42	106	45·91	151	65·49	196	84·90	241	104·39
17	7·36	62	26·85	107	46·34	152	65·84	197	85·33	242	104·83
18	7·79	63	27·29	108	46·78	153	66·27	198	85·76	243	105·26
19	8·22	64	27·72	109	47·21	154	66·70	199	86·20	244	105·69
20	8·66	65	28·15	110	47·64	155	67·14	200	86·63	245	106·13
21	9·09	66	28·58	111	48·08	156	67·57	201	87·07	246	106·56
22	9·53	67	29·02	112	48·51	157	68·00	202	87·50	247	106·99
23	9·96	68	29·45	113	48·94	158	68·43	203	87·93	248	107·43
24	10·39	69	29·88	114	49·38	159	68·87	204	88·36	249	107·86
25	10·82	70	30·32	115	49·81	160	69·31	205	88·80	250	108·29
26	11·26	71	30·75	116	50·24	161	69·74	206	89·23	251	108·73
27	11·69	72	31·18	117	50·68	162	70·17	207	89·66	252	109·16
28	12·12	73	31·62	118	51·11	163	70·61	208	90·10	253	109·59
29	12·55	74	32·05	119	51·54	164	71·04	209	90·53	254	110·03
30	12·99	75	32·48	120	51·98	165	71·47	210	90·96	255	110·46
31	13·42	76	32·92	121	52·41	166	71·91	211	91·39	256	110·89
32	13·86	77	33·35	122	52·84	167	72·34	212	91·93	257	111·32
33	14·29	78	33·78	123	53·28	168	72·77	213	92·26	258	111·76
34	14·72	79	34·21	124	53·71	169	73·20	214	92·69	259	112·19
35	15·16	80	34·65	125	54·15	170	73·64	215	93·13	260	112·62
36	15·59	81	35·08	126	54·58	171	74·07	216	93·56	261	113·06
37	16·02	82	35·52	127	55·01	172	74·50	217	93·99	262	113·49
38	16·45	83	35·95	128	55·44	173	74·94	218	94·43	263	113·92
39	16·89	84	36·39	129	55·88	174	75·37	219	94·86	264	114·36
40	17·32	85	36·82	130	56·31	175	75·80	220	95·30	265	114·79
41	17·75	86	37·25	131	56·74	176	76·23	221	95·73	266	115·22
42	18·19	87	37·68	132	57·18	177	76·67	222	96·16	267	115·66
43	18·62	88	38·12	133	57·61	178	77·10	223	96·60	268	116·09
44	19·05	89	38·55	134	58·04	179	77·53	224	97·03	269	116·52
45	19·49	90	39·98	135	58·48	180	77·97	225	97·46	270	116·96

Head in feet = 2·306768 × pressure in lbs. per sq. inch.
,,   ,,   = 0·0160192 × ,,   ,,   ,, foot.
Pressure in lbs. per square inch = 0·433507 × head in feet,
,,   ,,   ,, foot = 62·425   × ,,   ,,

Power required to raise water.

Q = Gallons per minute.
h = Height in feet.
E.H.P. = Effective horse-power.
$$\text{E.H.P.} = \frac{Q\,10\,h}{33,000}$$

Add $\frac{1}{3}$ to $\frac{2}{3}$ for losses due to friction, slip, &c.

Pump Formulæ.

D   = Diameter of pump in inches.
A   = Area of pump in square inches.
U   = Piston speed in feet per minute.
G^m = Gallons per minute.
G^h = Gallons per hour.

$$A = \frac{G^m\,23}{U}; \text{ also } A = \frac{G^h}{0·385\,U}$$

$$G^m = \frac{A\,U}{23}; \text{ also } G^h = \frac{A\,U}{0·385}$$

$$G^m = D^2 \times 0·034\,U; \text{ also } G^h = D^2 \times 2·04\,U$$

$$D = \sqrt{\frac{G^m}{0·034\,U}}; \text{ also } D = \sqrt{\frac{G^h}{0·1698\,U}}$$

If quantity required is in cubic feet, multiply gallons by 0·16 for water, and by 0·128 for petroleum.

Feed Pumps.

Feed Pumps should be at least of twice the capacity required by the boiler.

D = Diameter of barrel in inches.
L   = Stroke, in inches.
n = Number of strokes per minute.
w = Cubic feet of water pumped per hour.
W = lbs. of water   ,,   ,,
$w = 1·7\,D^2\,L\,n$
$$W = \frac{D^2\,L\,n}{36·6}$$

H 2

Duplex Pumps.

D = Diameter of steam pistons in inches.
d = Diameter of plungers in inches.
L = Length of stroke.
N = Number of single strokes of one piston or plunger per minute.
U = Speed of pistons in feet per minute.
Q = Gallons of water delivered per minute.
P = Pressure in lbs. per square inch on pistons.
p = Pressure in lbs. per square inch on plungers.

$$Q = \frac{2\,(0{\cdot}7854\,d^2\,L\,N)}{277} = 0{\cdot}00567\,d^2\,L\,N.$$

$$\text{Since } U = \frac{L\,N}{12}, \quad Q = 0{\cdot}068\,d^2\,U.$$

$$\text{Also } d = \sqrt{\frac{Q}{0{\cdot}068\,U}} \text{ and } D = \sqrt{\frac{1{\cdot}25\,p\,d^2}{P}}$$

FIRE STREAMS.

Pressure required at nozzle and at pump, with quantity and pressure necessary to throw good effective streams various distances through different size nozzles, using 100 feet of ordinary 2½-inch rubber lined hose and smooth nozzles.—(FREEMAN.)

SIZE OF NOZZLE, ¾ INCH.

Pressure at Nozzle, in lbs. per sq. in.	40	50	60	70	80	90	110
Pressure at Pump, ,, ,,	46	57	68	80	91	102	114
Imperial Gallons per Minute	86	96	105	114	122	129	136
Distance thrown Horizontal, in feet...	44	50	54	58	62	65	68
Distance thrown Vertical, ,, ...	60	67	72	76	79	81	83

SIZE OF NOZZLE, ⅞ INCH.

Pressure at Nozzle, in lbs. per sq. in.	40	50	60	70	80	90	100
Pressure at Pump, ,, ,,	50	63	75	88	101	113	126
Imperial Gallons per Minute	118	132	144	156	167	177	186
Distance thrown Horizontal, in feet...	49	55	61	66	70	74	76
Distance thrown Vertical ,, ...	62	71	77	81	85	88	90

SIZE OF NOZZLE, 1 INCH.

Pressure at Nozzle, in lbs. per sq. in.	40	50	60	70	80	90	100
Pressure at Pump, ,, ,,	58	72	87	101	115	130	144
Imperial Gallons per Minute	154	173	189	204	218	232	245
Distance thrown Horizontal, in feet...	55	61	67	72	76	80	83
Distance thrown Vertical, ,, ...	64	73	79	85	89	92	96

Fire Streams—(continued).

SIZE OF NOZZLE, 1½ INCHES.

Pressure at Nozzle, in lbs. per sq. in.	40	50	60	70	80	90	100
Pressure at Pump, ,, ,,	69	86	103	120	138	155	172
Imperial Gallons per Minute	197	221	241	260	279	295	312
Distance thrown Horizontal, in feet...	59	66	72	77	81	85	89
Distance thrown Vertical, ,, ...	65	75	83	88	92	96	99

SIZE OF NOZZLE, 1¼ INCHES.

Pressure at Nozzle, in lbs. per sq. in.	40	50	60	70	80	90	100
Pressure at Pump, ,, ,,	84	106	127	148	169	190	211
Imperial Gallons per Minute	246	275	301	325	348	368	388
Distance thrown Horizontal, in feet ..	63	70	76	81	85	90	93
Distance thrown Vertical, ,. ...	67	77	85	91	95	99	101

SIZE OF NOZZLE, 1¾ INCHES.

Pressure at Nozzle, in lbs. per sq. in.	40	50	60	70	80	90	100
Pressure at Pump, ,, ,,	107	134	160	187	214	240	268
Imperial Gallons per Minute	301	337	369	398	426	452	476
Distance thrown Horizontal, in feet...	66	73	79	84	88	92	96
Distance thrown Vertical, ,, ...	69	79	87	92	97	100	103

N.B.—The above pressures are based on the supposition that the hose is coupled direct to the delivery of the pump and while the stream is flowing; if, however, the hose is coupled to a hydrant which is supplied direct from the pump, then the corresponding fire pump pressure must be greater than the hydrant pressure by an amount equal to friction loss, and difference of head between hydrant and pump. The pressures given are *indicated* pressures, not effective pressures. Effective pressures would be slightly greater. The distances given are for *effective* fire streams adapted for fire purposes, and are not for mere isolated drops.

AIR.

1 Atmosphere .. ..
$\left\{\begin{array}{l} 14\cdot7 \text{ lbs. per sq. inch.} \\ 2116\cdot4 \text{ lbs. per sq. foot.} \\ 1\cdot0335 \text{ kilos. per Cm}^2. \\ 29\cdot922 \text{ inches of mercury at } 32° \text{ F.} \\ 30\cdot000 \quad,, \qquad ,, \qquad 62° \text{ F.} \\ 33\cdot947 \text{ feet of water at } 62° \text{ F.} \\ 76 \text{ cms. of mercury at } 0° \text{ C.} \\ 10\cdot347 \text{ metres of water at } 17° \text{ C.} \end{array}\right.$

1 cubic foot of air at a pressure of 14·7 lbs. per sq. inch
$\left.\begin{array}{l} \\ \\ \end{array}\right\}$ Weight at 32° F.=0·08073 lbs. or 1·29 ounces or 565·1 grains.

1 litre of air, at a pressure of 1 atmosphere at 0° C., weighs 1·293 grammes.

FUELS.

Calorific Power of a Fuel.

$$\text{Units of heat} = (14500 \times \% \text{ C}) + \left\{ 62535 \times \left(\% \text{ H} - \frac{\% \text{ O}}{8} \right) \right\}$$

where C, H, and O represent carbon, hydrogen, and oxygen.

Example : A sample of petroleum contains 85·3 % C and 14·7 % H. What is its calorific power ?

$$\frac{(14500 \times 85 \cdot 3) + (62535 \times 14 \cdot 7)}{100} = 21561 \text{ units.}$$

A coal contains 82 % C, 5 % H, and 8 % O. What is it heating value ?

$$\frac{(14500 \times 82) + \left\{ 62535 \times \left(5 - \frac{8}{8} \right) \right.}{100} = 15016 \text{ units.}$$

Coke being practically all carbon (0·935 C) its heat value cannot exceed 14500 × 0·935 = 13557 heat units.

Units of Work contained in a Fuel.

Found by multiplying the number of heat-units contained in 1 lb. of fuel by 772, the mechanical equivalent of heat. Thus, 1 lb. of coal containing 15,061 heat units has a dynamical value of 15,061 × 772 = 11,627,092 foot pounds of work.

Composition of Coals.

GOOD QUALITY COALS.

	Anthracite.		Semi-bituminous.		Bituminous.
Water	1·00	..	1·00	..	1·00
Volatile matter..............	5·00	..	18·00	..	40·00
Fixed Carbon	88·50	..	75·50	..	53·50
Sulphur	0·50	..	0·50	..	0·50
Ash	5·00	..	5·00	..	5·00
	100·00		100·00		100·00

COAL ANALYSES.

	Carbon	Hydrogen.	Oxygen and Nitrogen.	Sulphur.	Ash.	Water.
English coal (average)	81·979	5·156	7·946	1·295	3·387	—
South Wales	86·63	4·33	2·46	0·99	4·70	0·89
Aberdare (average)....	88·0	8·5		0·80	2·70	—
Aberaman steam coal ..	86·29	10·37		0·90	2·44	—
Carmarthen (Anthracite) (Rockcastle)	93·10	3·10	{ 0·86 } { 1·59 }	0·56	0·79	—

PETROLEUM.

The following table shows some of the characteristic properties of the petroleum and shale oils sold in this country :—

Name of Oil.	Colour.	Specific gravity at 60° F.	Flashing Point. F.	Wholesale Price, per gallon.
				d.
American Royal Daylight ...	Light Straw	0·815	83°	4
,, Ordinary	,,	0·791	75°	3¾
,, Water White ...	Colourless	0·780	105°	5
,, Tea Rose	Light Straw.	0·797	83°	4
Russian Ordinary (Russoline)...	,,	0·824	82°	3½
Russian Lustre	,,	0·825	130°	4
Broxburne Lighthouse... ...	,,	0·810	160°	5
American Mineral Sperm ...	Straw	0·833	270°	—
Storrar's Scotch Gas Oil ...	Reddish Brown	0·843	110°	2
Scotch Intermediate Shale Oil	Clear Brown	0·846	—	2¼
Light Lubricating Oil	,,	0·853	225°	2

The Law of Economy.

By this law we are enabled to say whether there will be an economical advantage in altering or extending a given plant.

In symbols this law may be thus written :—

Let £ be the cost of a plant.

Let l be the annual cost of working it.

Let Δ £ be the cost of an addition to the plant, the annual interest on which at n per cent. is $\dfrac{\Delta \pounds n}{100}$.

Let l' be the annual cost of working the plant after the addition is made,—

Then the most economical design is that in which—

$$(l - l') = \frac{\Delta \pounds n}{100}.$$

PETROLEUM AND COAL.

	Specific Gravity.	Chemical Composition.						British Heating Powr. Thermal Units.	Theoretical Evaporation.		Evaporation in lbs. from and at 212° F. by Experiment.
		Carbon.	Hydrogen.	Nitrogen.	Sulphur.	Oxygen.	Ash.		Lbs. from and at 212° F.	Lbs. air requir'd per lb. 23%0.	
PETROLEUM—		%	%	%	%	%	%				
Pennsylvanian heavy crude ...	0·886	84·9	13·7	—	—	1·4	—	20,736	21·48	11·56	16
Caucasian light crude	0·884	86·3	13·6	—	—	0·1	—	22,027	22·79	14·74	16
Caucasian heavy crude	0·938	86·6	12·3	—	—	1·1	—	20,138	20·85	14·28	16
Refuse	0·928	87·1	11·7	—	—	1·2	—	19,832	20·53	14·12	16
Crude average, 15 samples	0·870	84·7	13·1	—	—	2·2	—	20,233	20·94	14·29	16
Refined average ...	0·760	72·6	27·4	—	—	—	—	27,531	28·5	17·03	16
Scotch blast furnace oil	0·920	83·6	10·6	—	—	0·1	9·4	18,590	19·2	—	14
COAL—											
Welsh, 37 samples...	1·315	83·8	4·8	1·0	1·4	4·1	4·9	14,470	14·98	—	9·05
Newcastle, 18 samples	1·256	82·1	5·3	1·3	1·2	5·7	3·8	14,432	14·94	—	8·01
Derbyshire & Yorkshire, 7 samples...	1·292	79·7	4·9	1·4	1·0	10·3	2·6	13,582	14·06	—	7·58
Lancashire, 28 samples	1·273	77·9	5·3	1·3	1·4	9·5	4·9	13,552	14·03	—	7·94
Scotch, 8 samples ...	1·260	78·5	5·6	1·0	1·1	9·7	4·0	13,804	14·29	—	7·70
Average British, 98 samples	1·279	80·4	5·2	1·2	1·25	7·87	4·0	13,968	14·46	11·34	8·13

The Flash-point of various Hydrocarbons.

The following table gives the temperature at which various Hydrocarbons give off inflammable vapour:—

Open Test.		Flash Point.		Fire Point.
Brandy, as usually sold retail	.. ..	69	..	92
Whisky ,, ,,	.. ..	72	..	96
Gin ,, ,,	.. ..	72	..	101
Petroleum (ordinary American Lamp Oil)	..	73	..	104
Saxoline	.. ..	110	..	150
Ordinary High-test Petroleum	..	110–120		140–160
Crystal Oil ..	.. ..	150	..	180
Downer's Oil ..	.. ..	270	..	310
Mineral Sperm	.. ..	310	..	330

This shows that potable spirits are really more liable to ignition than petroleum, a fact corroborated by the experience of Insurance Companies.

Naphtha vapour, benzoline vapour, petroleum vapour, and alcoholic vapour, by themselves, are so far as an explosive is concerned perfectly harmless.

In order to produce an explosion, there must be a mixture of the spirit or petroleum vapour and air, and it is the proportion in which the latter is present that determines the intensity of the explosion.

Hydrometers.

The hydrometers chiefly used in this country are Twaddell's and Beaumé's. Following are rules for reducing them to specific gravity:—

BEAUMÉ.

For liquids lighter than water. Rule: $\dfrac{144}{\text{B.} + 134} = \text{sp. gr.}$

Thus $\dfrac{144}{20° \text{ B.} + 134} = 0 \cdot 935$ sp. gr. And $\dfrac{144}{\text{sp. gr.}} - 134 = \text{B.}$

Thus $\dfrac{144}{0 \cdot 935 \text{ sp. gr.}} = 154 - 134 = 20°$ B.

For liquids heavier than water. Rule: $\dfrac{144}{144 - \text{B.}} = \text{sp. gr.}$

Thus $\dfrac{144}{144 - 10° \text{ B.}} = 1 \cdot 074$ sp. gr. And $144 - \dfrac{144}{\text{sp. gr.}} = \text{B.}$

Thus $144 - \dfrac{144}{1 \cdot 074} = 10°$ B.

TWADDELL.

Tw. to sp. gr.: multiply by 5 and add $1 \cdot 000$. Thus $80°$ Tw. × 5 = $0 \cdot 400 + 1 \cdot 000 = 1 \cdot 400$ sp. gr.

Sp. gr. to Tw.: deduct $1 \cdot 000$ and divide by 5. Thus $1 \cdot 400$ sp. gr. − $1 \cdot 000 = 400 \div 5 = 80°$ Tw.

Liquid Fuel Burners.

These are mainly of two distinct types, gasifiers and sprayers. In the former the fuel, usually a heavy liquid hydrocarbon, flows into a chamber called a vaporiser, upon which impinges a flame. The liquid is converted into a vapour or gas which burns in the free presence of air with a yellow flame, or it can be mixed with air as in a Bunsen burner, when a blue flame is produced. The latter system is the better, but difficulties are experienced in preventing the deposition of carbon in the small orifices through which the vapour passes. The former system is that generally adopted for moto-vehicles and small vessels. This type of burner is usually regenerative, that is the vaporisation is effected by the flame produced. The *following* are examples of this type.

Fig. 1 illustrates the Longuemarre burner as employed by M. Serpollet in his oil fuel boilers. In it ordinary kerosine is supplied under pressure at *A* to the coil *B*, and after circulating through it passes away as oil gas at *C*, down the pipe *D* into the central chamber of the burner, which is closed by means of a valve on the end of a rod *E*, actuated by some form of lever *F*. From the central chamber the gas can, when the valve *E* is opened, pass to the burners *G G G*.
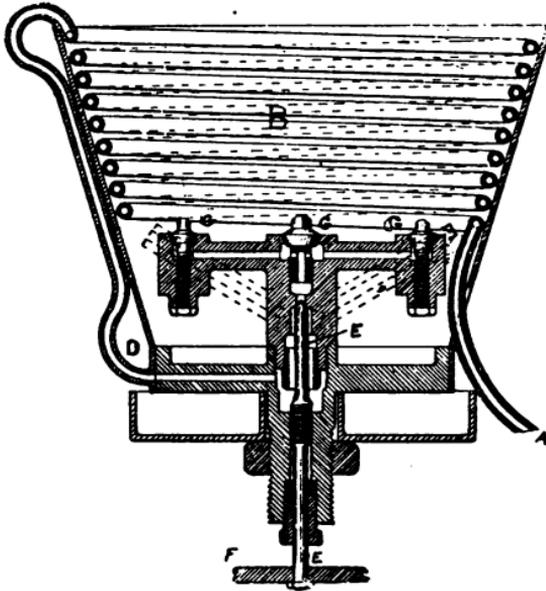
FIG. 1.

It also passes to two burners at the ends of arms at right-angles to the arms carrying the burners *G*, and shown by dotted lines, but as it enters these from the lower chamber below the valve, these burners are not extinguished when the three first mentioned are: thus, when it becomes necessary to stop the engine, one half of the heating power of the burner is shut off, and the other half remains to keep the boiler warm and to act as pilot lights for the other burners when full steam is again required; the lever *F* moves the valve *E*.

Figs. 2 and 3 are a plan and section of the "Lifu" burner, manufactured by the Liquid Fuel Engineering Co., of Cowes.
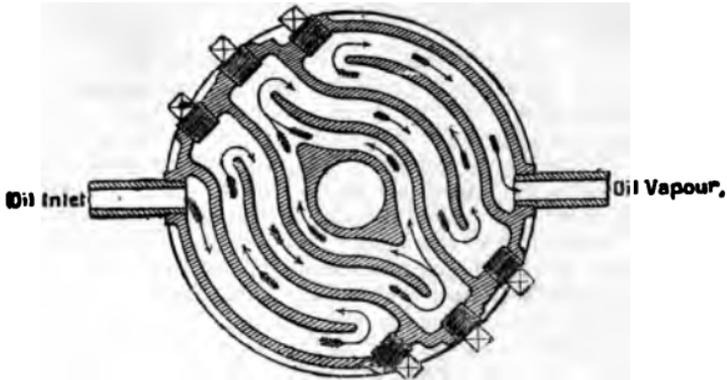
FIG. 2.
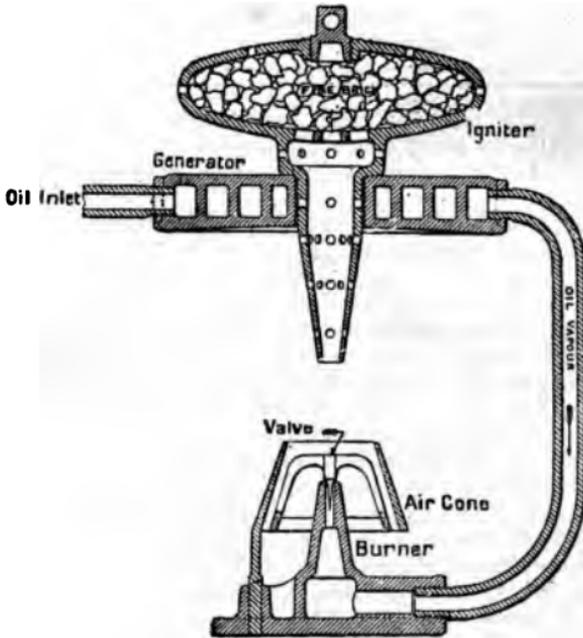
FIG. 3.

This burner consists of two parts, an upper chamber, having various passages, forming the generator, and the burner proper. The principle is clearly shown in the above drawings, in which Fig. 2 is the generator or vaporiser, and Fig. 3 the burner. The oil enters the upper chamber and, after traversing the passages, descends to the burner; in order

to vaporise it, the oil is turned on from the tank, and a temporary flame applied to the generator ; the oil becomes heated and vaporised, and, in the condition of a hot vapour, passes to the burner, lifting the needle valve; on ignition a large and compact volume of flame is produced which keeps the generator hot, and also maintains in a red-hot state a chamber, called an igniter, filled with firebrick ; this chamber, by means of a central stalk, fits into a central hole in the generator. The object of the igniter is to act as a reservoir of heat in case the burner flame is temporarily extinguished from any cause.

In connection with the oil supply pipe a diaphragm valve is fitted; the diaphragm is acted upon by the steam pressure, and actuates a spindle which controls the supply of fuel to the generator. Should the pressure of steam fall or be too low the supply valve is opened full, and on an excess of steam pressure it is closed, or partially so. The valve can be set to work within any stated limits, the oil supply, and consequently the volume of flame and quantity of steam produced, being entirely automatic.

Local Authority.

Local authority is not defined in the Locomotives on Highways Act, but the following is the definition given in the Public Health Act, 1875 :—

By Sect. 4 of that Act "local authority" means "urban sanitary authority" and "rural sanitary authority." By Sect. 6 urban sanitary authorities are either corporations of boroughs, local boards, or improvement commissioners. Under the Local Government Act, 1894, Sect. 21, all urban sanitary authorities, other than corporations or councils of boroughs, are to be called urban district councils, and for every rural sanitary district there is to be a rural district council, to whom, by Sect. 25, all the powers, duties and liabilities of rural sanitary authorities are transferred. "Local authority," therefore, in England, outside the metropolis, must be taken to mean either— (1) The corporation or council of a borough or county borough, or (2) The urban district council of an urban district, or (3) The rural district council of a rural district.

In London, having regard to the definition of "sanitary authority" contained in the Public Health (Metropolis) Act, 1891, "local authority" probably means—(1) In the City, the Commissioners of Sewers.   (2) The Vestries.   (3) The District Boards.   (4) The Local Board of Woolwich. It is doubtful if it includes the London County Council, which has no direct control over the streets of the metropolis except the Thames Embankment.   In Ireland "local authority" means the urban sanitary authority or the grand jury. In Scotland "local authority" probably means the road authority of any county or burgh, and the commissioners of police burghs.

(The Law of Motor Cars, LEWIS & PORTER.)

The Dürr Burner

Consists of two burners and one vaporising chamber—one burner being used to heat the latter and so vaporise the oil, while the other acts as the burner proper, *i.e.*, it performs the function for which the apparatus is intended. These burners are placed the latter in front of the former, and both are enclosed in chamber *h*, as shown in Fig. 4.
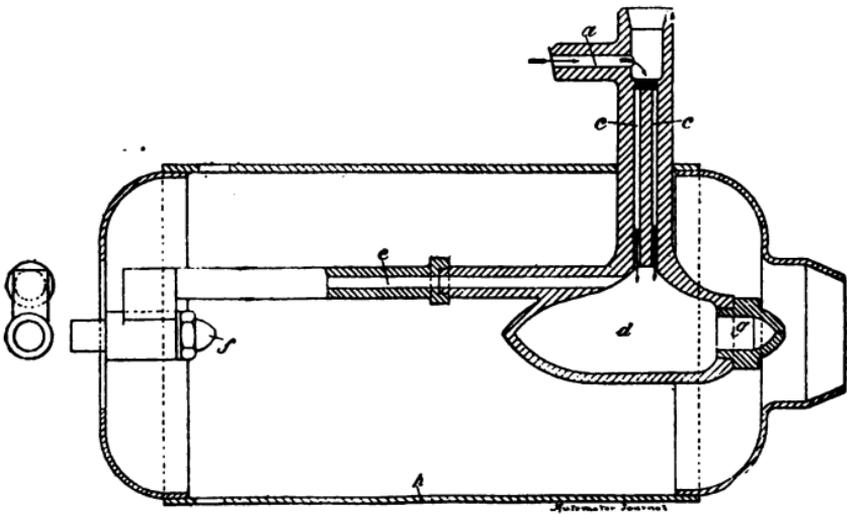
FIG. 4.

The vaporiser consists of a chamber *d*, having two pipes, *a* and *e*, at right-angles to each other, the whole forming one casting. The upper one of these pipes, *a*, is connected with the source of supply, the admission of the liquid fuel being regulated by a valve *c*. The other pipe, *e*, supplies vapour to the heating burner *f*. This burner, after a preliminary heating of *d*, keeps the latter hot so as to vaporise the oil flowing into it. Part of the vapour thus formed goes to *f*, and the greater part to the main burner, *g*. There are thus two burners, which produce a compact body of flame.

Sargeant's Burner.

This burner consists of a vaporising chamber *A*, Fig. 5, of cast-iron, and formed with numerous passages in which the oil from the source of

supply, a, circulates, and in so doing becomes vaporised, the vapour passing down the pipe a^1 into the passage b.
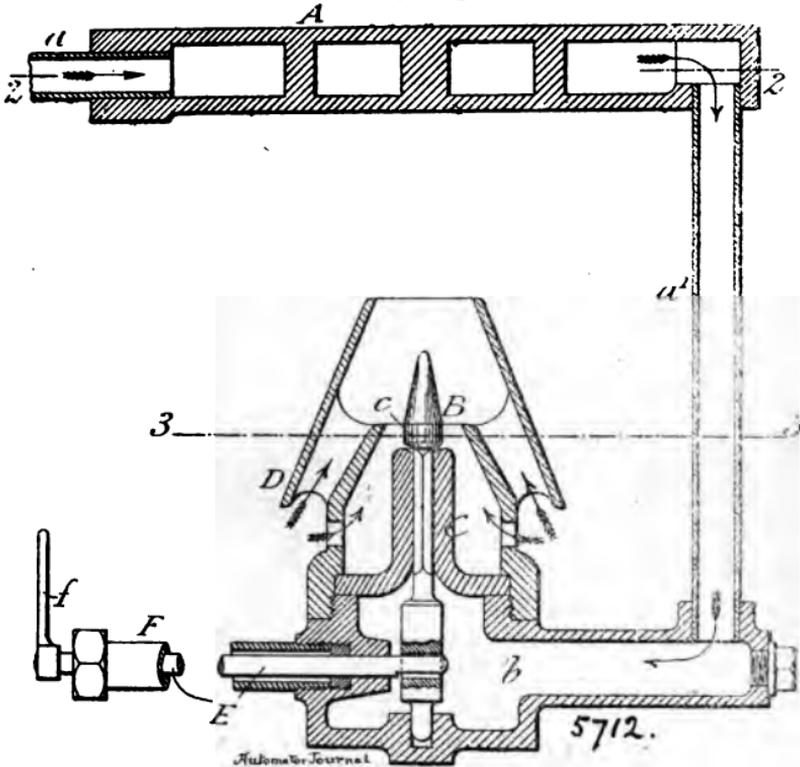
FIG. 5.

The burner comprises a central tube C, through which passes the squared or longitudinally grooved stem of a valve c, and the tube C is surrounded by a shield D, having inlet for air entering as indicated by the arrows. In the lower part of the valve stem there is a slotted hole, in which is engaged the eccentric end of a spindle E, which extends along a tube F, and through a stuffing box, and terminates in a handle f, by which it can be turned.

The vapour ascending from the space b, up the tube C, issues between the valve c and its seating, and, being ignited while it mixes with the air, forms a flame which heats the vaporiser A, and, passing upwards around it, serves to heat a boiler situated above the vaporiser.

By turning the handle f, the valve c can be raised or lowered ittle, so as to increase or diminish the flame as may be required.

Sprayers are subdivided into two kinds—flat and jet sprayers. In these air or steam pulverises the oil into a fine spray, which renders the combustion very easy; and this is still more so when steam is employed, as the oil particles are projected in a heated state, and more readily combine with the oxygen. The disadvantage of using steam is, however, the amount required, which is variously estimated at 5 to 13 per cent. of the total quantity produced. This is an objection of great weight in situations such as for sea and river services, where fresh water is, or may be, an expensive item. Sprayers also involve the use of larger feed pumps.

Of flat jet sprayers, Tweddle's, Figs. 6, 7, and 8, is much used in Great Britain and on board oil-fired steamers. It is simple and inexpensive, and easily cleaned.

TWEDDLE.

FIG. 6.

FIG. 7.
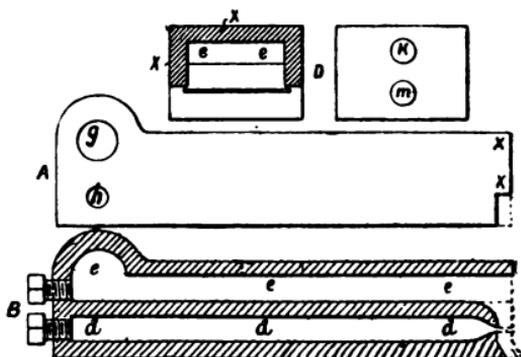
FIG. 8.

Figs. 6, 7, show perspective views of the burner, and Fig. 8 sectional elevations. At *g* it is tapped for a 1¼" oil pipe, and at *h* for a ¼" steam pipe. *e e e* is the oil passage; *d d d* the steam passage, and these are each 3" × ¼". The oil coming through the passage *e e e* falls directly on the steam shooting through the narrow slit at the end of the passage *d d d* and is completely pulverised, passing into the furnace as a fine spray. The holes *k* and *m* at the back of the burner are closed with plugs. By unscrewing these the burner can be quickly cleaned without removing; this, however, is rarely found necessary, the burner as a rule keeping perfectly clean for an indefinite period.—("ENGINEERING.")
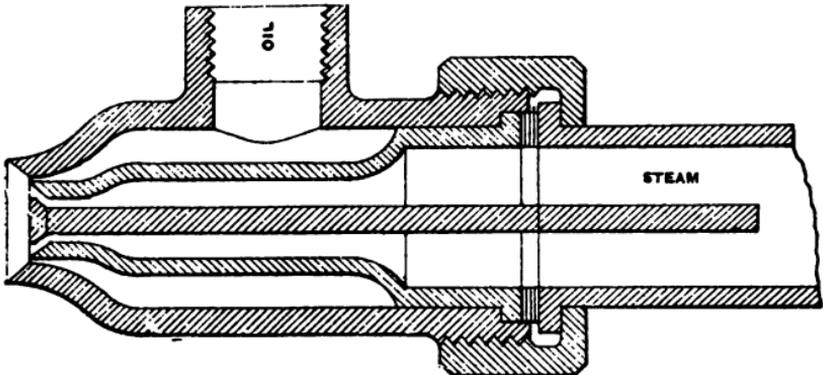
FIG. 9.—KORTING.
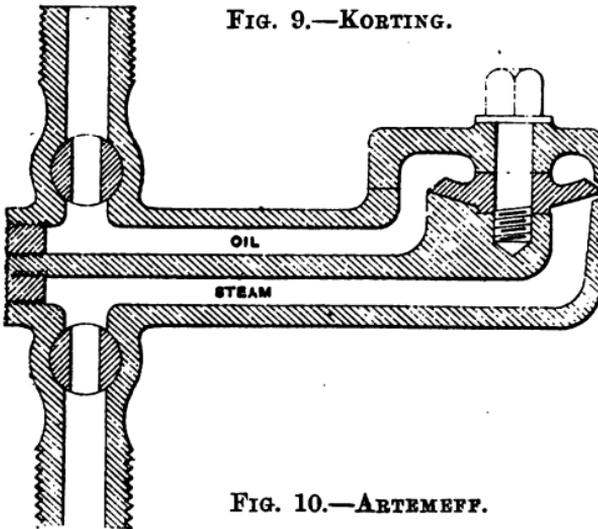
FIG. 10.—ARTEMEFF.

Other examples of gasifiers are a Korting (Fig. 9) and an Artemeff (Fig. 10), both these kinds being extensively employed in the steam vessels on the Caspian and Black Seas.

Of jet sprayers the following are the better known :—
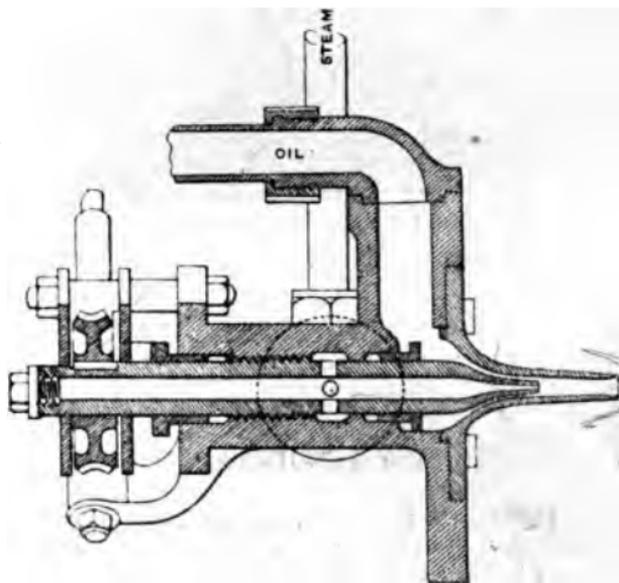
FIG. 11.—URQUHART.
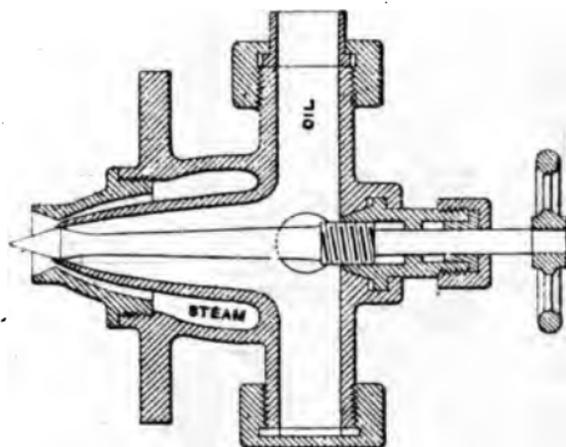
FIG. 12.—D'ALLEST.
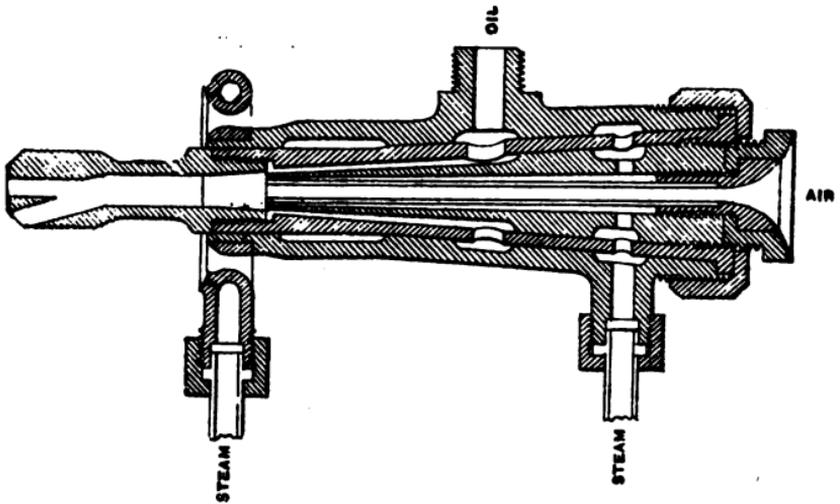
FIG. 13.—HOLDEN.

Of these, Urquhart's is used very extensively on the Russian railways; D'Allest's is used on some French torpedo boats; while Holden's is used on the Great Eastern Railway.

A burner which has given very excellent results, and which is simple to make and fit, is that of Rusden & Eeles (*see* Fig. 14).
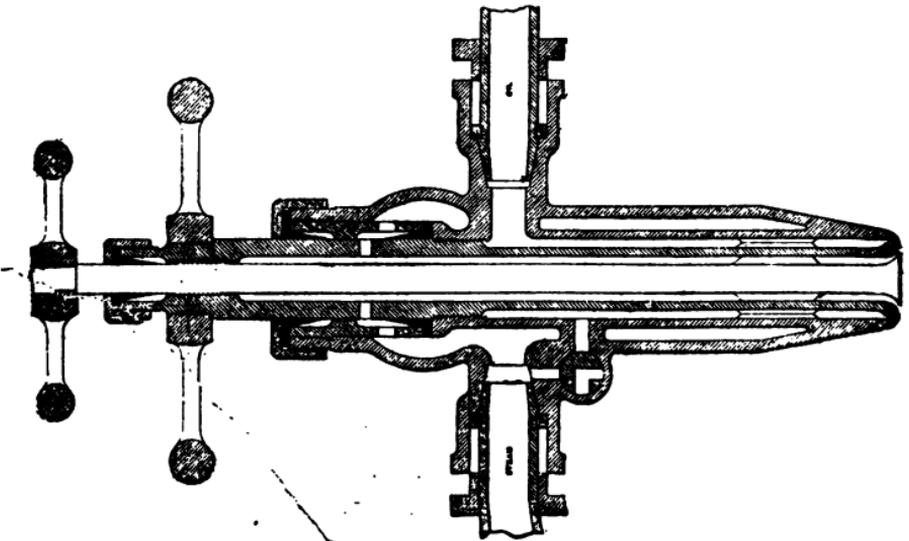
FIG. 14.—RUSDEN & EELES.

Advantages of Liquid Fuel.

1. The combustion of liquid fuel is complete, whereas that of coal is not, consequently in the former case there is no lost heat in smoke or soot.

2. There are no ashes or clinkers, and consequently no fires to clean, with the accompanying loss of heat and drop in the steam pressure—the steam pressure and revolutions of the engines being maintained at one point throughout.

3. The boiler tubes are always free from soot, and are clean; therefore always in the best condition for transmitting the heat from gases passing through them to the water of the boiler.

4. The temperature of the escaping gases may be considerably lower than is required to create the necessary draught for coal firing. With coal the air has to be drawn through the bars and the fire in the furnaces; by natural draught this requires a temperature of the escaping gases about 600° to 700° F. But in the case of liquid fuel there are no bars or thick fire for the air to force its way through, and the required amount of air can be drawn through the furnaces by a much lower uptake temperature—about 400° to 450° F. being in most cases sufficient.

5. The admission of air to the furnace being under complete control, and the fuel being burnt in fine particles in close contact with the oxygen of the air, only a very small excess of air above that actually necessary for the complete combustion of the fuel is required. With coal, in order to ensure as complete combustion as possible, a very much larger excess of air is required.

In addition to its higher calorific value, liquid fuel has many other advantages, especially on board ship.

Stowage.--A ton of coal will occupy about 45 cubic feet of bunker space, and a ton of oil will require about 40 to 45 cubic feet. Assuming that both coal and oil will require the same bunker space per ton, then, since one ton of oil fuel is equal to two tons of coal, the bunker space necessary to steam the same distance at the same speed is only one-half. In addition to this, there is no lost space caused by the projection of frames, stringers, or beams. Also, portions of the ship which, if used as coal bunkers would be inaccessible, can be utilised for the stowage of oil.

Test of Boiler using Astatki (Petroleum Refuse) Fuel, fitted with a Rusden & Eeles Burner.

The boiler, which was of the ordinary marine type, evaporated with coal fuel from 7 to 8 lbs. of water from and at 212° F. for each pound of coal burnt, the uptake temperature being about 650° F. With Russian Astatki, the evaporation was from 13 to 16 lbs. from

I 2

and at 212° F. per lb. of oil. The following are the average data from some experiments with a Rusden & Eeles sprayer, and a heat account from the same data :—

Kind of Liquid Fuel.	*Russian Astatki.*
Specific gravity	0 ·9

Chemical analysis (approximate) :—

Carbon	87 per cent.
Hydrogen	12 ,,
Oxygen	1 ,.
Temperature of stokehold	60° F.
,, escaping gases	450° F.
Weight of steam required to spray 1 lb. of oil..	0 ·3 lb.

Assuming that the air contained 23 per cent. of oxygen, and that the excess of air over that required for complete combustion passing into the furnace was 20 per cent., which would be about correct because the slightest reduction of air caused smoke to issue from the chimney.

		Heat Units.	Equivalent Evaporation from and at 212° F.
Total heat from combustion of 1 lb. of oil—			
Carbon 0·87 × 14,500 ... ... =		12,615	
Hydrogen 0·12 × 62,032 ... ... =		7,444	
		—— 20,059	20 ·7
Heat lost in waste gases at 450° F.—			
Carbonic acid gas	3 ·19 lbs.	269	
Nitrogen	10 ·72 ,,	909	
Water vapour from combustion ...	1 ·08 ,,	1,452	
,, ,, sprayer ...	0 ·30 ,,	29	
Surplus air, 20 per cent.	2 ·78 ,,	257	
		—— 2,916	3 ·0
		17,143	17 ·7
Heat lost in radiant heat, &c.		1,687	1 ·7
Heat absorbed by water in boiler		15,456	16

(WALLIS.)

Benzene.

Benzene gas is nearly three times as heavy as air. One cubic foot of benzene gas weighs 0·2181 lb. ; while 1 lb. of gas occupies at ordinary temperature and pressure 4·58 cubic feet. The corresponding *figures for air being 0·08 lb.* and 12·39 cubic feet respectively.

Precautions to be taken in using Liquid Fuel in Furnaces.

In lighting up from " all cold," it is as well to open the fire door and damper so as to create a draught, and thereby drive away any possible explosive mixture of air and oil gas which might be present through leaks in the oil valves. If possible, blow through with the steam jet from an adjacent boiler, then introduce the lighted torch, and *then* (*not before*) turn on the oil supply. If relighting a " hot " furnace, *i.e.*, that in which the oil has been shut off for a time, as, say, during a meal hour, blow through thoroughly with steam first as a precaution, and proceed as before. The great danger to be guarded against is the formation of an explosive mixture in a very confined space. As a general rule, the lighted torch should be affixed to a bent rod, so that the attendant can stand away from the fire door. Remember, that a *flame must never be brought to the oil*, *but the oil must always be brought to the flame*, *i.e.*, in oil fuel furnaces, there must first be a flame in the furnace, then the oil can be turned on.

Petroleum.—In carrying petroleum or its products on motor vehicles, never allow the containing vessel to be quite full, as petroleum sensibly expands when heated, and unless provision is made for this, the tank might be ruptured.

Melting Point of Metals, &c.

Names.			Fahr.	Names.			Fahr.
Platina	..	..	4590°	Wrought iron	..	..	2900°
Antimony	..	..	842	Steel	..	..	2500
Bismuth	..	..	487	Copper	..	..	2000
Tin	..	..	475	Glass	..	..	2377
Lead	..	..	620	Beeswax	..	..	151
Zinc	..	..	700	Sulphur	..	..	239
Cast iron	..	..	2100	Tallow	..	..	92

STEAM.

The intensity of heat is measured by a thermometer.

The quantity of heat is measured in thermal units, the British thermal unit being the amount of heat required to raise 1 pound of water through 1 degree F., when the water is at its greatest density, viz., 39·1 F. This amount of heat = 772 ft. lbs.

Specific Heat is the power a body or substance possesses for absorbing heat. It is the amount of heat in British thermal units required to raise the temperature through 1 degree F.

SPECIFIC HEAT.

Water at 39° F. ..	1·00	Iron ..	..	..	·11
„ „ 212° F. ..	1·013	Copper	..	..	·09
Ice at 32° F. ..	·504	Coal ..	..	..	·24
Mercury	·03	Air ..	..	..	·23

Specific Density is the number of pounds in a cubic foot.

Dryness Fraction is the ratio $\dfrac{\text{Weight of dry steam}}{\text{Weight of water particles}}$ in a given volume. If 1 lb. of wet steam has a weight of w dry steam in it, then $(1 - w)$ is the weight of the water particles, and dryness fraction $= \dfrac{w}{(1 - w)}$.

Total Heat of Evaporation is the quantity of heat required to raise 1 pound of water from 32° F. to a given temperature and then evaporate it.

Latent Heat is the quantity of heat units absorbed or given out in changing one pound of a substance from one state to another without altering its temperature. The latent heat of water is that quantity of heat required to melt 1 pound of ice = 144 units.

LATENT HEAT OF STEAM.

Let T be the temperature of the steam.

L the latent heat.

$$L = 966 - \left\{ (T - 212°)\ 0·7 \right\}$$

TOTAL HEAT OF STEAM.

Let T be the temperature of the steam.

H the total heat.

$$H = 1082 + 0·305\ T.$$

The **Saturation Point** is attained when all the latent heat required for the steam has been taken up.

The **Boiling Point** occurs when the tension of the water overcomes the surrounding pressure.

Dry Saturated Steam is that which has a specific volume, pressure and temperature corresponding to its complete formation.

Wet Saturated Steam is that in process of formation, and in contact with water.

Superheated Steam is that which has its temperature raised above formation point.

Specific Volume is the number of cubic feet to the pound weight. From recent experiments, it would seem that superheating results in an economy of from 10 to 20 per cent. in the weight of steam required per I.H.P.-hour, and from 16 to 20 per cent. in weight of coal consumed.

Properties of Saturated Steam.

Absolute Pressure in lbs.	Pressure above Atmosphere in lbs.	Temp. or Boiling Point in degs. F.	Total Heat in units required to generate 1 lb. of Steam from Water at 32° F. under constant pressure.	Volume: cubic feet per lb.	Weight of 1 cubic foot of Steam in lbs.	Relative Volume or cubic feet of Steam from 1 cubic foot of Water.
1	..	102·0	1113·01	332·6	·0030	20760
2	..	126·4	1120·49	173·0	·0058	10728
4	..	153·1	1127·02	90·12	·0112	5625
5	..	162·3	1131·44	73·05	·0138	4559
8	..	183·0	1137·75	46·83	·0214	2923
10	..	193·3	1140·89	37·87	·0264	2363
12	..	202·0	1143·55	31·85	·0314	1988
14·7	..	212·0	1146·60	26·36	·0380	1644
15	0 3	213·1	1146·93	25·86	·0387	1614
18	3·3	222·5	1149·80	21·76	·0459	1360
20	5·3	228·0	1151·47	19·70	·0507	1231
22	7·3	233·3	1153·09	18·01	·0555	1125
25	10·3	240·5	1155·29	15·97	·0625	998
30	15·3	250·5	1158·34	13·46	·0743	841
35	20·3	259·4	1160·9	11·65	·0858	730
40	25·3	267·0	1163·3	10·28	·0974	640
45	30·3	274·5	1165·4	9·18	·1089	574
50	35·3	281·0	1167·64	8·31	·1202	522
55	40·3	287·1	..	7·46	·1314	477
60	45·3	292·6	1171·82	7·04	·1425	444

Properties of Saturated Steam—*continued*.

Absolute Pressure in lbs.	Pressure above Atmosphere in lbs.	Temp. or Boiling Point in degs. F.	Total Heat in units required to generate 1 lb. of Steam from Water at 32° F. under constant pressure.	Volume: cubic feet per lb.	Weight of 1 cubic foot of Steam in lbs.	Relative Volume or cubic feet of Steam from 1 cubic foot of Water.
65	50·3	298·0	..	6·54	·1538	407
70	55·3	302·8	1174·29	6·10	·1648	381
75	60·3	307·5	..	5·72	·1759	360
80	65·3	312·1	1177·13	5·39	·1869	337
85	70·3	316·1	..	5·08	·1980	322
90	75·3	320·3	1179·63	4·83	·2089	301
95	80·3	324·0	..	4·58	·2198	286
100	85·3	327·7	1181·88	4·37	·2307	273
105	90·3	331·2	1182·95	4·18	·2414	261
110	95·3	334·6	1183·99	4·00	·2521	250
115	100·3	337·9	118··0	3·83	·2628	239
120	105·3	341·1	1186·0	3·68	·2759	230
125	110·3	344·2	11·6·92	3·54	·2867	221
130	115·3	347·2	1187·85	3·42	·2977	213
135	120·3	350·1	1188·72	3·30	·3080	206
140	125·3	352·9	1189·57	3·18	·3184	199
145	130·3	355·6	1190·40	3·08	·3294	192
150	135·3	358·3	1191·22	2·98	·3397	186
155	140·3	361·0	..	..	·3500	180
160	145·3	363·4	1192·77	2·81	·3607	175
165	150·3	366·0	..	..	·3714	170·
170	155·3	368·3	1194·27	2·65	·3821	166
175	160·3	370·8	..	..	·3928	162
180	165·3	373·0	1195·70	2·51	·4035	157
185	170·3	375·3	..	..	·4142	153
190	175·3	377·5	1197·07	2·39	·4250	149
195	180·3	379·6	..	..	·4357	145
200	185·3	381·8	11·8·39	2·28	·4464	142
210	195·3	385·8	1199·60	2·18	·4668	136

What is a Light Locomotive?

Any vehicle propelled by mechanical power, and weighing under three tons unladen, and which is not used for the purpose of drawing more than one vehicle.

Moto-cycles are light locomotives.

Any vehicle drawn by a light locomotive is also legally a light *locomotive.*

A light locomotive is also a "carriage."

Mean Pressure of Steam in Cylinders (terminal pressure being 15 lbs. per square inch).

Degree of Expansion or Number of Times Steam is Expanded.	Hyperbolic Logarithms of the Degree of Expansion.	Points of Cut-off in Fractions of the Stroke, reckoned from the commencement.	Mean Pressure during the Stroke, the Initial Pressure being taken as=1	Absolute Pressure. Initial Pressure in lbs. per sq. in., suitable for given Degree of Expansion.	Mean Pressure in lbs. per sq. in.
6	1·7918	$\frac{1}{6}$	·4653	90	41·8
6¼	1·8326	$\frac{4}{25}$	·4532	93·75	42·4
6½	1·8718	$\frac{2}{13}$	·4418	97·5	43
6¾	1·9095	$\frac{4}{27}$	·4310	101·25	43·4
7	1·9459	$\frac{1}{7}$	·4208	105	44
7¼	1·9810	$\frac{4}{29}$	·4111	108·75	44·6
7½	2·0149	$\frac{2}{15}$	·4002	112·5	45
7¾	2·0477	$\frac{4}{31}$	·3932	116·25	45·6
8	2·0794	$\frac{1}{8}$	·3849	120	46
8¼	2·1102	$\frac{4}{33}$	·3779	122·75	46·3
8½	2·1401	$\frac{2}{17}$	·3694	127·5	47
8¾	2·1691	$\frac{4}{35}$	·3621	131·25	47·5
9	2·1972	$\frac{1}{9}$	·3552	135	47·9
9¼	2·2246	$\frac{4}{37}$	·3486	138·75	48·3
9½	2·2513	$\frac{2}{19}$	·3422	142·5	48·7
9¾	2·2773	$\frac{4}{39}$	·3361	146·25	49
10	2·3026	$\frac{1}{10}$	·3302	150	49·5
10¼	2·3279	$\frac{4}{41}$	·3246	153·75	49·8
10½	2·3513	$\frac{2}{21}$	·3191	157·5	50·2
10¾	2·3749	$\frac{4}{43}$	·3139	161·25	50·6
11	2·3979	$\frac{1}{11}$	·3089	165	50·9
11¼	2·4201	$\frac{4}{45}$	·3040	168·75	51·2
11½	2·4430	$\frac{2}{23}$	·2993	172·5	51·6
11¾	2·4636	$\frac{4}{47}$	·2947	176·25	51·9
12	2·4849	$\frac{1}{12}$	·2904	180	52·2
12¼	2·5052	$\frac{4}{49}$	·2861	183·75	52·3
12½	2·5262	$\frac{2}{25}$	·2821	187·5	52·8
12¾	2·5455	$\frac{4}{51}$	·2780	191·25	53
13	2·5649	$\frac{1}{13}$	·2742	195	53·4
13¼	2·5840	$\frac{4}{53}$	·2704	198·75	53·8
13½	2·6027	$\frac{2}{27}$	·2668	202·5	54
13¾	2·6211	$\frac{4}{55}$	·2633	206·25	54·2
14	2·6391	$\frac{1}{14}$	·2599	210	54·5
14¼	2·6567	$\frac{4}{57}$	·2566	213·75	54·8
14½	2·6740	$\frac{2}{29}$	·2533	217·5	55
14¾	2·6913	$\frac{4}{59}$	·2502	221·25	55·3
15	2·7081	$\frac{1}{15}$	·2472	225	55·6
15½	2·7408	$\frac{2}{31}$	·2412	232·5	56
16	2·7726	$\frac{1}{16}$	·2358	240	56·5

N.B.—These results are for steam expanding adiabatically. To apply them to ordinary unjacketed cylinders, multiply the pressures in last column by 0·92.

To find Quantity of Steam used by an Engine.

Multiply piston area by piston speed in inches per minute, and by numerator of fraction denoting cut-off, and divide the product by the product of 1,728, and by the denominator of fraction denoting cut-off. The quotient will be cubic feet per minute, which if multiplied by 60 will give cubic feet per hour.

To find Quantity of Water evaporated to Steam per hour.

Multiply piston area by piston speed in inches, and by the numerator of the fraction denoting cut-off and by 60; divide the product by the product of the vol. of steam (see p. 135), 1,728, and the denominator of fraction denoting cut-off.

Consumption in Steam Engines.

	lbs. Water per I.H.P.		lbs. Coal per I.H.P.
Non-condensing	..	30-45	.. ..	3·75-5·0
Condensing ..	..	22-30	.. ..	2·75-3·75
2-Stage Compound ..		14-22*	.. ..	1·75-2·75*
3-Stage Compound ..		11·5-15*	.. ..	1·25-1·75*

Evaporative Power and Efficiency of a Boiler.

The approximate evaporative power of a boiler may be found by this Rule :—

Let E = the theoretical evaporative power of the fuel.
w = the weight of coal burned on the grate in lbs. per hour.
H* = the heating surface in square feet.
W = the weight in lbs. of water evaporated per lb. of fuel.

$$W = 1·833 \left(\frac{H^*}{2 H^* + w} \right) E.$$

And the efficiency is

$$1·833 \left(\frac{H^*}{2 H^* + w} \right)$$

Surface Condensers.

H = Total heat of 1 lb. of exhaust steam in B. T. Units.
t = Temperature of hot well.
t' =   ,,   cooling water on entering.
t'' =   ,,   ,,   ,,   discharge.
W = Weight of water in lbs. required per lb. of steam.

$$W = \frac{H - t}{t - t'}$$

---

* Condensing.

To find the Mean Effective Pressure P^m on the Piston of a Cylinder.

Let P be the absolute initial pressure (*i.e.*, pressure shown by gauge + 14·7 lbs.), r the rate of expansion, and $\frac{1}{r}$ the cut off; then

$$P^m = \frac{P\ 1 + \log.\ \varepsilon\ r}{r}.$$

Example 1.—A pair of simple engines take steam through a reducing valve at 90 lbs. $r = 9$ and $\frac{1}{r} = \frac{1}{9}$. Absolute initial pressure P is 90 + 14·7 = 105 and $\frac{105}{9}$ = 11·7 lbs. final pressure.

$$\text{Log. } \varepsilon\ r = \quad 2\cdot197$$
$$1$$
$$9)\overline{3\cdot197}$$
$$\cdot3552$$
$$105$$
$$\overline{1\cdot7760}$$
$$35\cdot52$$
$$\therefore P^m = \overline{37\cdot2960}$$

N.B.—This is the mean pressure in each cylinder.

Steam Engine Design.

Let D = Diameter of cylinder in inches.
d = Any other required diameter in inches.
A = Area of piston in square inches.
L = Length of stroke in inches.
P = Standard steam pressure, taken as 100 lbs.
H.P. = The horse-power.
n = Revolutions per minute.
W = Weight in lbs.

Crank-shaft $d = 6 \sqrt[3]{\dfrac{\text{H.P.}}{n}}$

Piston rod $d = 0\cdot145 \sqrt{\text{D L}}$

Connecting rod, rectangular section, where d is the thickness and is one half the breadth, and L′ is the length—
$$d = 0\cdot05 \sqrt{\text{D L}'}$$

Piston face = 0·44 D.

Weight of flywheel : $W = 833^9 \cdot \dfrac{\text{H.P.}}{\text{D}^2\ \text{N}^3}$

Total weight of engine : W = 117 H.P.

BOILERS OR STEAM GENERATORS.

The Thornycroft Generator.

This is vertical, water-tubular and central fired. Heating surface, 65 square feet; grate area, 2½ square feet; steam pressure, 175 lbs. per square inch. Fuel is coke or coal. Fan is fitted for forcing the draught.
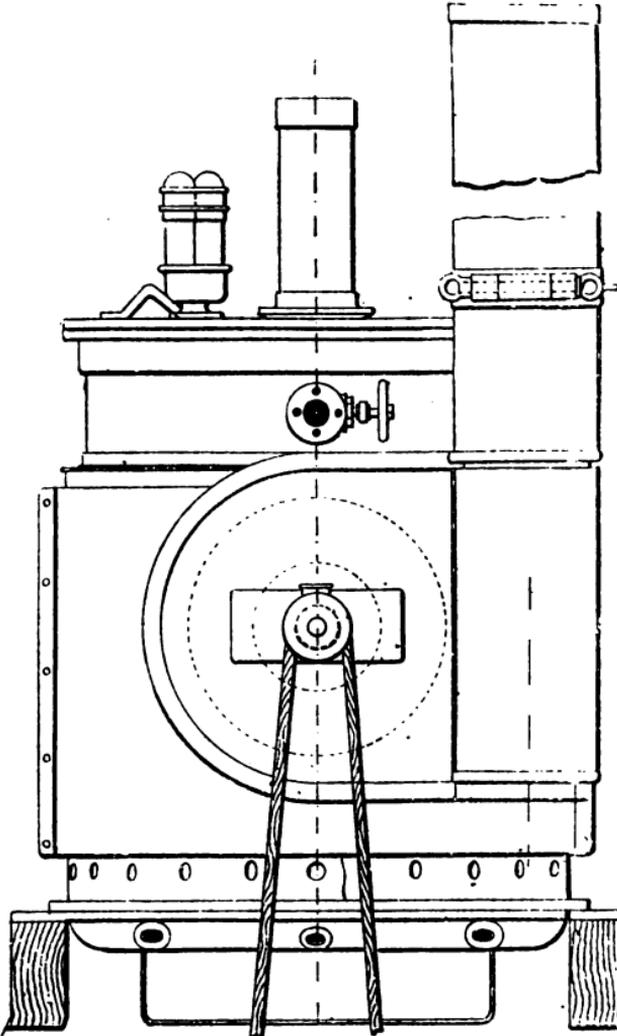
FIG. 15.—THORNYCROFT'S GENERATOR: ELEVATION.
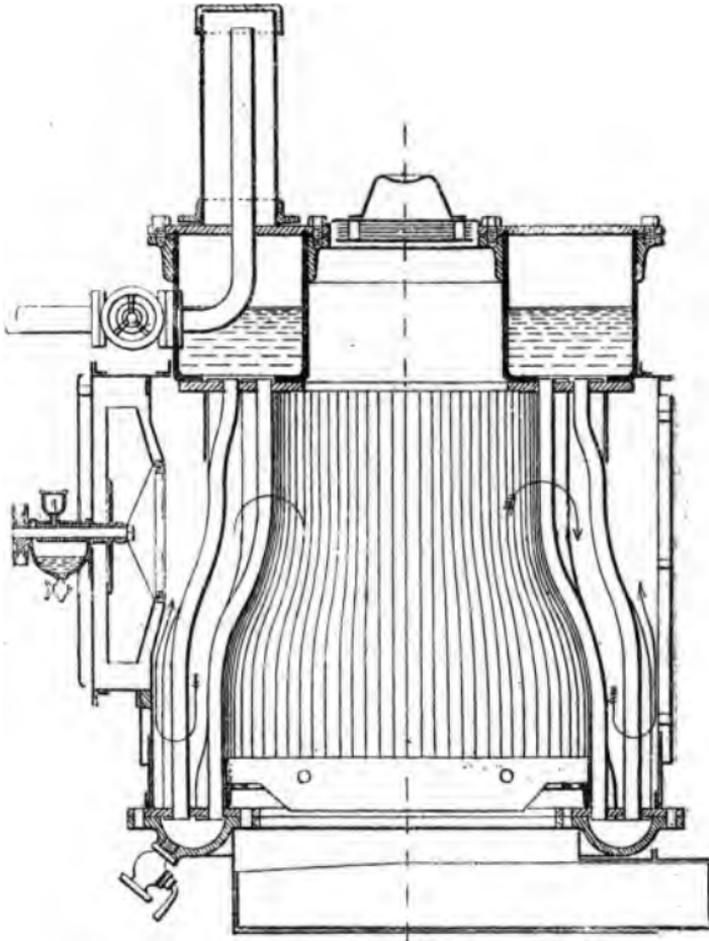
FIG. 16.—THORNYCROFT GENERATOR : SECTIONAL ELEVATION.

The "Lifu" Steam Generator.

This generator (*see* Fig. 17) consists of a lower horizontal circular drum and an upper vertical one, both connected by small copper pipes arranged spirally as shown. There is about 80 square feet of heating surface, and the working pressure is 280 lbs. per square inch. It is fired by liquid fuel (kerosine), the burner being shown on page 128.
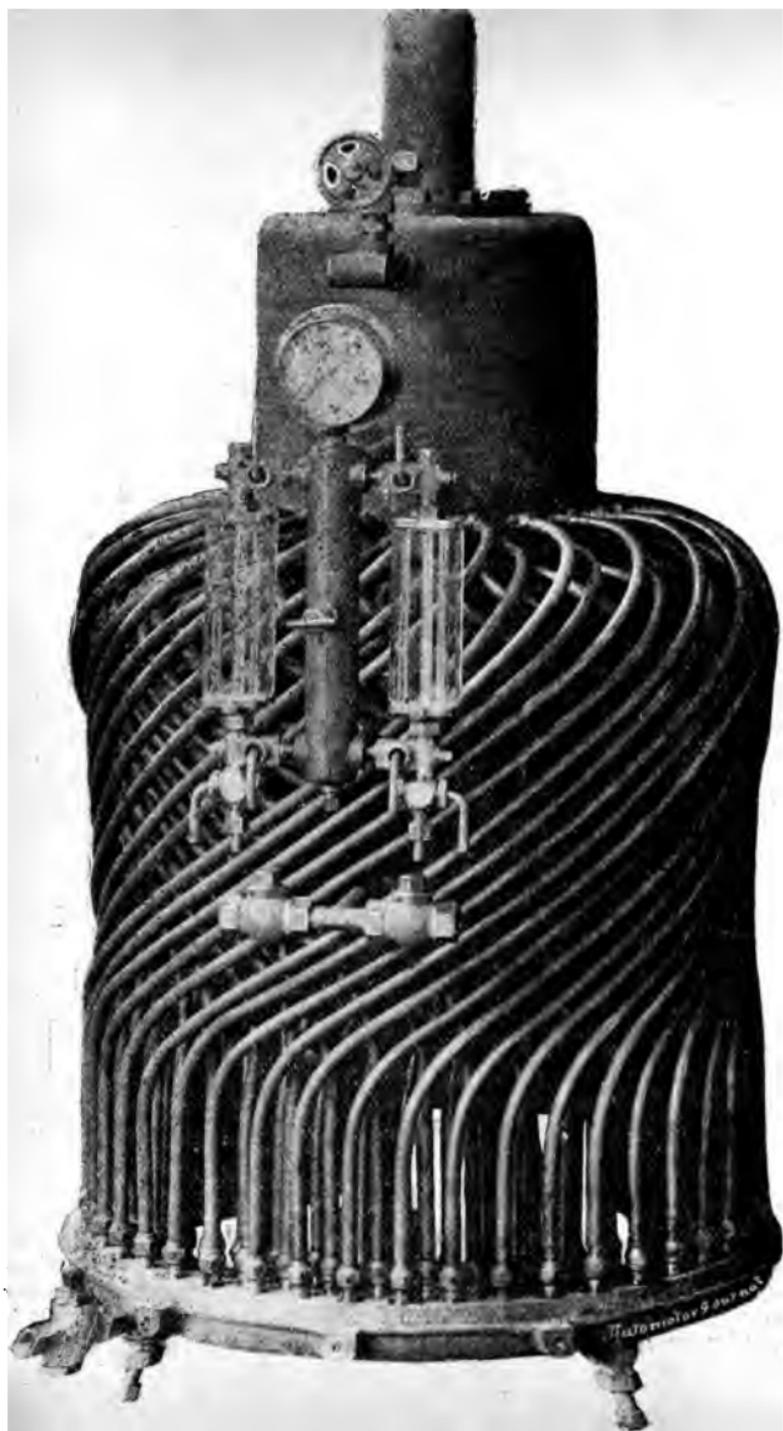
Fig. 17.— The "Loco" Steam Generator.
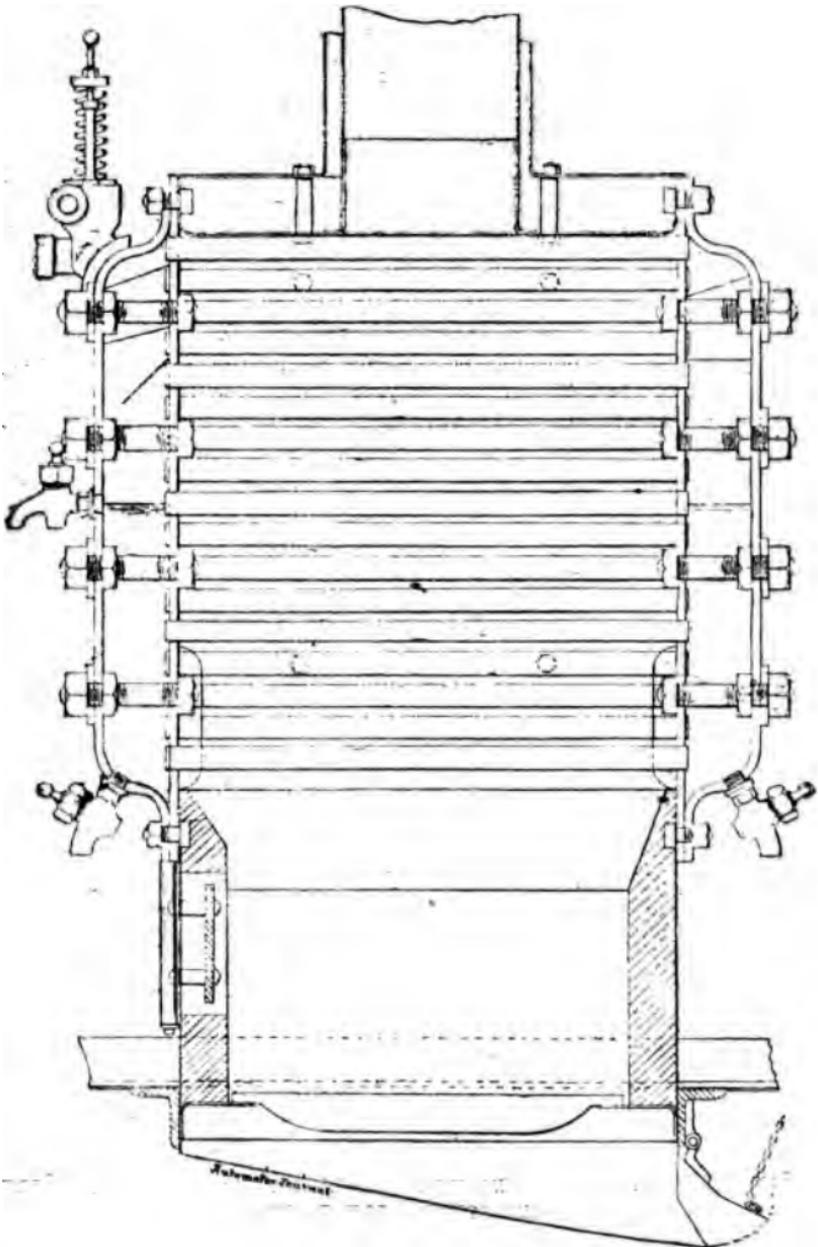
FIG. 18.—THE TOWARD GENERATOR: VERTICAL ELEVATION.

The Toward Generator.

This (*see* Fig. 18) is of the rectangular vertical type, and is constructed to Board of Trade requirements. It has 111 square feet of heating surface, and 2¼ square feet of grate area. The normal pressure of steam is 190 lbs., and the valves are set to blow at 200 lbs. per square inch. The weight of the generator with all mountings and fittings is about 1,000 lbs., and the weight of the contained water 120 lbs. The consumption of fuel (coke) is about 8 lbs. per mile. This generator is used with a motor developing about 25 I.H.P.

The Wiedknecht Generator.

This (*see* Figs. 19 and 20) is a vertical boiler fitted with cross tubes. It has a grate area of 3 square feet. There are 87 tubes 1·18 inches diameter external, the total heating surface being 64 square feet. The boiler will evaporate 572 lbs. of water per hour.

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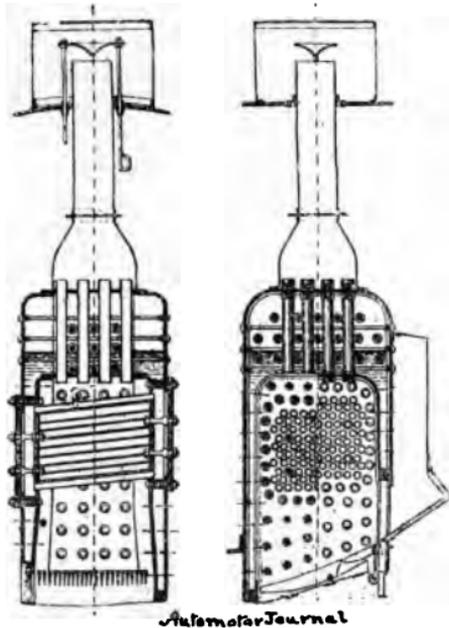
FIGS. 19 & 20.—THE WIEDKNECHT GENERATOR: FRONT AND SIDE SECTIONAL ELEVATIONS.

The De Dion and Bouton Steam Generator.

The accompanying illustration (*see* Fig. 21) represents the latest design of this generator, which is guaranteed to generate from 4·5 lbs. to 6 lbs. of dry steam per square foot of heating surface, and from 7 lbs. to 8 lbs. per pound of coal, using natural draught. From trials recently conducted by Messrs. Sautter, Harlé et Cie., it appears that this boiler, weighing 1,430 lbs. empty, with a heating surface of 64·5 square feet and a grate surface of less than 3 square feet, consumes 88 lbs. of coal per hour, and generates 550 lbs. of steam.
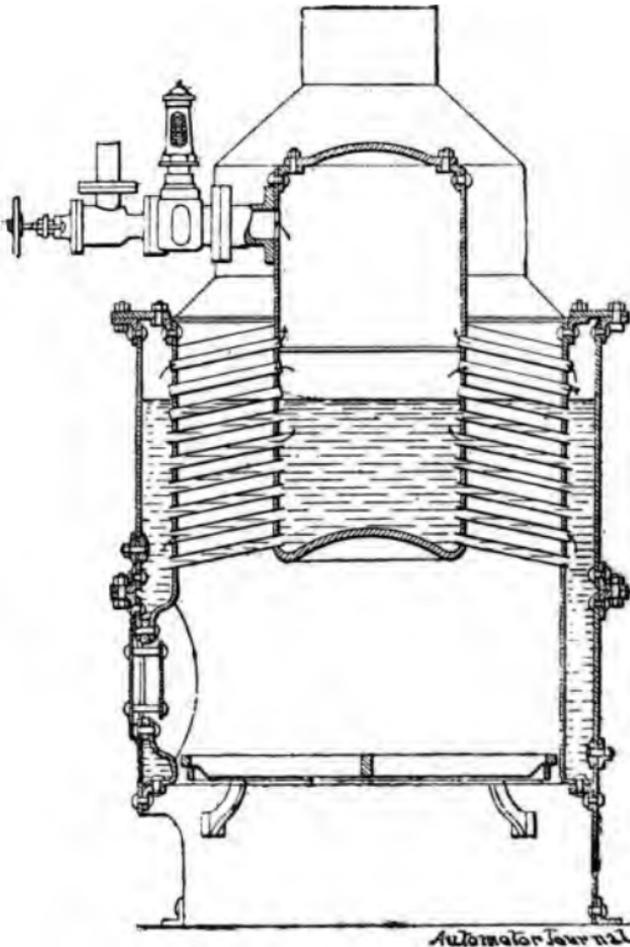
FIG. 21.—*ELEVATION OF THE* DE DION ET BOUTON GENERATOR.

K

The Serpollet Generator.

This consists of a chamber (*see* Figs. 22 and 23), having insulated sides, and having within it three separate groups of tubes—all, however, being in series. The water is fed into the lower tubes, which are of plain section, and heated by the petroleum burner; it then passes into the twisted tubes, where it is "flashed" into steam, which becomes superheated on passing into the upper group. A feature about this generator is the automatic feed pumps, by which the quantities of petroleum and water are regulated by the work to be done.
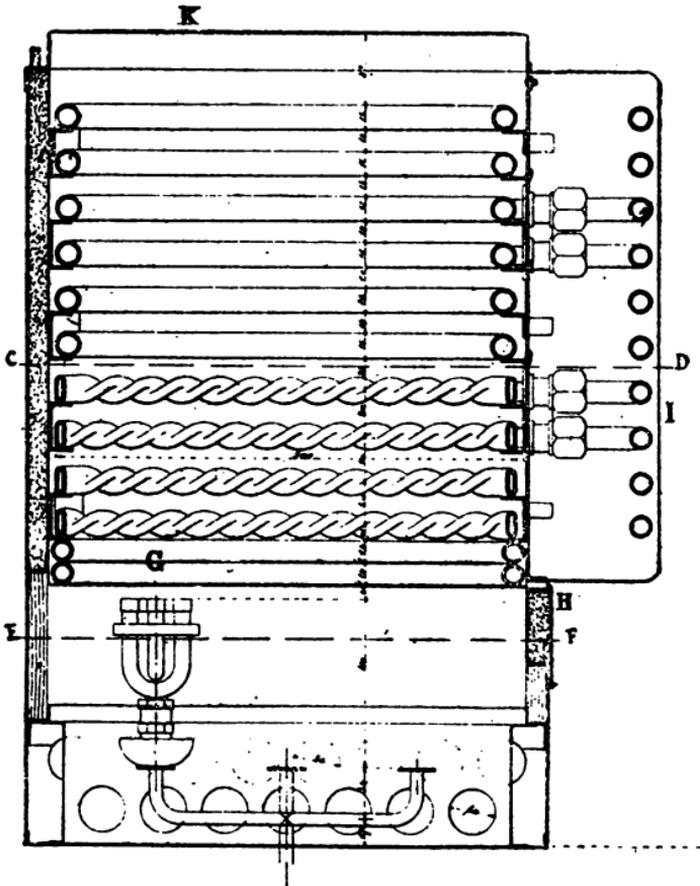
FIG. 22.—THE SERPOLLET GENERATOR: SECTIONAL ELEVATION.
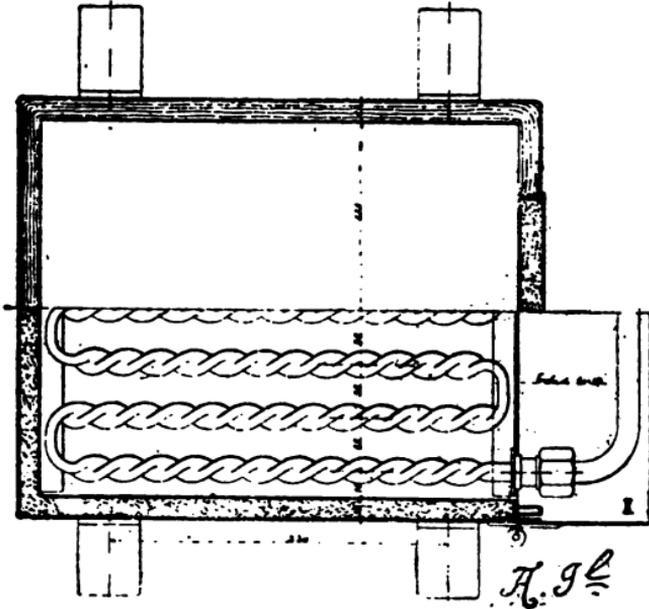
FIG. 23.—SERPOLLET GENERATOR : PLAN.

STEAM MOTORS.

THE WIEDKNECHT MOTOR.

This (*see* Fig. 24) is a horizontal high-pressure engine, having two cylinders each 4"·92 × 4"·92 stroke. They are fitted with a Solen's valve gear. At 350 revs. per minute the power developed is 19·7 h.p.

What is a Hackney Carriage?

A " Hackney Carriage " means any carriage standing or plying for hire, and includes any carriage let for hire by a coachmaker or other person whose trade or business it is to sell carriages or to let carriages for hire, provided that such carriage is not let for a period amounting to three months or more.

FIG. 24.—WIEDKNECHT MOTOR: SECTIONAL ELEVATION.
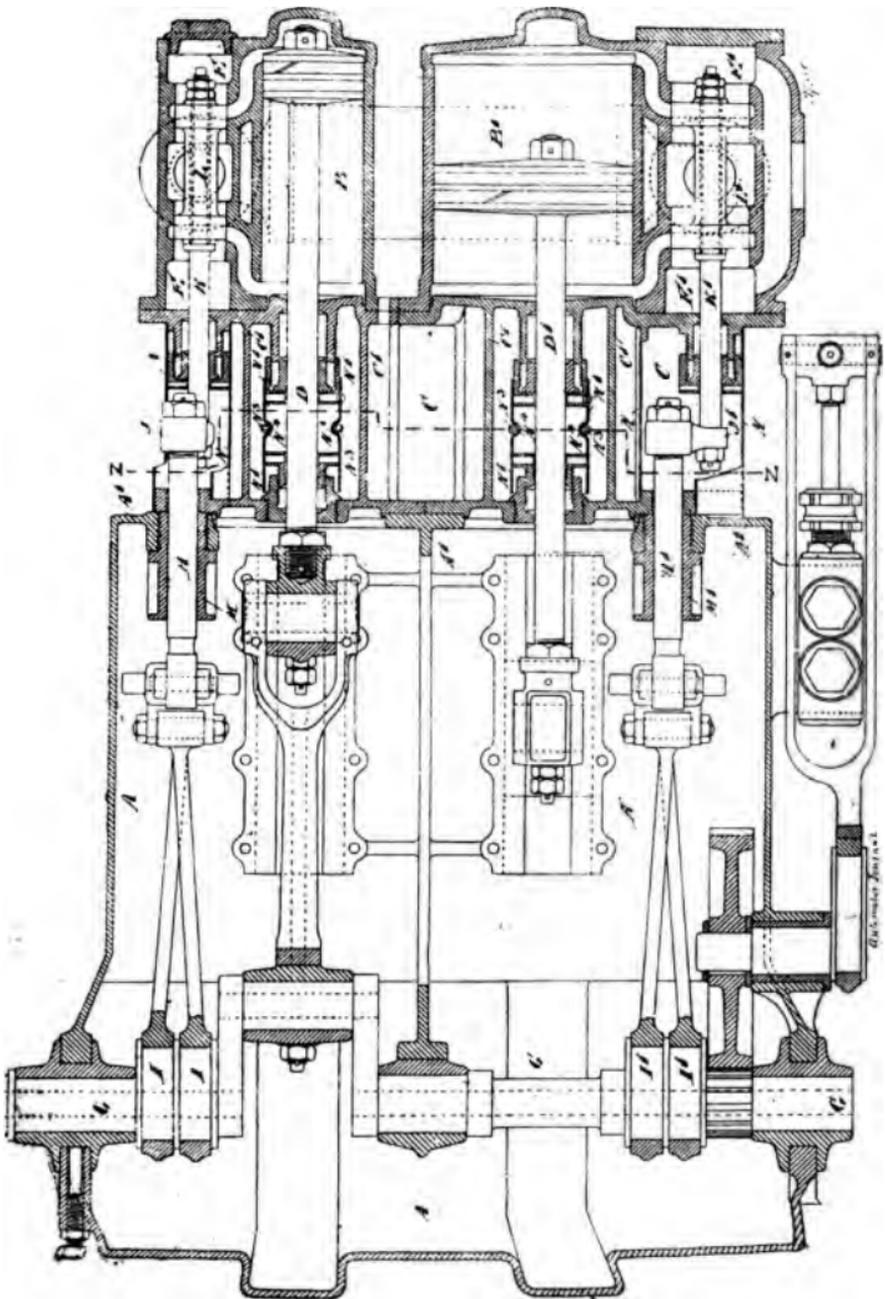
FIG. 25.—"LIFU" STEAM MOTOR: SECTIONAL PLAN.
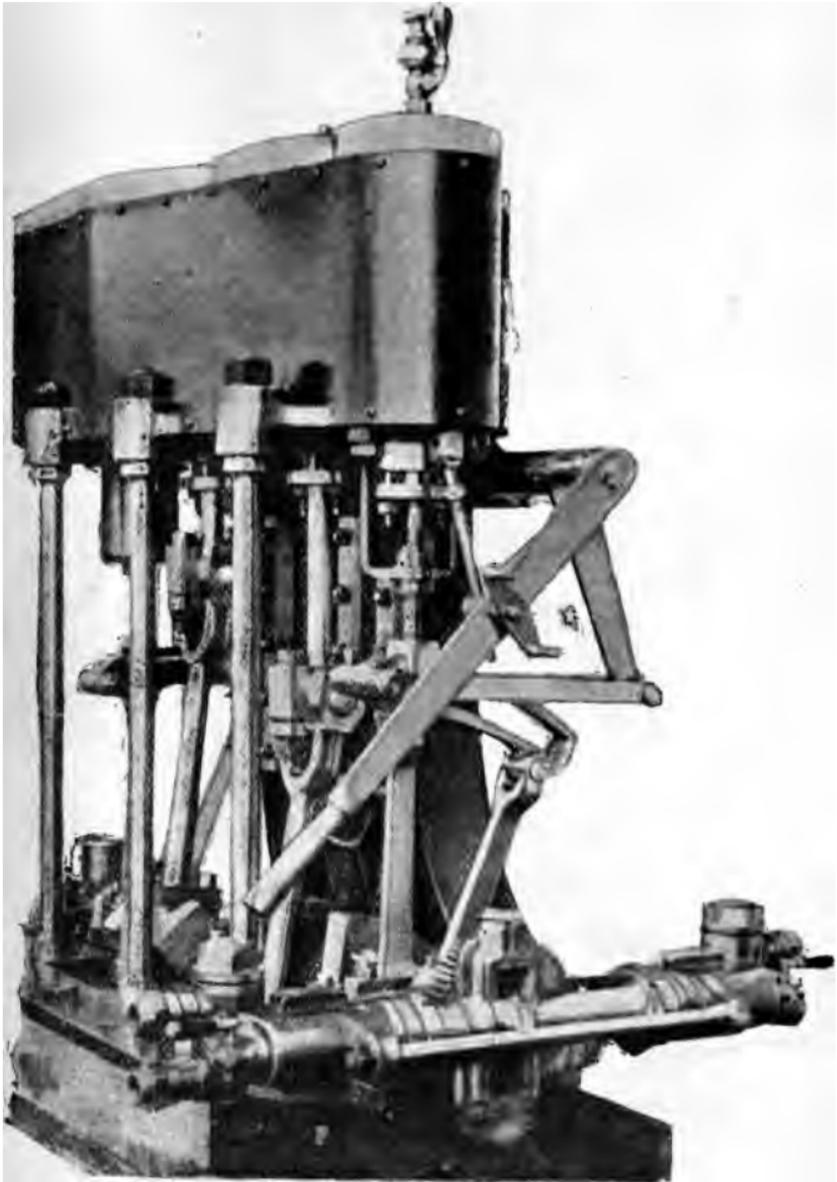
Fig. 26.—Sargeant's Steam Motor.

Sargeant's Steam Motor.

This (*see* Fig. 26) consists of a pair of vertical compound engines, 3¾″ and 7½″ × 5½″ stroke. A piston valve is fitted to the H.P. cylinder, and an ordinary D slide to the L.P. cylinder. The cylinders are jacketted, and the tops and bolts are covered with aluminium covers. The cranks are balanced and are of steel, as are the connecting rods, which are hollow. The link motion is of the Stevenson type, the links being solid slotted. The feed is worked through reducing gear off a crank at one end of the shaft, and is a gunmetal construction. With a boiler pressure of steam of 250 lbs. per square inch, the engines run at 500 revs. per minute, and give off about 35 I.H.P. The weight of the engine as shown in the condition in the drawing is 600 lbs. with pumps.

JOY'S VALVE GEAR.

This gear is shown in Fig. 27, which represents the connecting and valve rods of a horizontal engine, the former being at the end of its stroke, and the latter, G, being practically at rest, but just about to make a sudden movement to the left, which constitutes the admission period of the ordinary steam cycle. To the connecting rod, at a point A, about one-third or so from the piston-rod end, is attached one end of the link B; the other end being attached to the end of a simple vibrating link C, the end of which, C', swings on a fixed pin. The point path described by A is an ellipse, hence the path described by a point in the link B will be the resultant of the elliptical path due to A, and the circular arc described by C; the result is that the point D describes a peculiar flattened oval as shown (in dotted line). At D is attached the swinging lever link E, which is fulcrumed to a pin F; this pin is held in a slipper which moves in the curved slotted path J, of radius equal to the slide-valve connecting rod G, the end of this rod being joined to the link E. The point D of the link E, during a complete revolution of the crank describes, as stated, the flattened oval as shown; the other end of E, viz., that connected to G, describes, as the fulcrum slides up and down the curved slot J, a vertical ellipse. The proportions of the links are so chosen that the lesser diameter of this ellipse is equal to twice (lap + lead). As shown, the curved slot is in a position at right-angles to the axis of the cylinder, this gives the mid-gear position. If now the curved slot, which is also fulcrumed at F, be inclined, the ellipse described by the end of rod G, where it joins link E, will be inclined; hence, by inclining this slot in either direction, direct and reverse motion is obtained. With this gear the "lap" and "lead" are constant, but the admission is regulated by the position of the curved slot.

The point F represents the centre of oscillation for the links and the centre or fulcrum of the lever.
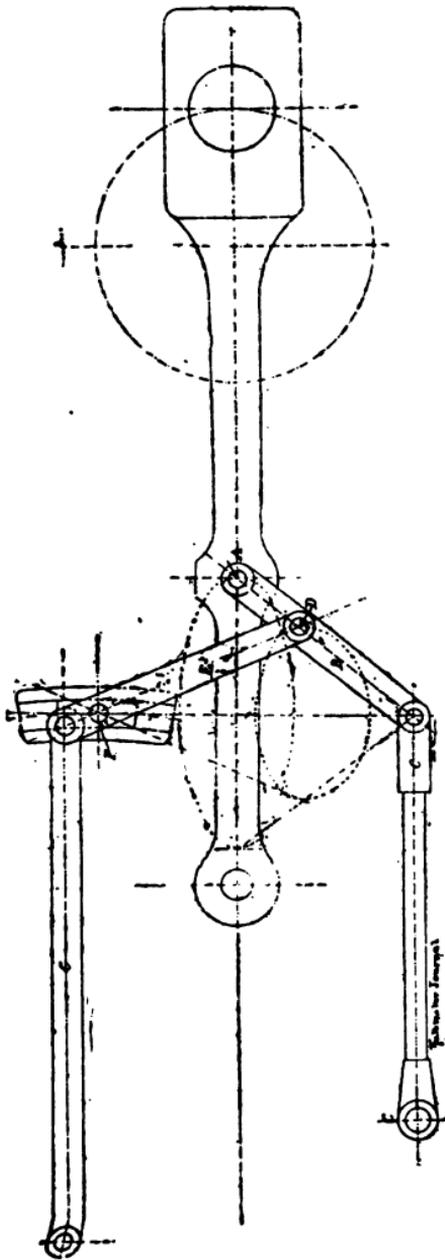
Fig. 27.—Joy's Valve Gear.

INTERNAL COMBUSTION MOTORS.

(Including those using Kerosine, Mineral Spirit, *i.e.*, Petrol, and Coal Gas.)

The Beau de Rochas or Otto Cycle.

Outstroke of piston—Draws in air and gas or oil vapour.
Instroke of piston—Compresses this charge.
Outstroke of piston—Ignition and explosion of charge.
Instroke of piston—Scavenger stroke, *i.e.*, products of combustion driven out.

Thus the cycle comprises two revolutions, during which there is but one impulse given to the piston. In a steam engine there are two impulses every revolution.

To find indicated horse-power :—

L = Length of stroke in feet.
A = Area of piston in square inches.
N = Number of explosions per minute.
P = Mean pressure in lbs. per square inch on piston.

$$\text{I.H.P.} = \frac{\text{L.A.N.P.}}{33,000}$$

Brake Horse-power Tests.

Let S = Mean spring balance reading, in lbs.
W = Total weight hanging upon the brake, in lbs.
R = Effective radius of brake wheel, in feet,—
= Radius of wheel + Radius of rope.
N. = Revolutions per minute.

Then

$$\text{B.H.P.} = (\text{W} - \text{S}) \ \frac{2 \pi \text{R N}}{33,000}$$

Composition of Gas obtained from Petroleum.

	American.	Russian.
No. of cubic ft. per gallon	72	104
Hydrogen	26·0	45·3
Methane	41·6	22·3
Ethane	12·5	13·9
Olefines	14·1	11·6
Carbon Monoxide	3·3	3·5
Carbon Dioxide	1·7	2·3
Oxygen	0·8	1·1
Nitrogen	*nil.*	*nil.*
	100·0	100·0

TABLE GIVING DIMENSIONS OF, AND DATA RELATING TO, PETROLEUM MOTORS USING KEROSINE.

Name of engine.	Cylinder sizes.			Full load indicator diagrams.			Maximum.			Oil used.	Oil consumption at full load.		Oil consumption at half load.		Method of governing.	Class of vaporiser (See definitions in text). No. 1	Revolutions per minute.	Authority.
	Diameter.	Stroke.	Clearance volume.	Maximum pressure.	Mean pressure.	Compress'n pressure.	I.H.P.	B.H.P.	Mechanical efficiency.		Per I.H.P. hour.	B.H.P. hour.	Per I.H.P. hour.	B.H.P. hour.				
	in.	in.	c. in.	lbs. s.in.	lbs. s. in.	lbs. s.in.			Per cent		lbs.	lbs.	lbs.	lbs.			Means	
Priestman	8⅜	12	363	151	53·2	35	9·37	7·72	82	Royal Day-light	0·694	0·842	1·063 Russoléne	1·381	Variable oil and air supply.	No. 1	210	Prof. Unwin
Weyman & Hitchcock's "Trusty"	7⅜	14	...	147	44·1	38	7·04	5·98	84	Royal Day-light	0·69	0·82	0·68	1·12	Oil intercepted	No. 3 (2)	248	Mr. W. W. Beaumont, M.I.C.E.
Hornsby-Akroyd	10	15	636	130	28·9	65	10·3	8·57	83	Russo-lene	0·81	0·977	...	1·49	Variable oil supply	No. 4	239	Prof. Capper
Crossley	7	15	2·6	238	72·2	82	7·9	7·01	88	Russo-lene	0·73	0·82	...	1·33	Intercepts oil supply	No. 2	200	Ditto
Wells' "Premier"	8¼	15	360	...	40·6	...	7·3	6·46	89	Russo-lene	0·93	1·04	...	1·59	Exhaust kept open. Oil intercepted	No. 3 (2)	160	Ditto
Campbell	7⅜	12	...	218	65·5	58	5·9	4·81	80	Russo-lene	0·93	1·12	...	1·30	Exhaust kept open. Oil intercepted	No. 3 (2)	208	Ditto
Britannia	7¼	13	260	170	47·0	60	8·4	6·21	74	Russo-lene	1·25	1·68	...	1·67	Oil variable	No. 3 (2)	243	Ditto
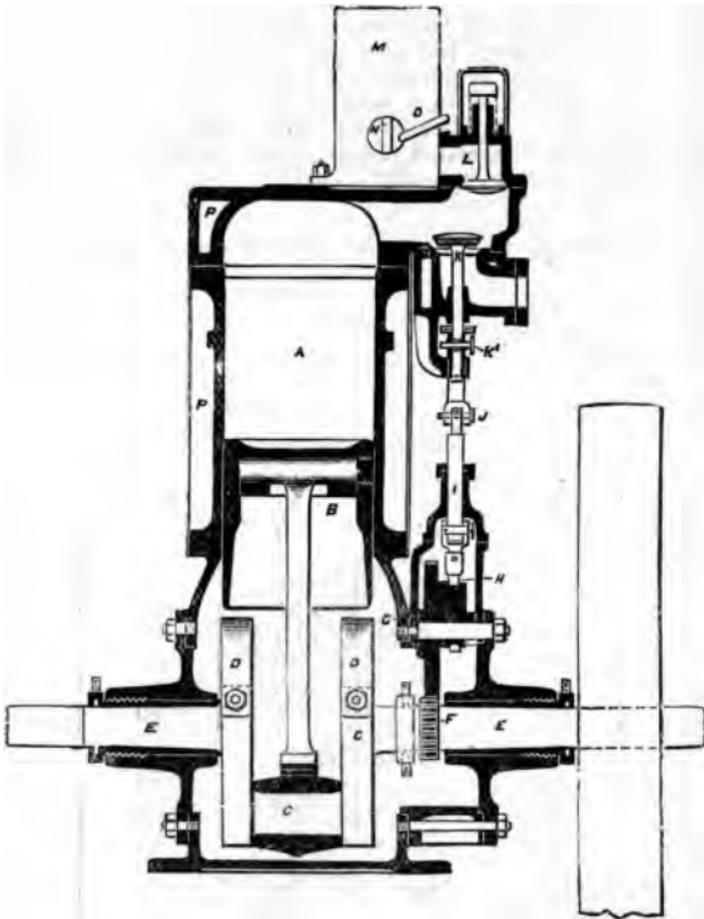
FIG. 28.—SECTIONAL ELEVATION ROOTS KEROSINE OIL MOTOR.

A is the cylinder, *B* piston, *C* crank, *D* balance weights, *E* taper on shaft to enable taper brasses to take up slank, *F* small toothed wheel, *G* toothed wheel, having twice the number of teeth of wheel *F*, *H* eccentric cast with wheel *G*, *I* reciprocating rod carrying a rocking weight governor on the pin *J* for opening the exhaust valve *K*. The pin *K* operates the lever which reciprocates the usual oil-feed spindle of the Roots oil engines. *L* is the admission valve opening directly into the vaporiser. *M* is the casing containing the

air-heater and vaporiser, having at its centre the ignition tube *N* of nickel alloy or of platinum. The engine is started with a burner, which is then put out, and the heat is maintained by an automatic burner, a portion of which shows at *O*. A second groove is cut on the oil-feed spindle, the oil from which is swept off by an air blast supplied by the closed crank-pit, the air and oil being mixed and vaporised in the pipe *O*, and directed upon the ignition tube *N*. *P* is the water jacket.

Tolch's Marine Kerosine Oil Engine.—Type A.

Actual or Br ake Horse-Power.	Revolutions per Minute.	Overall Dimensions.			Weight Complete. Net.
		Length.	Width.	Height.	
SINGLE CYLINDER.					
		ins.	ins.	ins.	cwts.
1	360	29	23	37	6¼
2	360	31	23	40	8
3	350	33	25	43	9½
4	320	40	28	48	12½
5	290	44	31	54	15
6	270	49	33	61	16
8	260	53	40	65	24
10	250	57	43	69	27
15	230	65	47	80	42
DOUBLE CYLINDER.					
6	350	47	25	44	13½
8	320	49	28	48	21
10	290	52	31	53	22½
15	270	55	33	59	33½
17	260	59	40	66	44½
20	250	63	43	69	52
30	240	68	47	80	63
40					
50					
60					

Names on Vehicles.—All vehicles used in trade or husbandry must have the christian name and surname, and place of abode or place of business visibly and legibly painted in letters of not less than one inch in length.

Vosper's Kerosine Oil Motors.

SINGLE ENGINES.

Actual Brake Horse-Power.	Approximate Height.	Approximate Breadth.	Approximate Length.	Approximate Weight.
	ft. in.	ft. in.	ft. in.	cwt.
$\frac{1}{2}$	2 0	1 0	1 0	$1\frac{1}{2}$
1	2 6	1 6	1 9	$2\frac{3}{4}$
$2\frac{1}{4}$	2 9	2 2	2 2	$4\frac{1}{4}$
$3\frac{1}{4}$	3 2	2 6	2 8	6
5	4 2	8 2	3 2	10
6	4 6	3 6	8 6	12

TWO-CYLINDER ENGINES.

Actual Brake Horse-Power.	Approximate Height.	Approximate Breadth.	Approximate Length.	Weight of Engine.
	ft. in.	ft. in.	ft. in.	cwt.
6	4 0	2 6	2 9	11
9	4 10	3 0	3 6	16
10	5 0	3 6	4 0	18

FOUR-CYLINDER ENGINES.

Actual Brake Horse-Power.	Height.	Breadth.	Length.	Weight of Engine, Intermediate Shaft, and Stern Tube.
	ft. in.	ft. in.	ft. in.	cwt.
12	3 8	4 2	8 8	25
14	3 9	4 3	3 9	27
16	4 0	4 7	4 0	35
20	5 6	6 2	5 6	50

(These engines are arranged that one cylinder can be shut off to work the engine at $\frac{3}{4}$-speed. This type of engine, taking up very little room, is particularly adapted for auxiliary boats and yachts.)

Particulars of Launches.

Length and Beam.	B.H.P.	Speed.	Total Weight in Cwts.
ft. in.　　ft. in.			
12　0　×　4　0	1	5¼	7¼
14　0　×　4　0	1	5½	8
16　0　×　4　6	2¼	6	10¼
18　0　×　4　9	3¼	6½	16¼
20　0　×　5　0	3¼	7¼	17½
22　0　×　5　0	3¼	6¼	18
25　0　×　5　6	5	8	24
30　0　×　6　10	6	7½	40
35　0　×　7　0	6	7	50
40　0　×　7　4	9	7½	70
40　0　×　7　0	12	8	10
50　0　×　8　0	16	9	120

(VOSPER).

Particulars of Priestman's Oil Motors suitable for Car or Marine purposes.

N.B.—These motors use heavy or ordinary petroleum, and are fitted either with flame or electric ignition.

	Size of Engine, Brake H.P.		
	2	8	15
Revolutions per minute ..	350	260	250
Diameter of disc　..　..	1 ft. 8 in.	2 of 2 ft.	2 of 2 ft. 7 in.
Overall Dimensions { Length	3 ft. 3¼ in.	4 ft. 3¼ in.	5 ft. 10 in.
Breadth	3 ft. 0 in.	3 ft. 2 in.	4 ft. 0 in.
Depth	3 ft. 10 in.	5 ft. 1 in.	5 ft. 11 in.
Weight　..　cwts.	14	29	54

These motors are made up to 75 and 90 B.H.P. for yachts, trawlers, &c.

PETROL.

This liquid is one of the products obtained by the distillation of petroleum, and forms one of the naphtha series of hydrocarbons. Petrol, known also as "Light Oil," "Mineral Spirit," "Moto-car Spirit," "Moto-Essence," "Petroline," "Moto-naphtha" is an exceedingly volatile and inflammable liquid, hence it readily evaporates, and an explosive mixture of air and petrol vapour is easily formed. It forms a clean, compact and very efficient source of energy for internal combustion motors. The principal varieties of petrol are:—

						sp. gr.
Gasoline ..	..	..	..	..	..	0·650
Moto-car spirit ..	..	..	..	..	0·680
Benzoline..	..	..	..	..	..	0·700
Benzine ..	..	..	..	..	..	0·730

Of these the moto-car spirit, 0·680 sp. gr., is the most suitable for use in motors, and a grade for this purpose, known as "Pratt's Moto-car Spirit," is specially prepared by the Anglo-American Oil Company. Benzoline is largely used for this purpose, but it is objectionable on account of the smell given off when the motor is not in perfect working order. With Pratt's moto-car spirit there is no smell, but its price is somewhat higher than that of benzoline. In the choice of a mineral spirit for use in a motor-vehicle the state of the weather must not be disregarded. In summer or in dry weather benzoline may be used, but in winter or in damp weather, when the dry and wet bulbs of the thermometer are nearly alike, the purer spirit will be found much more satisfactory.

In using petrol, the regulations issued by the Home Office (*vide* Automotor Pocket Book, p. 37) should be carefully and intelligently followed. Should any difficulty be experienced in obtaining "Petrol" or Moto-Car Spirit, communicate with Carless, Capel, & Leonard, or the nearest depôt of the Anglo-American Oil Company respectively.

Petrol Stores, Repairers, and Storage of Moto-Vehicles.

A full alphabetical list (names of towns) of these was published in the AUTOMOTOR JOURNAL of November 15, 1898, occupying 6¼ pages. The following are the particulars and references given in this and the additional lists published in subsequent issues of the AUTOMOTOR JOURNAL :—

References.

(*a*) Moto-Car Spirit or Petrol. (*b*) Repairs. (*c*) Accommodation for storing Moto-vehicles. (*d*) Hold Moto-Car Spirit License; will stock when requested and as demand grows. (*i*) Ironmonger. (*o*) Oil merchant. (***) Authorised Agents of Messrs. Carless, Capel, & Leonard.

The issue for November 15 and following numbers can be obtained from the publishers of this Pocket Book, price 7½d. each, post free.

Weights of some typical French Petrol Motors.

Name of Maker.	Horse-power.	Revs. per min.	Weight. Kilos.
Dion et Bouton	1¼	1,600	35
Landry et Beyroux	5	400	160
,, ,,	10–12	400	180
Panhard et Levassor	4	700	75
,, ,,	6	700	130
,, ,,	8	700	160
,, ,,	12	700	250
,, ,,	5·2	1,000	75
,, ,,	8	1,000	130
,, ,,	10·4	1,000	160
,, ,,	16	1,000	250

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Particulars of Tests made with Petrol Motors.

	De Dion et Bouton Tricycle.	Daimler-Panhard, 2¾ H.P.	Daimler-Panhard, 3½ H.P.	Phœnix et Canstart, 4 H.P.	Phœnix-Panhard, 4 H.P.	Peugeot (Horizontal), 4 H.P.	Phœnix-Panhard, 6 H.P.	Peugeot (Horizontal), 6 H.P.
1. Number of cylinders	1	2	2	2	2	2	2	2
2. Diameter of piston in mm.	62	72	76	90	80	84	90	98
Diameter of piston in inches	2·44	2·83	2·99	3·54	3·14	3·30	3·54	3·85
3. Area of piston in square mm.	302	407	454	636	593	554	636	754
Area of piston in square inches	4·67	6·29	7·03	9·84	7·74	8·55	9·84	11·64
4. Stroke of piston in mm.	70	126	146	120	120	126	140	144
Stroke of piston in inches	2·75	4·96	5·74	4·72	4·72	4·96	5·51	5·67
5. Volume of cylinder in cubic centimetres	211	513	663	763	604	698	890	1086
Volume of cylinder in cubic inches	12·66	30·78	39·78	45·78	36·94	41·88	53·40	65·16
6. Speed (revolutions per minute)	1400	750	750	750	750	750	750	750
7. Displacement of pistons in litres per second*	9·85	25·6	33·2	31·8	30·2	34·9	45·0	54·3
Displacement of pistons in cubic feet per second	0·344	0·896	1·162	1·113	1·057	1·221	1·575	1·90
8. H.P. of motor on brake	1·25	2·5	3·75	5·5	4·5	4·9	6·5	7·1
9. Power of motor in poncelets†	0·95	2·0	2·8	4·12	3·4	3·7	4·9	5·3
10. Specific displacement of pistons in litres per second and per poncelet	9·36	12·8	11·7	7·7	8·9	9·4	9·2	10·3

* Cubic feet = litres × ·035.
† Poncelet = H.P. × ·763, or ·981 kilowatt.

The Paris Singer Motor.

The accompanying illustration is a sectional elevation of a ½ B.H.P. tricycle motor. The working parts consist of piston, connecting rod and crank shaft. No valves are used. The cylinder, D, is of cast iron, having radiating rings cast with it. There are two elongated port openings in its sides, one of which is the "suction," the other the "exhaust."

These port openings are controlled by the rotary and reciprocating action of the piston, and its two round ports, one of which is shown at E.

The body (or crank chamber), K, is in two halves, and is of aluminium. It contains the two fly wheels, marked J, and can readily be taken apart for inspection.

The fly wheels are coupled together by the crank pin, and form one complete shaft, on the side of one of the fly wheels, close around the end of crank pin, is fitted a scroll (or quick pitch) screw, which drives the tangent wheel fixed on the front portion of connecting rod H, and through which is conveyed the rotary action to the piston, the gear being so arranged as to perform the Otto cycle.

The back portion of the connecting rod, I, acts as a stay and guide bearing for the front half to turn in, and also secures the crank pin brasses.

The connecting rod is attached to the piston by a ball (or universal) joint, marked F.

The electric ignition, marked A, and the relief cock (for use at starting), marked C, are attached or screwed into the cylinder cover B, which is of a hollow (or dished) shape, and is screwed into the mouth of the cylinder, and consequently can be removed at a moment's notice, for inspection, if desired.

The combustion (or explosion) chamber is in the interior of the piston, instead of being surrounded by the walls of cylinder, as in other motors, thus protecting the cylinder bore from the effects of the heated products of combustion, as at no part of the stroke of the engine do they come in contact with the walls of the cylinder.

The fuel of the motor is "gasolene," or "petrol," and flows by gravity to the cylinder, and is introduced into the air passage, close to the cylinder, where it is vaporised.
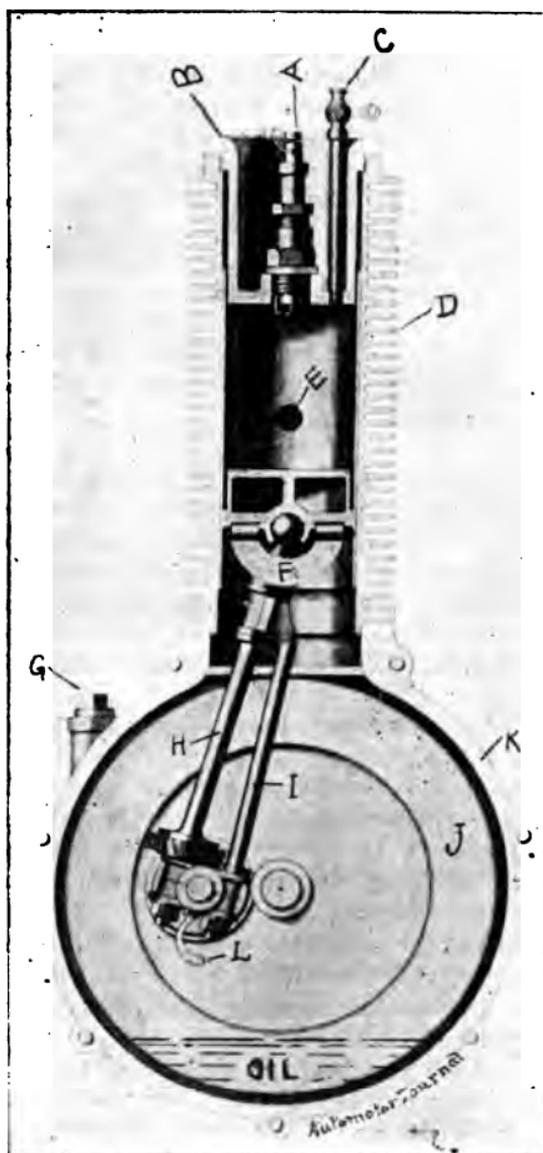
FIG. 29.—PARIS SINGER MOTOR (½ B.H.P.).

The Paris Singer Petroleum-Spirit Motor.

Size.	Brake H.P.	Speed Revs.	Length, inches.	Breadth, inches.	Height, inches.	Weight of Engine, lbs.
			Space Occupied by Engine.			
A	1	960	8½	9½	18	50
C	2	800	20⅛	11¼	28	142
CC	4	800	20½	11¼	28	230
DD	7½	700	27	13	34	—

Particulars of Daimler Motor, as fitted in Boats.

Length of Boat.	Beam.	Draft at Screw End.	Approximate number of Passengers.	Nominal Horse Power.	Length.	Breadth.	Height.	Weight of Motor and Casing.	Weight of Fittings.	Speed in Miles.
					Dimensions of Motor.					
ft.	ft. in.	ft. in.			in.	in.	in.	cwts.	cwts.	
18	4 10	1 8	6	1	21	15	36	2½	¾	5½
21	5 8	1 10	8	2	26	18	39	3¼	1	7
23	5 8	1 10	10	2	26	18	39	3¼	1	7
25	5 8	2 0	12	3	27	19	42	3½	1¼	7½
28	6 0	2 2	15	3	27	19	42	3½	1¼	7½
31	6 0	2 6	18	4	31	20	44	4½	1½	7½
34	7 0	2 8	20	6	36	22	46	6½	1¾	8
38	7 6	2 10	25	8	44	24	48	8	2½	8½
41	8 0	3 0	30	10	52	26	50	10	3½	9

Negligence.

Negligence is defined as "Absence of care according to the circumstances." In actions for damage, &c., plaintiff must give evidence of the negligence of the defendant, and the onus of disproving this rests upon the defendant.

L. 2
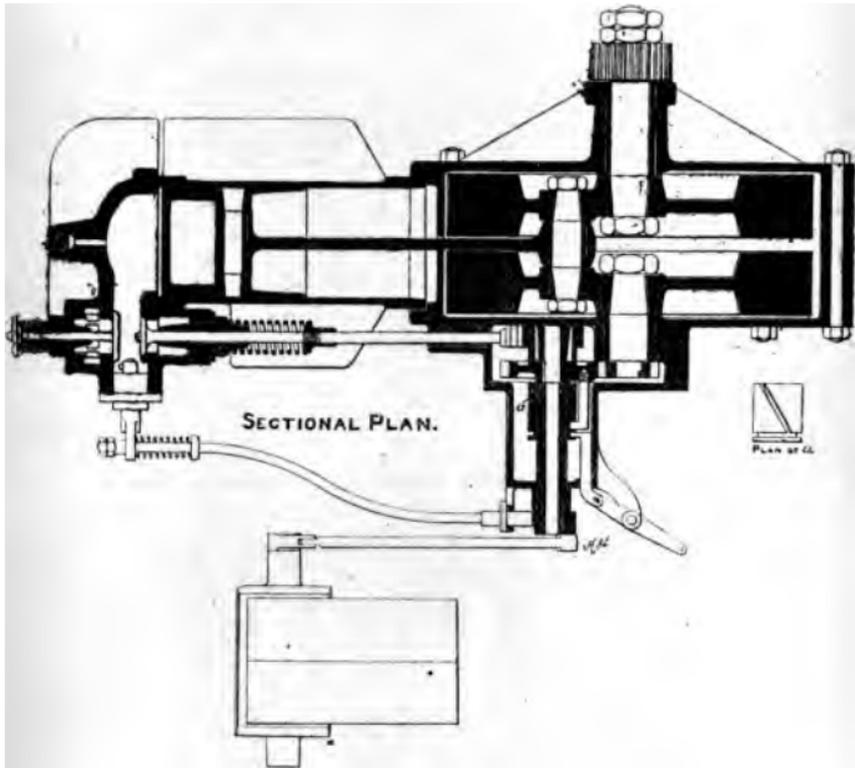
FIG. 30.—SECTIONAL PLAN THROUGH CENTRE OF THE SIMMS
1½-H.P. PETROL MOTOR. (HORIZONTAL TYPE.)

In this motor the valves are arranged so as to be co-incidal in their
horizontal axes, and are so constructed that it is a simple matter to
remove either valve or gain access to the ignition contact breaker,
by breaking one joint only, which can be remade with but little
difficulty.

The ignition is effected in the following manner:—The half-speed
shaft is continued through the crank-chamber casing, and carries
a bush or sleeve throughout its entire length. On this bush is a
second loose sleeve, marked *a*, driven by a lug piece from the gear
wheel fitting into the archimedean thread cut on the side of the
sleeve, and free to slide on the key fitted on to the last-mentioned
bush; this bush also carries, on its outer extremity, the cam actuating

the rod connected to the contact-breaker on the cylinder head, and also the crank pin which, by means of a connecting rod, actuates a soft iron envelope of the magneto machine simultaneously with the time of the spark. By this arrangement the spark can be "timed," *i.e.*, formed at any portion of the stroke of the piston and altered to any other point while the motor is running. This is done by means of a lug piece projecting between the gear casing and moved by a small lever. As the bush *a* is drawn outwardly, the lug piece in the archimedean thread forces the cam at the extremity of the crank pin to take up a different position with regard to the crank, gradually altering the time the spark takes place. By this means the speed of the motor can be altered at will as it is running.

The following are the principal dimensions of this motor :— Diameter of cylinders 70 m.m., stroke 78 m.m., clearance space 1,346·33 cu. c.m., B.H.P. 1¼, at 900 revs. per minute. Range of speed 300–1,200 revs. per minute. Weight of motor 42 lbs. Two fly-wheels 20 lbs. each.
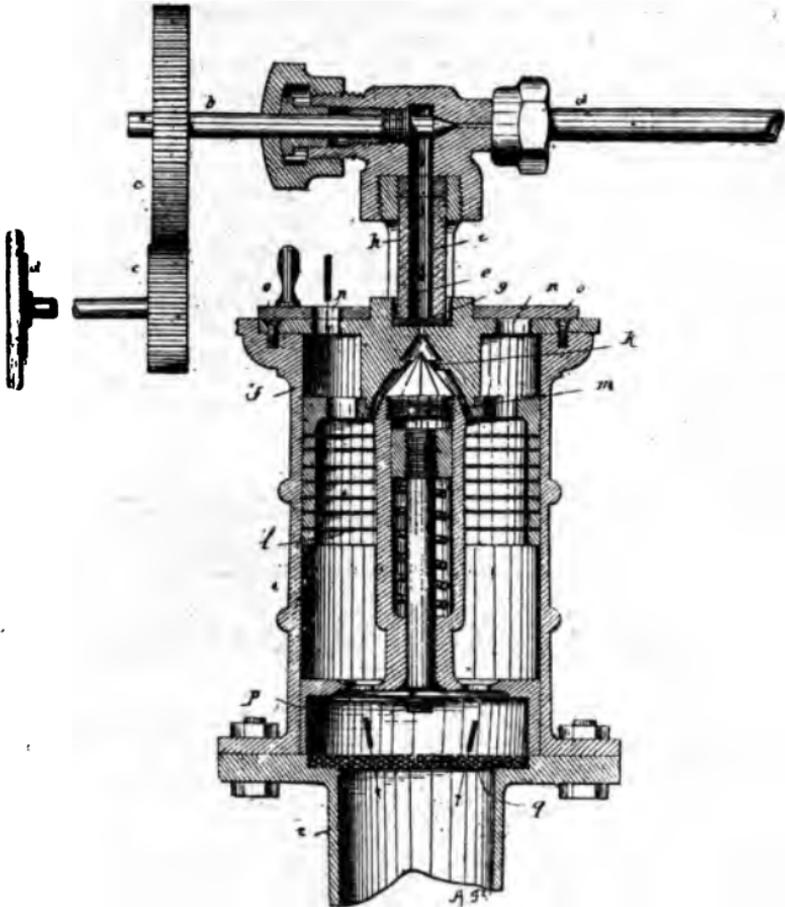
FIG. 31.—LUCAS CARBURATOR.

This consists of a cylindrical chamber, having a connection on its lower end to the cylinder of the motor, and fitted with a spring-controlled piston *p*, and valve *k*; on the upper part is a perforated cover *n*, upon which is a sliding circular baffle-plate *o*; thus the holes in the cover can be opened or closed to any desired extent for the admission of air. The upper central spindle *h* is hollow, and forms the feed-pipe *e*, for the spirit; at its upper end is a needle-valve *b*, operated either by hand or by gearing from the motor. *Within* the cylinder are a series of plates *l*, also perforated with *small holes, while just* below the piston-valve is a fine wire gauze, *q*.

The action of the carburator is as follows:—Petrol spirit comes through the pipe *a*, and on opening the needle-valve *b*, flows down, in very minute drops, the central tube *e*, the quantity of spirit so admitted being regulated by the valve. The spirit cannot then enter the carburator, as the passage *g* is closed by the pointed head of the spindle *k*, which is held up to its seat by the spring. The lower part of the carburator is in communication with the cylinder of the motor, and on the suction stroke of the latter the piston *p* of the carburator is sucked down with its spindle and opens valve *k*, the spirit runs through the passages *m*, and falls upon the perforated plates *l*. At the same time air rushes into the partial vacuum in the chamber through the ports *n*, and through the perforated plates *l*, and hence becomes intimately mixed with the spirit. This explosive mixture of air and spirit passes or is sucked through *q*, and thence to the cylinder of the motor, where on ignition an explosion ensues, the pressure thus generated depending upon the proportions of air and spirit in the mixture. These can be regulated to any desired degree.

Nuisance.

A private person cannot maintain an action for nuisance unless he suffers personal wrong or inconvenience over and above that caused to the public at large. The smoke, steam, noise, and speed of light locomotives, may be regarded as nuisances; so may the fœcal evacuation of horses.

A nuisance is either public or private; and is generally an unlawful act or omission to discharge a legal duty such as endangers the lives, safety, health, property, or comfort of the public, or by which the public are obstructed in the exercise or enjoyment of any right common to all Her Majesty's subjects.

What is a Carriage?

Carriage means and includes any carriage (except a hackney carriage) drawn by a horse or mule, or horses or mules, or drawn or propelled upon a road or tramway, or elsewhere than upon a railway, by steam or electricity or any other mechanical power; but shall not include a waggon, cart, or other such vehicle which is constructed or adapted for use, and is used solely for the conveyance of any goods or burden in the course of trade or husbandry.— (Sub-sec. 3, sec. 4, Customs and Inland Revenue Act, 1888.)
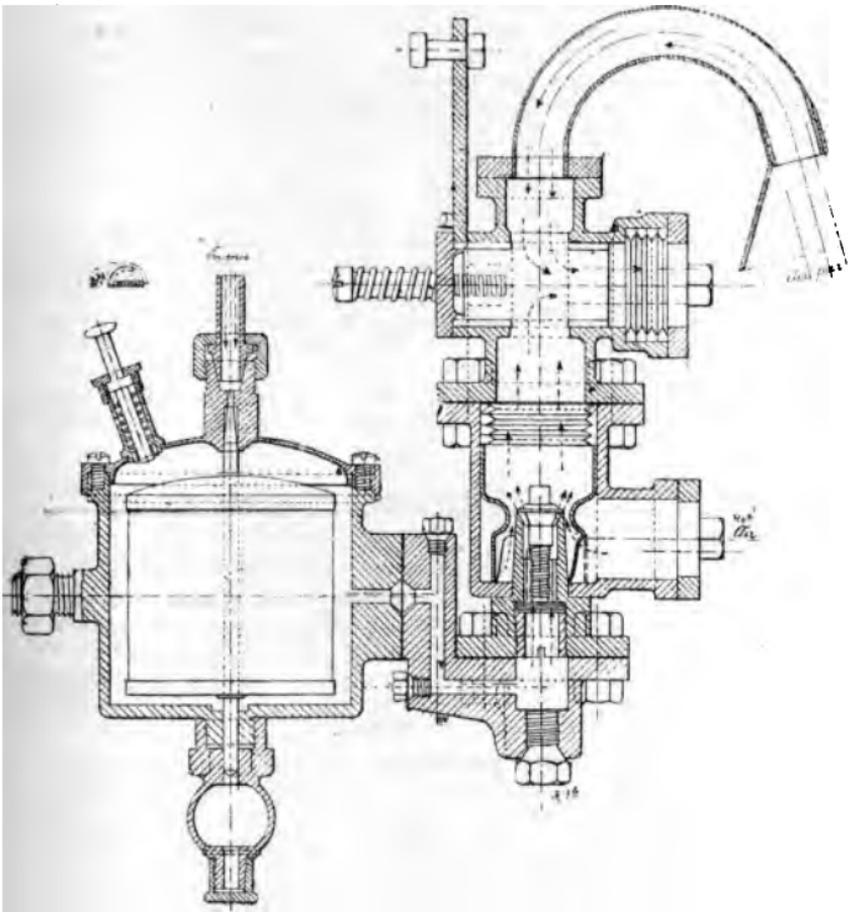
FIG. 32.—THE LONGUEMARRE CARBURATOR.

This is of the float valve type. A chamber (seen on the left) has a float to which is attached a spindle forming a needle valve. Spirit enters this chamber through the needle valve, and flows either by gravity or air pressure into the vertical pipe (seen on the right); this pipe is in communication with an air pipe, and is so constructed that, on the suction stroke of the motor, an intimate mixture of spirit and air is formed which goes in the usual way to the cylinder, and is there exploded. By means of the needle and air valves the proportions *of spirit and air can* be regulated at will.

The Agricultural Society's Trials of Motor Vehicles, held at Birmingham, June, 1898.

General Dimensions of the Competing Vehicles.

	The Daimler Motor Company, Article 4930.	The Lancashire Motor Company, Article 4936.	The Carriage and Wagon Company, Chiswick, Article 4938.
Overall dimensions of vehicle	10′ × 5′	18½″ × 6¼″	16′ × 6½′
Inside dimensions of van ..	4¼′ × 5′	12½″ × 5⅞″	9½′ × 6½′
Diameter of wheels, front ..	2′ 6″	3′ 1¾″	2′ 9″
„ „ back ..	2′ 3″	3′ 1¾″	3′ 3′
Tyres..	2½″ solid rubber	4″ and 5″ iron	4½″ iron
Length of wheel base ..	69½″	121″	87″
Ratio of gearing between engine and road wheels ..	8·8, 12·6, 18, and 35 to 1	8, 13½, and 28 to 1	8 to 1
Type of engine	2-cylinder vertical, 4 H.P.	Compound vertical, 14 B.H.P.	Compound vertical.
Size of engine cylinders ..	3⅞″ × 6⅜″	3″ & 5″ × 6″	4″ & 7″ × 5″
Revs. of engine at full speed	700	500	500
Type of boiler	—	Vertical tubular	Water-tube.
Heating surface of boiler ..	—	110 sq. ft.	65 sq. ft.
Working pressure per sq. in.	—	200 lbs.	175 lbs.
Water-tank capacity ..	15 galls.	46 galls.	50 galls.
Condenser	None	Air surface	Air surface.
Fuel	Benzoline	Russian petroleum	Newcastle coal.
Capacity of oil tank ..	7 galls.	20 galls.	—
„ of coal bunker ..	—	—	2 cwt.
Weight of vehicle empty ..	1·162 tons	2·86 tons	3·00 tons.

Consumption of Fuel and Cost of Running.

The following table gives the data of the amount of fuel used, the amount of water used, and the calculated cost of running. Benzoline is taken to cost 7½d. a gallon; lamp oil, such as was used by the Lancashire car, 4¾d. per gallon; coal, 20s. a ton.

Consumption of Fuel and Water.

		Daimler.	Lancashire.	Chiswick.
Short Course.				
Total weight of car and load .. tons		2·43	6·45	6·82
Coal used .. .. .. cwts.		—	—	1·37
Burning-oil used .. .. galls.		0·63	7·50	—
Water used .. .. .. ,,		None	45	50
Cost of fuel for journey .. pence		4·7	35·6	16·4
,, ,, per mile .. .. ,,		0·355	2·69	1·24
,, ,, per ton per mile .. ,,		0·146	0·416	0·181
,, ,, per ton of cargo per mile .. .. ,,		0·366	0·873	0·415
Long Course.				
Total weight of car and load .. tons		2·49	6·54	6·88
Coal used .. .. .. cwts.		—	—	7·5
Burning-oil used .. .. galls.		2·81	23·5	—
Water used .. .. .. ,,		13	·165	193
Cost of fuel for journey .. pence		21·1	111·6	90
,, ,, per mile .. .. ,,		0·45	2·38	2·10
,, ,, per ton per mile .. ,,		0·18	0·36	0·30
,, ,, per ton of cargo per mile .. .. ,,		0·465	0·774	0·704

Coefficient of Performance.

	Ton-miles of Cargo per Hour.		
	Daimler.	Leyland.	Chiswick.
Reckoned on gross running time—			
Short course	9·30	15·81	17·40
Long course	8·12	17·62	12·70
Reckoned on net running time—			
Short course	9·30	17·74	19·93
Long course	8·12	20·38	18·92

Effective Horses' Power Exerted.

	Daimler.	Leyland.	Chiswick.
Total weight .. .. .. tons	2·49	6·54	6·88
Coefficient of friction	$\frac{1}{44}$	$\frac{1}{27}$	$\frac{1}{31}$
Resistance on level .. .. lbs.	126·8	542·6	497·2
Net mean speed.. miles per hour	7·82	6·48	6·20
Net mean speed.. .. ft. per sec.	11·47	9·50	9·09
Effective H.P. on level	2·64	9·38	8·20
Resistance due to gradient .. lbs.	464·8	1221·0	1284·0
Total resistance on gradient .. ,,	591·6	1763·6	1781·2
Assumed speed on gradient ft. per sec.	5·73	4·75	4·54
Effective H.P. on gradient	6·16	15·23	14·72

Continental Trials of some Petroleum* and Steam Motors.

COMPARATIVE trials have recently been made at the Brussels Exhibition and at Tervueren as to the working and cost of fuel of lightweight petroleum and steam motors. *La Nature* gives an account of this, according to the data furnished by Mr. Max Ringelmann, in *Le Journal d'Agriculture Pratique.* The competition included petroleum motors, semi-portable, of 4 to 6 H.P., and automotors of 8 to 10 H.P.

The Nagel and Hermann motors, of Brussels; the Capitaine motor, of Frankfort; and the Société Française de Materiel Agricole, were amongst the first class of motors.

The Nagel and Hermann motor, set in motion in 9 minutes, furnishes a force of 4 H.P. at 288 revs. per minute, and consumes 4·66 lbs. petroleum per hour, of which 0·386 lb. are for the lamp, or 1·139 lbs. per H.P. per hour.

The Capitaine takes 7 minutes to be set in motion, and furnishes a force of 4 H.P. at 334 revs. per minute, with a total consumption of 4·7828 lbs. petroleum, or 1·194 lbs. per H.P. per hour.

The Société Française de Materiel Agricole motor takes 12½ minutes, and two men, to be set in motion; at 354 revs. per minute it furnishes a force of 4 H.P. with a total consumption per hour of 4·448 lbs. petroleum, or 1·44 lbs. per H.P. per hour.

The weights of these three motors are respectively 2,310, 1,386, and 1,760 lbs., and their price varies from 2,500 to 2,275 francs.

The locomotives of 8 to 10 H.P. belonged to Messrs. Swiderski, Hille, and La Société Française de Materiel Agricole.

* *Ordinary burning* petroleum, sp. g. about 0·8 and flashing at about 100° F.

The Swiderski motor, at 274 revs. per minute, furnishes a force of 8 H.P. with a total consumption of 8·518 lbs. of petroleum per hour, or 1·0648 lbs. per H.P. per hour, and was set in motion in 10½ minutes by two men. Its weight is 5,390 lbs., and price 5,000 francs.

The Société Française motor was set in motion in 5 minutes by one man; at 219 revs. per minute it developed 8 H.P., and consumed 7·559 lbs. of petroleum, or 0·945 lb. per H.P. hour. Its price is 5,400 francs, and weight 9,600 lbs.

The Hille motor can be set in motion by one man in 11½ minutes. At 240 revs. per minute it develops 8 H.P., and consumes 10·1398 lbs. per hour, or 1·2675 lbs. per H.P. hour. Its weight is 9,350 lbs., and cost 7,000 francs.

The steam automotor section comprises motors of 4 to 6 H.P., made by MM. Lefebre-Albaret, Laursedat, et Cie., and M. A. Raze, and also motors of 8 to 10 H.P. by the former firm.

As regards the former, these give off 5 H.P. at 140 revs. per minute, and consume 24·64 lbs. of coal and 303·6 lbs. of water per hour, or 4·93 lbs. of coal and 60·7 lbs. of water per H.P. hour. The weights vary from 7,040 lbs. to 7,480 lbs., and the cost is about 5,000 francs.

The Raze motor gives off 5 H.P. effective (brake) at 154 revs. per minute, and consumes 28·6 lbs. of coal and 131 lbs. water, or 5·7 lbs. of coal and 26 lbs. water per H.P. hour. The weight is about 7,480 lbs., and cost 5,000 francs.

Motors of 8 to 10 H.P. give an effective power of 8 H.P., and consume per hour 44 lbs. coal and 442 lbs. water, or 5·5 lbs. coal and 55·2 lbs. of water per H.P. hour. They weigh about 9,790 lbs., and cost 6,650 francs.

These trials are interesting, as they show the practical value of the two systems—petroleum and steam—side by side. It may be concluded that petroleum motors of 4 to 6 H.P. consume from 1·1 to 1·3 lbs. of petroleum per H.P. hour, while those of 8 to 10 H.P. consume from 0·88 to 1·1 lbs. of oil per H.P. hour. Steam motors of 4 to 10 H.P. consume from 4·4 to 5·5 lbs. coal, and from 55 to 66 lbs. of water.

It is also to be noted that, whereas petroleum motors only require a few minutes to set in motion, steam motors require often an hour.

ELECTRICITY.

Electrical Formulæ.

Let C = Current in ampères.
    E = Electromotive force in volts.
    R = Resistance in ohms.
    Q = Quantity in coulombs.
    W = Work in foot-pounds.

Then—

$$\text{H.P.} = \frac{C^2 R}{746} = \frac{E C}{746} = \frac{E^2}{746 R}$$

$$W = 0\text{·}737 \; E \; Q.$$

$$C = \frac{E}{R} = \sqrt{\frac{746 \; \text{H.P.}}{R}} = \frac{746 \; \text{H.P.}}{E}$$

$$E = C \; R = \frac{746 \; \text{H.P.}}{C} = \sqrt{\text{H.P.} \; 746 \; R} = \frac{W}{737 \; Q}$$

$$R = \frac{E}{C} = \frac{746 \; \text{H.P.}}{C^2} = \frac{E^2}{746 \; \text{H.P.}}$$

$$Q = \frac{W}{0\text{·}737 \; E}$$

If L be the length of a circuit in feet, out and in, and A the sectional area in square inches, then R at 60° F $= \frac{L}{A} \times \frac{8\text{·}4}{1,000,000}$.

If the E.M.F. drops from E to e volts, and the current from C to c ampères in flowing from dynamo or battery to motor, and if W is the work put into the dynamo or battery and w that received by motor, then efficiency of circuit $= \frac{w}{W} = \frac{e}{E} = \frac{C-c}{C}$.

--- --- ---

To Calculate the Induction Factor (M) of a Motor :—

    Let A = Number of conductors on surface of armature.
        N = Number of lines of force = number of lines of force per square centimetre, multiplied by area of pole piece.
        p = Number of polar divisions of armature connected in series; for ordinary 2-pole machines, $p = 1$.
        M = The induction factor, then—

$$M = p \; A \; N \; 10^{-8}$$

To calculate the tension or E.M.F. between the brushes :—

Using the previous notation, and let N be the revolutions per second of the armature, and E the electromotive force or pressure in volts, then—

$$E = A \, n \, N \, 10^{-8}$$

If p be the number of polar divisions of the armature connected in series,—

$$E = p \, A \, n \, N \, 10^{8}$$

or knowing M—

$$E = M \, n$$

To calculate the torque or twisting moment on the armature shaft—

Let t = The torque.
C = The current in ampères.
M = The induction factor; then—

$$t = 1\cdot41 \, C \, M$$

To calculate the tractive force or draw-bar pull T :—

Using the previous notation, and—

Let d = Diameter of driving wheel.
v = The velocity ratio between armature and driving wheel.
E = The mechanical efficiency of the gear (usually taken at about 80 to 85 %), then—

$$T = \frac{t}{\frac{d}{2}} \cdot E$$

(Carus Wilson.)

Working Dynamos and Motors.

Belting.—Where practicable, the drive should be arranged so that the under side of the belt is the tight or driving side. A flexible belt should always be used. Leather-linked belting, arched on the face next the pulleys and flat on the outside, is very suitable. Such a belt should *not* be taken off after working.

Single belting with double edges makes a good cheap belt for ordinary use, and may be jointed with a butt joint, secured by belt fasteners.

If an ordinary single belt is used, it should be straight and of good quality. It should be jointed with a laced butt joint, until it has stretched, and then a proper spliced and cemented joint made.

A dynamo belt must run evenly. A belt which lashes either up and down, or from side to side, should not be tolerated.

Steadiness.—It is important (*a*) that the machine be firmly fixed to a good foundation. If supported on solid joists (either timber or *iron*), a machine may be run successfully on an upper floor. (*b*) That

no vibration be set up in the armature and spindle by a lashing belt. The machine will spark and the brushes and commutators wear unduly if there is vibration.

Commutator and Brushes.—These will always repay careful attention. If the brushes are left to wear unequally, and the commutator is not cleaned, the machine will soon commence to spark badly, and both brushes and commutator will wear rapidly. If, however, these parts are attended to in accordance with the following instructions, the wear and tear will be very small.

The commutator is built up of a number of segments of copper, insulated from each other by thin plates of mica; the ends of the plates are turned to a cone, and are held by strong plates turned to fit the cone, and bearing tightly upon it by nuts threaded on a bush which carries the whole and takes the spindle.

The bush is driven by a feather let into the spindle, and the copper plates are insulated from the end plates by means of coned insulating washers of mica, and other insulators.

The ends of the armature coils are soldered into the copper segments.

The commutator is built so that it may be disconnected from the armature and replaced in small machines by unsoldering these connections and loosening two set-screws.

The brushes bear upon the smooth surface of the copper segments, which are turned to a true cylinder.

Adjustment of Brushes.—The brushes must be set truly on a diameter, so that the point of one is diametrically opposite the point of the other. As they wear they must be advanced to maintain the same distance, and consequently to bear at the same angle on the surface of the commutator.

They must be advanced frequently, even though the wear may be very small, otherwise the brush will not bed properly on the surfaces of the commutator when advanced.

Each brush must always bed equally well at the point, or toe, and at the heel. If brushes are allowed to wear too much before advancing (but this should not be), they must be taken out and filed to fit truly.

In filing a brush, clamp it firmly, and file by taking long strokes with a file always in one direction. If it is the toe that requires filing, after filing to fit, take off the sharp edge, leaving the toe always $\frac{1}{16}$ inch thick.

One brush often wears faster than its fellow (or fellows), and must be set up accordingly. Moreover, sometimes a whole set of brushes on one side of the commutator will wear faster than those on the other side, and this must be allowed for, or the brushes will cease to be on a diameter, and sparking and flatting of the commutator may result.

Flats.—The most fruitful source of the formation of little "flats" upon the surface of the commutator is the brushes being out of adjustment. Another cause is vibration of the brushes, due primarily

to vibration of the machine, owing to improper foundations or a badly-jointed belt. The flats are sometimes caused by the pressure of the brushes being reduced to too low a limit.

Pressure. — It is well to have the pressure as light as possible, so long as no sparking and no vibration takes place at the brushes.

Oiling and Cleaning the Commutator. — Use a little good mineral oil or vaseline, applied with a piece of rag. Do not on any account apply oil with a feeder, or on a piece of waste.

A commutator well looked after will acquire in time a dark-coloured, smooth polish. When this takes place run a piece of No. O O emery cloth on the commutator occasionally before starting to work.

In flour-mills and dusty places it is necessary to clean the commutator with a little benzoline every day before starting, or, if run continuously, during the run, taking care not to drench the commutator; also to apply emery cloth about once a week as just directed.

Oiling the bearings. — Adjust the sight-feed lubricator to give about 3 to 10 drops per minute. The amount required varies with the quality of the oil used and the load on the machine. If the machine has been standing, give it a few extra drops before starting.

Good castor-oil is the best lubricant. It is well to use an oil feeder made *entirely of copper.* Keep the machine clean—free from copper dust and waste oil.

Should the commutator wear out of truth or become very uneven (scored), take out the armature and turn up the commutator in a lathe, being careful to use a fine-pointed tool and not to take heavy cuts; afterwards polish with emery cloth. If the commutator should be only scored, it may be dressed in the machine with coarse, and afterwards fine, emery cloth, finishing with No. O. Slight "ringing" does not matter.

TESTING SECONDARY CELLS.

If C is the discharge current in ampères, T the time of discharge in hours, then—

$$C^n \ T = A \ \text{constant},$$

where the exponent n has usually some value between 1·35 and 1·5.

If K denotes the capacity of the cell for a discharge current C and time of discharge T, the capacity K for some other discharge current C and time of discharge t will be given by—

$$k = K \left(\frac{C}{c}\right)^{n-1}.$$

Table giving Sizes, Areas, Carrying Capacity at 1,000 Ampères per Square Inch, and Resistance in Ohms per Statute Mile of Electric Cables.

PARTICULARS OF CONDUCTORS.

Legal Standard Gauge.	Diameter of each Wire.		Diameter of the Strand.		Sectional Area.		Weight.	Resistance.	Carrying Capacity.
	Inches.	$^m/_m$	Inches.	$^m/_m$	Square Inches.	Sq. $^m/_m$	Per Mile in lbs.	Ohms.	Ampères
7/22	·028	·711	·084	2·13	·0044	2·838	90	9·908	4·4
7/21	·032	·813	·096	2·44	·0057	3·703	117	7·596	5·7
7/20	·036	·914	·108	2·74	·0072	4·690	148	5·998	7·2
7/19	·040	1·02	·120	3·04	·0089	5·786	183	4·861	8·9
7/18	·048	1·22	·144	3·66	·0129	8·321	263	3·380	12·9
7/17	·056	1·42	·168	4·27	·0176	11·35	358	2·477	17·6
7/16	·064	1·62	·192	4·88	·0230	14·83	468	1·895	23·0
7/15	·072	1·83	·216	5·49	·0291	18·77	592	1·498	29·1
7/14	·080	2·03	·240	6·10	·0359	23·16	731	1·214	35·9
7/13	·092	2·34	·276	7·01	·0475	30·64	967	·9176	47·5
7/12	·104	2·64	·312	7·93	·0607	39·16	1235	·7183	60·7
7/11	·116	2·94	·348	8·84	·0755	48·70	1537	·5776	75·5
7/10	·128	3·25	·384	9·75	·0919	59·28	1870	·4744	91·9
19/22	·028	·711	·140	3·56	·0120	7·741	244	3·634	12·0
19/21	·032	·813	·160	4·07	·0156	10·06	318	2·795	15·6
19/20	·036	·914	·180	4·57	·0198	12·77	403	2·202	19·8
19/19	·040	1·02	·200	5·08	·0244	15·74	497	1·786	24·4
19/18	·048	1·22	·240	6·10	·0351	22·64	714	1·243	35·1
19/17	·056	1·42	·280	7·11	·0479	30·90	975	·9103	47·9
19/16	·064	1·62	·320	8·13	·0625	40·32	1272	·6976	62·5
19/15	·072	1·83	·360	9·14	·0791	51·03	1610	·5512	79·1
19/14	·080	2·03	·400	10·16	·0976	62·96	1987	·4467	97·6
19/13	·092	2·34	·460	11·68	·129	83·22	2625	·3380	129
19/12	·104	2·64	·520	13·22	·165	106·4	3358	·2642	165
19/11	·116	2·94	·580	14·73	·205	132·2	4173	·2126	205
19/10	·128	3·25	·640	16·26	·250	161·2	5090	·1744	250
37/19	·040	1·02	·280	7·11	·0477	30·77	971	·9140	47·7
37/18	·048	1·22	·336	8·53	·0686	44·25	1396	·6355	68·6
37/17	·056	1·42	·392	9·96	·0934	60·25	1901	·4667	93·4
37/16	·064	1·62	·448	11·38	·122	80·70	2483	·3574	122
37/15	·072	1·83	·504	12·80	·154	99·35	3134	·2831	154
37/14	·090	2·03	·560	14·22	·191	123·2	3887	·2283	191
37/13	·092	2·34	·644	16·36	·252	162·5	5129	·1730	252
37/12	·104	2·64	·728	18·49	·322	208	6554	·1354	322
37/11	·116	2·94	·812	20·63	·401	259	8160	·1087	401
37/10	·128	3·25	·896	22·76	·488	315	9931	·0893	488
61/18	·048	1·22	·432	10·97	·113	73	2300	·3859	113
61/17	·056	1·42	·504	12·80	·154	99·35	3134	·2831	154
61/16	·064	1·62	·576	14·63	·201	129·6	4091	·2169	201
61/15	·072	1·83	·648	16·46	·255	164·5	5189	·1710	255
61/14	·080	2·03	·720	18·29	·315	203	6410	·1384	315
61/13	·092	2·34	·828	21·03	·416	268	8467	·1048	416
61/12	·104	2·64	·936	23·77	·532	343	10820	·0810	532
61/11	·116	2·94	1·044	26·52	·661	426	13450	·0659	66
61/10	·128	3·25	1·152	29·26	·805	519	16390	·0541	

THE "LUNDELL" CONTINUOUS CURRENT MOTORS.

Brake Horse Power.	Ampères at 115 Volts.	Voltage.	Approximate Speed.	Pulley.		Weight in lbs.
				Diameter.	Face.	
$\frac{1}{4}$	2·2	115, 230	1,700	$2\frac{3}{4}''$	$1\frac{1}{4}''$	40
$\frac{1}{2}$	4·3	115, 230	1,500	$3\frac{1}{2}''$	$2''$	75
1	8·7	115, 230	1,300	$4\frac{1}{2}''$	$2\frac{3}{4}''$	135
2	16·7	115, 230, 500	1,150	$6''$	$3\frac{1}{4}''$	210
3	23·9	,, ,,	1,150	$6''$	$3\frac{3}{8}''$	..
4	32·0	,, ,,	1,200	$7''$	$3\frac{3}{4}''$	..
5	39·4	,, ,,	1,100	$8''$	$4\frac{1}{4}''$	..
$7\frac{1}{2}$	57·8	,, ,,	1,050	$9''$	$5''$	..
10	76·1	,, ,,	1,000	$11''$	$6''$	..
15	118·7	,, ,,	850	$13''$	$6\frac{1}{2}''$	..
20	145·2	,, ,,	800	$15''$	$7''$	..
25	179·5	,, ,,	750	$17''$	$8''$	..

THE FULMEN ACCUMULATOR.

Traction Type.

	Average rate of charge.	Normal rate of discharge.	Capacity at Normal rate.	External Dimensions.			Approximate weight of cell complete.
				Length.	Width.	Height over all.	
	Ampères.	Ampères.	Amp.Hrs.	Inches.	Inches.	Inches.	lbs.
B 11 ..	9	17	85	$3\frac{3}{4}$	4	$11\frac{3}{4}$	15
B 13 ..	10	20	100	$4\frac{1}{2}$	,,	,,	18
B 15 ..	12	23	115	5	,,	,,	$20\frac{1}{2}$
B 17 ..	14	27	135	$5\frac{1}{2}$	,,	,,	23
B 19 ..	16	30	150	$6\frac{1}{2}$	,,	,,	26
B 21 ..	17	33	165	7	,,	,,	$28\frac{1}{2}$

These cells are stated to be capable of standing four times the normal discharge for heavy inclines. The makers have found by experience that the most economical way to charge these cells is by constant E.M.F. (110 volts for a battery of 44 cells).

THE "ROSENTHAL" ACCUMULATOR.

The National Motor Carriage Syndicate, Ltd., 37, Walbrook, E.C.

Type.	No. of Plates.	Weight. Plates.	Weight. Complete Cell.	Normal Charge in amperes.	Capacity in ampère hours at 10 amperes.	20 ampères.	30 ampères.	40 ampères.	Size of complete cell. Height over all.	Height.	Width.	Depth.	Size of Plates. Width.	Depth.	Ampère hours of Plates.	Ampère hours of Complete Cell.	Remarks.
R°	9	kilos. 8·25 / lbs. 18·1	kilos. 10 / lbs. 22	20	160	140	130	120	9¼" / 23·5 c.m.	8½" / 21·5 c.m.	2⅞" / 18·7 c.m.	4" / 10·2 c.m.	6⅝" / 17·1 c.m.	6½" / 16·5 c.m.	17·3 per kilo. / 2·9 per lb.	14·3 per kilo. / 6·5 per lb.	Can be charged at 40 ampères and discharged at 60 if pressed.

N 2

THE LITHANODE CELL.

DATA OF 30 AMPÈRE HOUR BATTERY.

No. of cells.	Outside dimensions of battery.			Open E.M.F. of battery.	Approximate gross weight of battery.
	Length.	Width.	Height.		
	ins.	ins.	ins.	volts.	lbs.
1	3·75	7·00	6·37	2	8¼
2	5·12	7·00	6·37	4	16
3	7·27	7·37	7·00	6	22¼
4	9·50	7·37	7·00	8	29
5	11·60	7·37	7·00	10	36
6	13·75	7·37	7·00	12	43
7	15·78	7·37	7·00	14	50
8	18·00	7·37	7·00	16	56¾
9	20·12	7·37	7·00	18	63¾
10	22·24	7·37	7·00	20	70¾
11	24·36	7·37	7·00	22	77¾
12	26·50	7·37	7·00	24	84½

Particulars of Cell.

Vulcanite containing cell .. .. $\begin{cases} 6·25 \text{ inches long.} \\ 2·12 \quad ,, \quad \text{ wide.} \\ 5·25 \quad ,, \quad \text{ high.} \\ \text{weight, 10 ozs.} \end{cases}$

Positive element .. $\begin{cases} \text{Two plates in each cell, 5·9 inches long.} \\ \qquad\qquad\qquad\qquad 3·9 \quad ,, \quad \text{ wide.} \\ \qquad\qquad\qquad\qquad 0·25 \text{ inch thick.} \\ \qquad\qquad\qquad\qquad \text{weight, 1 lb. 1½ ozs.} \end{cases}$

Negative element .. $\begin{cases} \text{Three plates in each cell, 5·9 inches long.} \\ \qquad\qquad\qquad\qquad 3·9 \quad ,, \quad \text{ wide.} \\ \qquad\qquad\qquad\qquad 0·13 \text{ inch thick.} \\ \qquad\qquad\qquad\qquad \text{weight, 11½ ozs.} \end{cases}$

Weight of connectors, 3 ozs.
Weight of cover, vent plug, sealing, and separators, 2 ozs.
Quantity of electrolyte, 15·5 fluid ozs.
Gross weight of complete cell, 6 lbs. 7 ozs.
Normal charging rate, 3 ampères.
Normal discharging rate, 3 to 4 ampères.
Maximum safe discharging rate, 9 to 12 ampères.
*App*roximate internal resistance, 0·015 ohm.

THE FAURE-KING ACCUMULATOR,

As made by the E.P.S. Co., London.

No. of Plates.	Max. Charge, Ampères.	Discharge, Ampères. For 5 hours. Rate.	Superficial Area. Per Kilowatt hour spread over 5 hrs. discharge.	Approximate External Dimensions. Length.	Width.	Height of Box.	Height over all.	Approximate Weight. Per Kilowatt hour spread over 5 hrs. discharge.	Complete with acid.	Dilute Acid each Cell. Weight of Acid.	Part of Carboy.
								lbs.	lbs.	lbs.	
5	10	10	178	2¾"	6½"	11"	11½"	180	18	4	·033
7	15	15	162	3½"	6½"	11"	11½"	153	23	4½	·038
9	20	20	150	4⅜"	6½"	11"	11½"	135	27	5	·044
11	25	25	143	5½"	6½"	11"	11½"	128	32	6	·052
13	30	30	138	6¾"	6½"	11"	11½"	120	36	7	·060
15	35	35	134	7½"	6¾"	11"	11½"	117	41	7½	·064
19	45	45	130	9"	6½"	12"	12½"	113	51	9	·077
23	55	55	127	10¼"	6¼"	12"	12½"	112	62	11	·094

Special charging Instructions for use with Faure-King Traction Cells.

The strength of Dilute Sulphuric Acid to be of 1,190 specific gravity. The rate of first charge should not exceed 2 ampères per positive plate; that is, for a 15-plate section, the current for the first charge would be 14 ampères, and so on. The first charge should be continued (approximately for 40 hours), and until the specific gravity (after having fallen) has risen again to 1,200. After a first discharge of about 3 ampères per positive plate, the second charge may be given at a rate of about 4 ampères per positive plate, after which the charges may be about 6 or 7 ampères per positive plate, and the battery may then be used at the listed rates.

THE ELIESON LAMINA ACCUMULATOR Co., Ltd.

"C" TYPE, in Ebonite Boxes.

(For Motor Cars.)

No. of plates.	Rates of Working.		Approximate Capacity in amp. hrs.		Approximate dimensions over all.			Weight complete with Acid.
	Charge in amps.	Discharge in amps.	Full list rate.	Half list rate.	Length.	Breadth.	Height.	
					in.	in.	in.	lbs.
7	15–25	20	100	120	7	4	13	27
9	25–35	30	130	160	7	5½	13	35

"T/B" TYPE, in Ebonite Boxes.

These cells are specially made for tramcar and heavy traction work.

No. of plates.	Rates of Working.		Approximate Capacity in amp. hrs.		Approximate dimensions over all.			Weight complete with Acid.
	Charge in amps.	Discharge in amps.	Full list rate.	Half list rate.	Length.	Breadth.	Height.	
					in.	in.	in.	lbs.
5	25–35	30	180	220	10½	4½	13	40
7	35–45	40	260	320	10½	6	13	56
9	45–60	50	360	450	10½	7½	13	72

Method of Grouping Cells and Connections in order to vary Speed.

The following method is that adopted by Mr. Carl Oppermann in his electro-motor vehicles. There are two batteries, each containing 21 elements, the average discharge being 25 ampères at 84 volts.

FIG. 1.—SLOW AHEAD, BATTERIES IN PARALLEL, F. M. COILS IN SERIES.
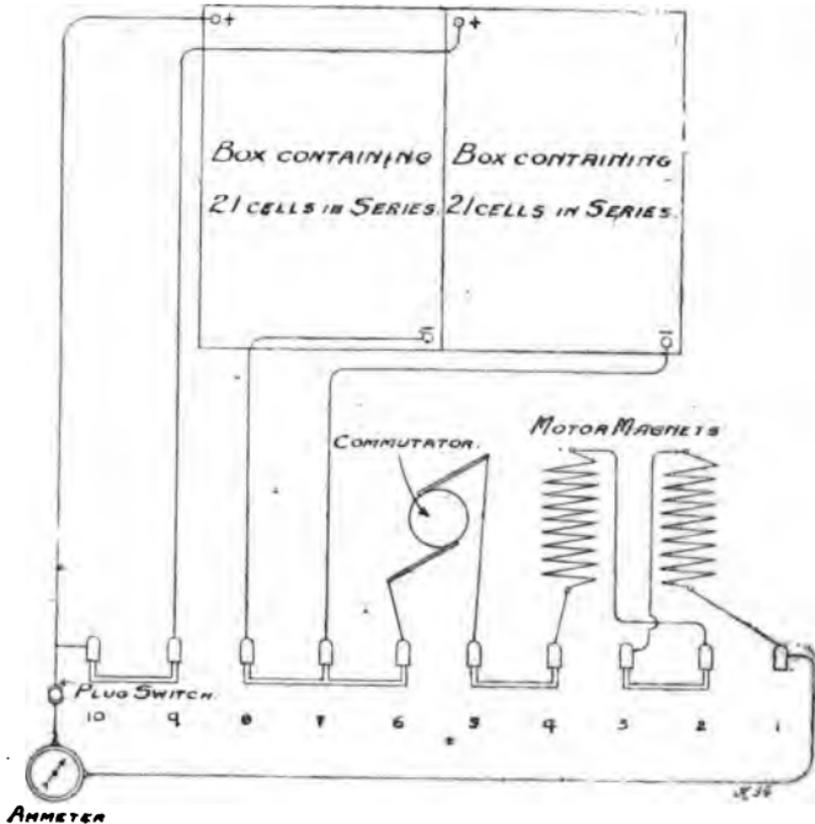
FIG. 2.—HALF-SPEED AHEAD, BATTERIES AND F. M. COILS IN SERIES.
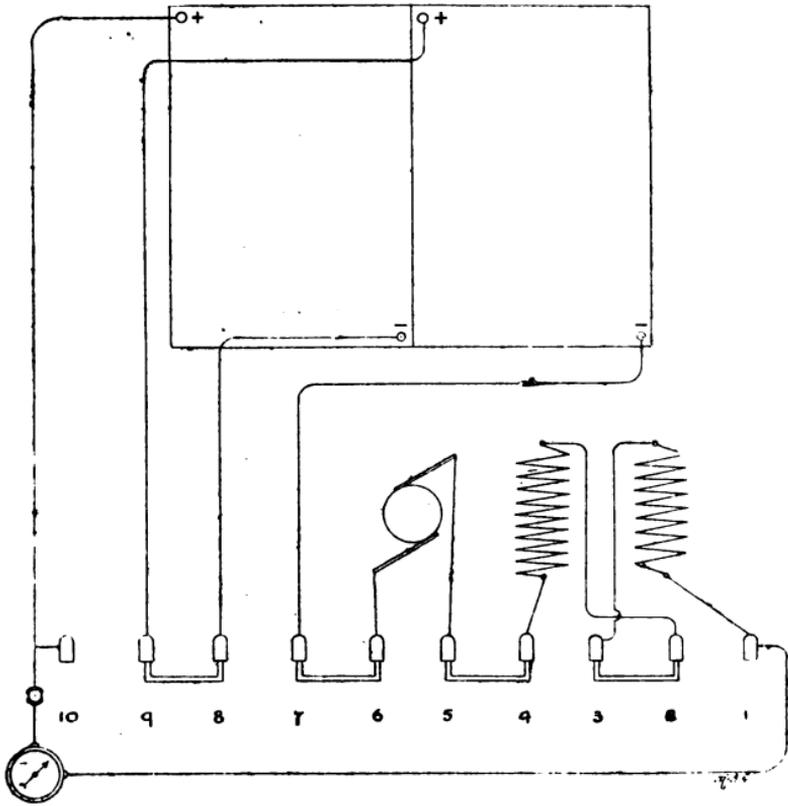
Fig. 3.—Full-speed ahead, Batteries in series, F. M. Coils
in parallel.
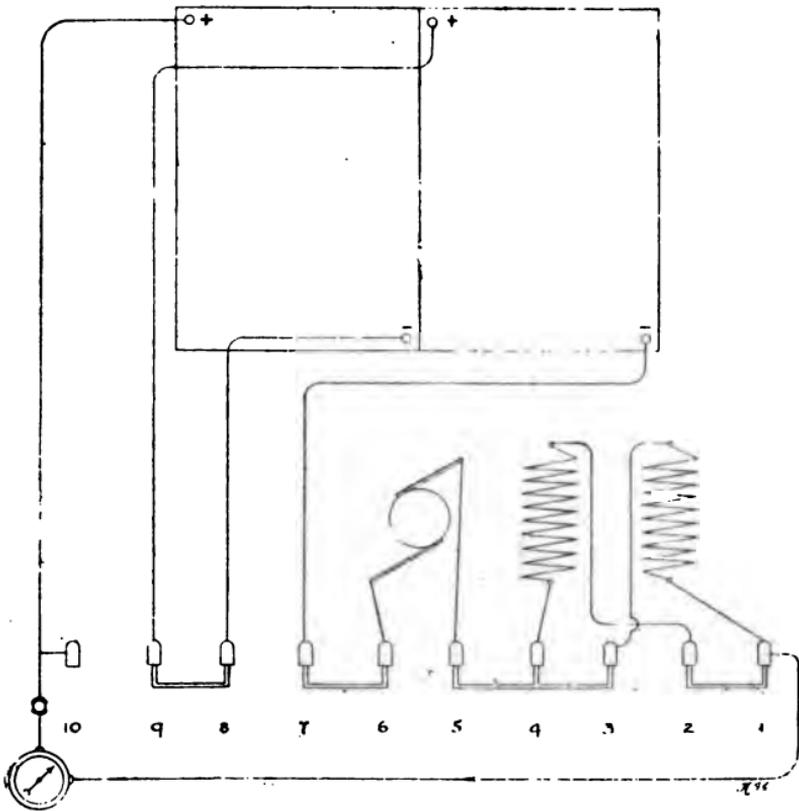
FIG. 4.—SLOW ASTERN, BATTERIES IN PARALLEL, F. M. COILS IN
SERIES. DIRECTION OF CURRENT IN COMMUTATOR REVERSED.
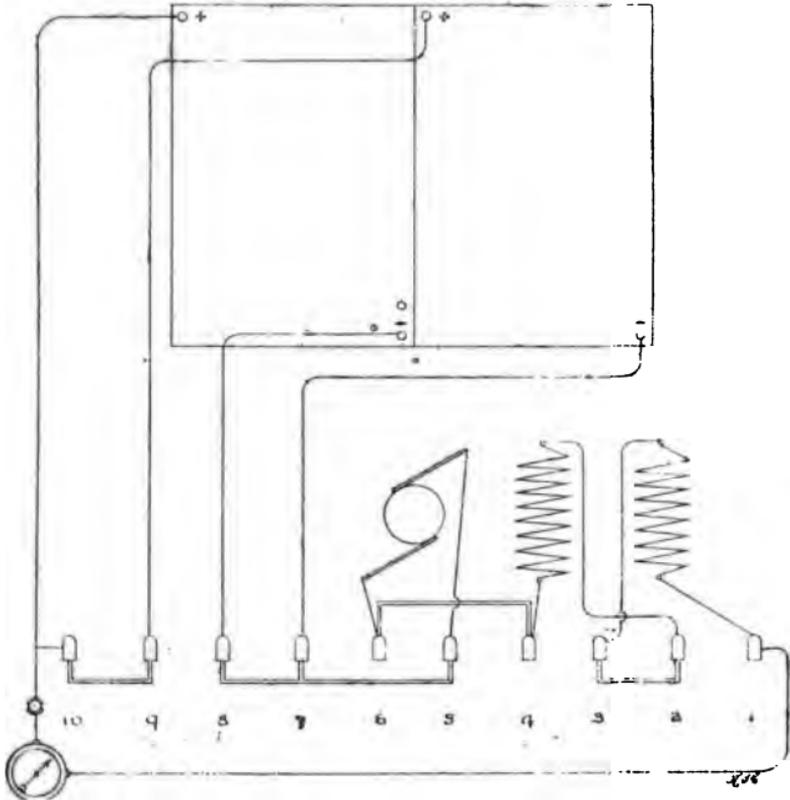
THE CARSAK CELL.

This is manufactured by the General Electric Company, who state
that it is eminently suitable for spark ignition in moto-tricycles.
It is claimed for the cell that it has a low internal resistance and
high output which is steadily maintained. The electrolyte is
"Salectron," or sal ammoniac. In the largest size of cell, $8\frac{3}{4}'' \times 5''$,
the initial current is 14 ampères and the internal resistance ·12 ohm.

"JOEL" PATENT ELECTRIC MOTORS.

THE NATIONAL MOTOR CARRIAGE SYNDICATE, LTD., 37, WALBROOK, LONDON, E.C.

Type.	B.H.P.	Speed. Revs. per minute.	Weight of Motor. lbs.	Electrical efficiency.	Remarks.
J M²	2	600	112	90°/₀	These motors will run at 1/4, 1/2, or full speed of 600 as required for carriages, and are made to give 50 per cent. more B.H.P. for short periods, and will give 100 per cent. more power if pressed.
J M¹	4	600	150	90°/₀	

ELECTRIC MOTORS.

Efficiencies of Electric Tramway System.

	Per cent.	Per cent.
Steam engines	70 to	95
Mechanical efficiency of dynamos..	80 ,,	95
Overhead line and feeders..	85 ,,	95
Motors, including gear	70 ,,	85
Single reduction gear	90 ,,	95
Accumulators in central stations	70 ,,	86
Rotary transformers..	90 ,,	96
Stationary alternating-current transformers ..	94 ,,	97
Return circuit	⅕ ,,	2

(DAWSON.)

PATENTS FOR INVENTIONS.

BY

R. HADDAN, of the firm of Herbert Haddan & Co.

PATENTS for Inventions are grants from the Crown to inventors, by virtue of which they are entitled to the exclusive use and manufacture of their inventions for a limited time, in return for an exact and complete description of their inventions, so that others, at the termination of such monopolies, may be able to employ the invention as beneficially as they themselves have done, or could have done.

To support a claim for a patent, it is essential that the invention be NEW and not previously disclosed, for it is a principle of great importance that no patent should exist for anything that any other subject of the Crown could at the time have freely from his own knowledge have employed. Mere slight changes that required no ingenuity to produce, and mere exercise of ordinary skill, such as any-one skilled in the trade could have performed without cudgelling his brains, do not entitle to a patent. There must be a substantial novelty.

An invention must also be USEFUL, or it cannot properly be patented.

Thus novel and useful inventions, which are for the benefit of trade, are alone proper subject matter for patents.

Usually, when an idea for an invention occurs to anyone, it is desirable to at once protect it by making an application for a patent for it. It is not necessary, nor is it advisable, to wait until the details of the invention are worked out; first, because the law permits an application for patent to be made while the invention is still in a crude state; secondly, because if two persons should independently apply for patents for the same or similar inventions, the first applicant has, in law, the preference.

With such an application a PROVISIONAL SPECIFICATION has to be filed explaining clearly the nature of the invention.

The inventor having taken this course (the cost of which, including the government stamp of £1 on the application form, is usually, with agent's charges, about three to five guineas) has now nine months in which to perfect his invention, and ascertain whether it is desirable to proceed.

As soon as the invention is worked out and proved, and presuming it is a sufficient success to warrant further expense, the COMPLETE SPECIFICATION, giving full particulars of the nature of the invention

and the method of performing it, is prepared, with drawings if needed, and lodged at the Patent Office. The cost is usually about seven to twelve guineas according to length, time, &c., including the government stamp of £3.

After "acceptance" by the Patent Office, which issues in about four to eight weeks, the inventor then acquires a fuller measure of protection; and at the expiration of a further two months, during which his application is exposed to opposition, he obtains the letters patent, with the full rights thereto pertaining.

There is another course, namely, to begin at once with a complete specification. The patent is obtained, of course, more quickly, but this course is not advisable, and the expense in government fees is the same.

It is to be observed that as the specifications are the very basis of the patent rights, they must be most carefully drawn; and it is desirable that they should satisfy not only the ordinary workmen in the trade, but also experts in the writing and construction of such documents, and last, but not least, lawyers, for the inventor's ultimate resort in case of infringement is the court, where the meaning of the specification will become the great bone of contention.

Another point to observe is that the inventor must be the applicant, or, at least, one of the applicants, or the patent is invalid. The inventor cannot, therefore, permit any other person to take the patent, but must apply for it himself; he can then assign it, or undertake to assign it, to others.

Patents date from the day they are applied for, and their term is fourteen years. No further fees are due on them until the end of the fourth year, when a £5 tax becomes due. Thenceforward there is a yearly tax increasing £1 per year during the remainder of the fourteen years. When any such is not paid the patent lapses, but three months' grace at the longest can be had for paying any of the taxes by petition, and payment of a fine.

The British patent, to which the above remarks almost exclusively apply, extends only to England, Wales, Scotland, Ireland, and the Isle of Man. If the colonies and other countries are to be covered, separate patents must be taken, each having its own laws and regulations. Most foreign and colonial patents cost from £5 to £20 each.

By applying for patent here, under a convention, the applicant obtains a priority of right to obtain patents in some twenty-two other countries and colonies, including France, Belgium, Sweden, Norway, Italy, Switzerland, Victoria, New Zealand, Queensland, Western Australia, Brazil, and the United States of America. That is to say, if he applies in any of these countries within six months his patent will not be affected by anything done in the meantime. This is a very valuable privilege.

Most government Patent Offices make no examination of the invention or specification before granting the patent, leaving these entirely at the inventor's risk. Some, such as the United States, Germany, Austria, Hungary, Sweden, Norway, &c., make such examination. That in the United States is extremely good, and it is desirable to make early application for this patent, not only for its own sake, being valuable and cheap, but to obtain the result of such examination which would save a search and considerable trouble in preparing the complete specification for England.

It is desirable to say a few words on the cost of foreign patents. This is made up of certain factors, first the government fees, unalterable in amount, the foreign agent's fee, depending somewhat on his professional standing, and lastly the charges for preparing specifications according to the practice, translations, copies, and similar expenses. It is obvious, therefore, that as a specification will often do for several countries or colonies, needing simply copying, there can be a considerable saving when several patents are taken at the same time. Unfortunately it is not generally customary in the profession to itemize these charges, so that such reductions are not always offered or properly computed.

In conclusion, the reader may be reminded that patents may be very valuable properties, and though many so-called inventions are worthless, and the readiness with which patents can be obtained facilitates the grant of many rubbishy and invalid patents, it is still desirable when an inventor recognizes that he has a valuable novelty that the patenting of it should be carefully undertaken, and the necessary expense of so doing borne at the outset, since faults are not afterwards repairable.

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MOTOR AND CYCLE TRADES CLUB, Corporation Street.

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* Members of the Club Committee.

The entrance fee is, at present, £1 1*s.*, and the Annual Subscription is £3 3*s.* Members who do not own Motor vehicles can take part in the Club Tours (of which there are some 5 or 6 each season), by securing seats in the Motor carriages engaged by or placed at the disposal of the Club.

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ABBREVIATIONS—Dir., Director; Man. Dir., Managing Director Sec., Secretary.

FOR full alphabetical list of Patentees' names, see Indexes to, and Vols. 1 and 2, of AUTOMOTOR JOURNAL.

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HOPKINSON, ED., M.A., &c. (Dir., Chloride Elec. Storage Synd., Ltd.).

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HORNSBY, R., & SONS, Grantham (Automotors).

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HOWARD, 13, Theobald's Row, W.C. (Tyres and Repairs).

*HOWARD, R., Durdham Down Villas, Westbury Road, Bristol.

HOWES BROS., 13, Prince of Wales Road, Norwich (Cycle and Motor Makers).

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*HUNTER & Co., East Down Works, Lewisham (Automotor Vehicle Manufacturers).

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HUTTON, A. H., Stonehall, Eccleshall, Bradford (Chairman Yorkshire Motor Car Co.).

*HYLER-WHITE, J., Coventry.

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ILIFFE, C. W. (Dir., Beeston Motor Co., Ltd.).

ILLINGWORTH, E. (Dir., Bradford Cycle and Motor Car Assocn., Ltd.).

ILLSTONE, G. (Dir., Brampton Bros., Ltd.).

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*Knight, J. H., Barfield, Farnham.
*Knowles, R. M., Colston Bassett Hall, Brigham.
*Koosen, John A., 1, Sussex Place, Southsea (Lutzmann Oil Motor).

Lambert, T. H. (Dir., Humber Co., Ltd.).
Lambert, W. (Dir., Leather Shod Wheel Co., Ltd.).
*Lancashire Steam Motor Co., Leyland, Lancashire (Steam Motor Vans, Buses, Drays, &c). T.A.: "Motor, Leyland."
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Lea, J. P. (Dir., Thornton Motor Co., Ltd.).
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Leeder, E. H. (J. M. Leeder & Son), Swansea (Dir., Swansea Motor Omnibus Co., Ltd.).
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Lever Bros., Ltd., Port Sunlight, Birkenhead.
Lewis & Lewis, Townmead Engineering Works. Fulham, S.W.
*Liquid Fuel Engineering Co., 20, Abchurch Lane, E.C. (Works : East Cowes, Isle of Wight), Sec., W. J. Songhurst (*Steam Engines, Steam Vans, Lorries and Omnibuses*). (*See Advt.* p. xvi.)

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MARQUAND, H. B., Shipowner, Cardiff (Dir., Marquand, Accumulator Co., Ltd.).

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MARSHALL, SONS, & CO., Britannia Ironworks, Gainsborough).

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McDONNELL, A. (Dir., Roots' Oil Motor Carriage Co., Ltd.).

McINTOSH, R. Y. (Dir., David Martyn & Co., Ltd.).

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MITCHELL & SMITH, 59, St. Vincent Street, Glasgow (Accountants).

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MONKS, H. R. (Dir., British Thomson-Houston, Ltd.).

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*MOTOR TOURING Co., THE, Head Quarters, Llandudno (Petrol Stores, Accumulators charged, &c.).

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MULLINER, A. G. (Dir., Mulliner, London, Ltd.).

MULLINER, H. H. (Dir., Lond. Elec. Cab Co., Ltd.).

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PARKER, THOS. H. (Dir., Elec. Street Car Manfg. Synd., Ltd.).

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PARSONS, HON. C. A. (Turbines), Newcastle-on-Tyne.

PATERSON, H. R. (Dir., Lond. Elec. Cab Co., Ltd.; Carter, Paterson, &c.).

PAVY, F. (Dir., New General Traction Co., Ltd.).

PEDLEY, G. F. (Lond. Motor Van & Wagon Co.).

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PEEK, W. (Dir., Madelvic Motor Car Co., Ltd.).

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  PROGRESS CYCLE Co., Coventry.
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  RAYNE, H. (Dir., Motor Attachment Synd., Ltd.).
·· READ, E. T. (Universal Motor Carriage & Cycle Co., Ltd.).
  REANEY, D. L. (Bradford Cycle & Motor Car Assocn., Ltd.).
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  RHODES, J. (Dir., Kelham Rolling Mills, Ltd.).
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  RICHTER MANUFACTURING Co , Bradford (Automatic Safety Guard).
  RICKARD, J. R. (Dir., Lond. Motor Car Wks. Co., Ltd.).
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  ROBINSON, THOS. (Man. Dir., Motor Manufacturing Co.; Lond. Steam Omnibus Co.).
·· ROLFE, J. H. H. (Dir., Pretot Motor Synd., Ltd.).
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, ROLLESTON, SIR J. F. L. (Dir., Clyde Cycle & Motor Car Co., Ltd.).
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Samuelson, Rt. Hon. Sir Bernhardt, Bart., 56, Princes Gate.

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WELDLESS STEEL TUBE Co., Icknield Port Road, Birmingham.

WELLS & Co., Hardman Street Oil Works, Manchester (Lubricating Oil).

WERNER ACCUMULATOR Co., 11 and 12, Devonshire Chambers, Bishopsgate Street, E.C.

WEST, H. H., Liverpool (Consulting Engineer).

*WEST, J. R., Alscot Park, Stratford-on-Avon.

*WHATTON, REV. A., Burleydown Vicarage, Southampton.

WHITE, A. J., Surrey House, Littlehampton (Dir., Motor Carriage Supply Co., Ltd.).

WHITE, G. F. (Dir., Smith, Parfrey & Co., Ltd.).

ͺWILLIAMS, J., St. Helen's Road, Swansea (Dir., Swansea Motor Omnibus Co., Ltd.).

*WILLIAMSON, L., Albert Road, Howick, Southport.

. WILLOUGHBY, F. S. (Dir., Challiner, &c., Tyre Co., Ltd.).

*WILLS, W. P. C., Southfield, Uxbridge, Middlesex.

. WILSON, PROF. CARUS (Electric Traction).

WILSON, W. H. (Dir., Challiner, &c., Tyre Co., Ltd.).

WISE, A. L. (Sec. Hydro-Pneumatic Traction Synd., Ltd.).

WISEMAN, E. (Dir., Compound Hydro-Carbon Motor Synd., Ltd.).

WOLESLEY SHEEP SHEARING Co., Birmingham (Automotors).

*WOOD, A. H. E., Sudbourne Hall, Wickham Market, Suffolk.

WRIDES, J. T., 3, Blomfield Pavement, Uxbridge Road, W. (Motor Builder).

WRIGHT, WM., Wollaton, near Nottingham (Daimler Co.).

ZACHARIAS, H. L. E. (Dir., Motor Car Emporium, Ltd., &c.).

NAMES OF ADVERTISERS.

LIST OF

LIMITED LIABILITY COMPANIES.

MANUFACTURING MOTOR VEHICLES OR COMPONENT PARTS AND ACCESSORIES.

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[NOTE.—To render this list of as much *practical* use as possible, those Companies appearing in the 1898 Pocket Book have been omitted which, although holding power under their Articles of Association to manufacture and deal in Motor Cars, obviously, in the opinion of the Editor, have no intention of exercising those powers, at least for the present. The registered particulars have been compiled from the latest official returns at Somerset House, and submitted for further verification to the Secretary of each Company individually. Where the particulars have been returned by the Company verified, an asterisk (*) is prefixed to the title.]

"T.A." *denotes Telegraphic Address.*

[NOTE.—For Limited Liability Companies not in this list, refer to the 1898 Pocket Book.]

A. R. ATKEY, Ltd., City Buildings, Carrington-st., Nottingham. Regd. Nov. 7, 1898. Cap. £2,000, in £1 shs. No returns.

ABEL MORBALL, Ltd., 10, Newhall-st., Birmingham. Regd. Jan. 3, 1898. Cap. £50,000, in £5 shs. (4,000 Pref.). 2,290 Pref. and 3,757 Ord. shs. taken up. 1,950 Pref. and 3,750 Ord. issued as paid. £5 per sh. called on 340 Pref. and 7 Ord. £1,735 paid.

*ACCUMULATOR SYNDICATE, Ltd., 21, Regent-st., Waterloo-place, S.W. Regd. May 13, 1897. Cap. £30,000, in £1 shs. All shares taken up, 25,000 issued as paid, 10s. per sh. called on 4,993 shs., and £1 per sh. on 7, £2,503 10s. paid. Dirs., Capt. H. C. Rigaud, H. Sartoris, J.P., F. Sartoris, J.P., J. V. Sherrin, W. T. Hick. Sec., J. W. Oakley.

AKESTER ELECTRO-MOTOR AND ACCUMULATOR Co., Ltd., 8, Wells-st., Oxford-st., W. Regd. May 16, 1887. Cap. £5,000, in £1 shs. 4,848 shs. taken up, 3,500 issued as paid, £1,324 12s. paid, £175 8s. unpaid, £475 12s. paid on forfeited shares.

ALLAN & ADAMSON, Ltd., 88 and 90, Tabernacle-st., E.C. Regd. Dec. 17, 1896. Cap. £30,000, in £1 shs. 7 shares taken up. No calls.

ANGLESEY MOTOR BUS CO., LTD. Regd. Oct. 12, 1898. Cap. £1,400, in £10 shs. Regd. by A. II. Atkins, Ltd., 22, Bouverie-st., E.C. No office or returns filed.

*ANGLO-FRENCH MOTOR CARRIAGE CO., LTD., 80, Digbeth, Birmingham. Regd. July 29, 1896. Cap. £300,000, in £1 shs. 171,107 shs. taken up, 100,000 issued as paid, £69,954 2s. 6d. paid, £1,152 17s. 6d. unpaid. Purchase consideration, £133,000. Dirs., Lord M. Beresford, A. Barrett, E. B. Ellice-Clark, F. Shanks, E. Elias.

ARSENAL MOTOR CO., LTD., Priory Park Villa, Priory Park, London-rd., St. Albans. Regd. Oct. 21, 1898. Cap. £100, in £1 shs. No returns,

AUSTEN'S PATENT WHEEL-MAKING MACHINE, LTD., 10, Draper's-Gardens, E.C. Regd. Dec. 30, 1897. Cap. £75,000, in £1 shs. No returns.

AUSTRALIAN CYCLE AND MOTOR CO., LTD., Broad Street House, Old Broad-st., E.C. Regd. Nov. 7, 1896. Cap. £75,000, in £1 shs. 56,337 shs. taken up, 21,500 issued as paid, 15s. per sh. called on 34,837, £21,396 10s. paid (including £164 paid in advance), £4,726 unpaid. Purchase consideration, £25,000. Dirs., W. Calcott, John Griffiths, J. B. Dunlop, C. H. Fox, W. J. Stoneham, T. Bayliss, L. W. Rudd.

*AUTOMATIC CONVEYANCE CO., LTD., Market Buildings, Market-st., Torquay. Regd. Mar. 1, 1898. Cap. £6,000, in £1 shs. 3,907 shs. taken up. 3,600 issued as paid. £307 received. Sec., W. T. Briggs.

*AUTOMOBILE ASSOCIATION, LTD., 1, Prince's-rd., Holland Park Avenue, W. Regd. July 16, 1898. Cap. £10,000, in £1 shs. No returns. (See Advt. pp. ii., iii.)

*AUTOMOBILE CLUB OF GREAT BRITAIN, LTD. Regd. Aug. 17, 1897. Cap. £100, in £1 shs. No returns. Merged in the Automobile Club of 4, Whitehall Court, London, S.W.

*AUTOMOBILE PROPRIETARY, LTD., 4, Whitehall Court, S.W. Regd. Dec. 7, 1897. Has no capital, but is limited by guarantee. Object: To promote and finance the Automobile Club of Great Britain and Ireland. Dirs., Roger W. Wallace, Q.C. (Chairman), W. Worby Beaumont, Frank Butler, Hon. Evelyn Ellis, C. Harrington Moore, Sir David Salomons, Bart., Frederick R. Simms, A. J. Walter. Sec., Claude Johnson.

AUTO-MOTOR EXPRESS CO., LTD., 1, York Street, Ramsgate. Reg. Aug. 20, 1896. Cap. £2,000, in £1 shs. 251 shs. taken up, 2s. 6d. per sh. called, £31 7s. 6d. paid.

AUTO-MOTORS, LTD., 40, Holborn Viaduct, E.C. Regd. Feb. 9, 1898. Cap. £60,000, in £1 shs. 32 shs. taken up, £32 paid.

BEESTON CYCLES (CONTINENTAL), LTD., Quinton Works, Cheylesmore, Coventry. Regd. Feb. 18, 1898. Cap. £15,000, in £1 shs.

2,475 shs. taken up. 15s. per sh. called, £2,005 paid. Dirs.,
R. Hill, S. Gorton, C. W. Iliffe.

*BEESTON MOTOR Co., Ltd., Cheylesmore, Coventry. Reg. Nov. 3,.
1897. Cap. £110,000, in £1 shs. (44,000 Pref.). z6,592 Pref. and
39,889 Ord. taken up. All issued with 17s. considered as paid,.
1s. called. £3,781 8s. Dirs., Rowland Hill, C. W. Iliffe, S..
Gorton. (T.A.: Quintons, Coventry.) Motor Cycles.

BELL-HALL TYRE SYNDICATE, Ltd., County Chambers, Westgate-rd.,.
Newcastle-on-Tyne. Regd. July 11, 1898. Cap. £50,000, in £1
shs. No returns.

BIRMINGHAM MANUFACTURING Co., Ltd., 70, Lombard-st., Birming-
ham. Regd. June 3, 1898. Cap. £11,000, in £1 shs. All shs.
taken up. 10,997 issued as paid, £3 paid. Ordered to be wound
up compulsorily on Sept. 28, 1898. Dirs., C. T. Mitchell, E. S.
Lermit, W. Davies, T. Spencer.

BIRMINGHAM MOTOR CYCLE Co., Ltd., 34, Waterloo-st., Birmingham.
Regd. Apl. 5, 1897. Cap. £125,000, in £1 shs. No returns.

BIRMINGHAM MOTOR OMNIBUS Co., Ltd. Regd. Apl. 7, 1897. Cap..
£10,000, in £1 shs. No office or returns filed. Filed by Jordan.
& Sons, 120, Chancery-lane, W.C.

BLACKPOOL MOTOR CAR Co., Ltd., Talbot Chmbrs., Talbot-sq.,.
Blackpool. Regd. July 30, 1897. Cap. £25,000, in £1 shs.
7,538 shs. taken up, 5,000 issued as paid. 10s. called, £1,240 15s.
paid, £28 5s. unpaid. Dirs., A. Dempster, J. Crabtree, W. R.
Ballantyne, J. Robinson, G. T. Hamilton, J. Harvey.

BLENHEIM CYCLE Co., Ltd. 116, Queen Victoria-st., E.C. Regd.
Oct. 8, 1897. Cap. £100, in £1 shs. 7 shs. taken up, £7
paid.

*BOAG'S CRESCENT CARRIAGE Co., Ltd., 54, Westgate-rd., Newcastle-
on-Tyne. Cap. £12,000, in £4 shs. 2,664 shares taken up, £3 per
sh. called and £7,992 paid. Dirs., G. Allison, W. E. Harker,.
T. Gillespie, J. R. Fletcher, A. Boag.

BOULTON AND PAUL, Ltd., Rose Lane Works, Norwich. Regd. Dec.
13, 1897. Cap. £128,000, in £10 shs. 11,157 shs. taken up.
11,150 issued as paid, £70 received. Dirs., J. J. D. Paul (Govg.
Dir.), H. Fiske.

*BRADFORD AND DISTRICT CYCLE AND MOTOR CAR TRADERS'
ASSOCIATION, Ltd., Unicorn Passage, Ivegate, Bradford. Cap..
£500 in £1 shs. 125 shs. taken up, called, and paid. Dirs.,.
A. Farnel, R. Blaymines, D. L. Reaney, E. Illingworth, T. Dyson,.
E. Holroyd (Sec. and Man.). (T.A.: Cyclist House, Bradford).
Not a Trading Company.

*BRAMPTON BROS., Ltd., Oliver-st. Works, Birmingham. Regd.
May 11, 1897. Cap. £200,000, in 15,000 Pref. shs. of £5, and
£125,000 Ord. shs. of £1 each. All shares taken up, Ord. issued as
paid, £5 per sh. called and paid on Pref. Dirs., E. Parkes, M.P.,

F. W. Brampton, G. Illston, C. H. Brampton, and A. Brampton.
Sec., J. J. Marriott. (T.A.: Brampton, Birmingham.) Driving
Chains, Wheels, Pinions and Saddles.

BRAYTON OIL MOTOR Co., Ltd., 74, Coleman-st., E.C. Regd. Jan.
13, 1898. Cap. £110,000, in £1 shs. No returns.

BRAYTON PETROLEUM MOTOR Co., Ltd., 74, Coleman-st., E.C. Regd.
Nov. 8, 1894. Cap. £80,000, in £1 shs. All shs. taken up, 79,993
issued as paid, £6 paid, £1 unpaid, and now in liquidation. Per-
mission has been given for the registration of the Brayton Oil
Motor Co., Ltd.

*BRITANNIA MOTOR CARRIAGE Co., Ltd., Britannia Motor Mills,
Woodstock-rd., Uxbridge-rd., W. Regd. Mar. 24, 1896. Cap.
£100,000, in £1 shs. 52,345 shs. taken up, 35,950 issued as paid,
15s. called on 16,595. £11,629 7s. 6d. paid, £816 17s. 6d. unpaid.
£1,250 paid on 5,000 forfeited shares. Purchase consideration,
£50,000. Dirs., Hon. J. H. H. Berkeley, W. M. Binnie, C. O.
Bastian, J. Bryant. Sec., C. H. Hancock. (Re-construction pro-
posed at Exty. Gen. Mg., Dec. 19, 1898, under title of British
Electric Motor Carr. Co., Ltd.)

BRITISH ALCOLITE, Ltd. Regd. May 26, 1898. Cap. £50,000, in
£1 shs. Regd. by Walker & Rowe, 8, Bucklersbury, E.C. No
office or returns fiied.

*BRITISH ALUMINIUM Co., Ltd., 9, Victoria-st., S.W. Regd. May 7,
1894. Cap. £300,000, in £10 shs. (20,000 Pref.). All shs. taken
up. 9,992 Ord. and 3,230 Pref. issued as paid, £10 per sh. called
and paid on 8 Ord. and 16,770 Pref. Debs., 1st, £50,000, 2nd,
£150,000. Dirs., R. W. Wallace, Q C., A. A. Common, LL.D., &c.,
A. S. Bolton, J.P., Robt. Heath, J.P., E. Ristori. Sec., C. F. Jones.
(T.A.: Cryolite, London.) Divs. 7 per cent. to July, 1896, on Pref.
shs. Aluminium castings of all kinds for sprocket wheels, gearing,
bearings, &c.

*BRITISH ELECTRIC TRACTION Co., Ltd., Donington House,
Norfolk-st., Strand, W.C. Regd. Oct. 26, 1896. Cap. £600,000,
in £10 shs. (30,000 Pref.). 30,000 Ord. and 10,000 Pref. shs.
taken up. £10 called on Ord., £6 10s. (including a premium of
£2 10s. per sh.) called on Pref. £354,817 paid, £57 paid in
advance of calls, and £10,183 in arrears. Dirs., Sir Chas.
Rivers Wilson, Earl of Suffolk, Sir C. Fremantle, J. S.
Raworth, Emile Garcke. Sec., C. Walmsley. (T.A.: Garcke,
London.)

BRITISH ELECTRICAL CYCLE AND MOTOR ENGINEERING Co., Ltd., 75,
Finsbury-pavement, E.C. Regd. Mar. 26, 1897. Cap. £40,000, in
£5 shs. No returns.

BRITISH HORSELESS CARRIAGE AND MOTOR CYCLE Co., Ltd. Regd.
May 6, 1896. Cap. £10, in £1 shs. No office or returns. Regd.
by Lumley & Lumley, 37, Conduit-st., W.

BRITISH HYDRAULIC JOINTING Co., Ltd. Regd. May 18, 1898. Cap. £1,200,000, in £1 shs. Resolution passed July 5, and confirmed July 22, 1898, for winding up voluntarily. The final meeting was held on Oct. 12, 1898.

*BRITISH MOTOR Co., Ltd., 40, Holborn-viaduct, E.C. Regd. Nov. 21, 1895. Cap. £1,000,000, in £1 shs. 250,000 shs. taken up, 249,999 issued as fully paid, £7 paid. Dirs., H. J. Lawson, T. Robinson, and H. Hewitt Griffin. (*See Advt.* pp. vi., vii.)

BRITISH MOTOR SYNDICATE, Ltd. Name changed to BRITISH MOTOR Co., Ltd. (q.v.)

*BRITISH THOMSON-HOUSTON, Ltd., 83, Cannon-st., E.C. Regd. May 18, 1896. Cap. £240,000, in £10 shs. All shs. taken up, 7,469 issued as paid, £165,310 paid. Dirs., E. Lazarus (Chairman), A. R. Marks (Man. Dir.), Sir Thos. Thompson, Bart., W. A. McArthur, M.P., W. Martindale, J. F. Nanheim, J. Hamspohn, J. Loewe, E. Thurnauer, C. Burrell, Capt. E. Griffin, and J. T. Merz. Divs. 1896–7, 5 per cent.; 1897–8, 10 per cent. (T.A.: Asteroidal, London.)

BRITISH WAGON Co., Ltd., 22, Moorgate-st., Rotherham. Regd. Feb. 10, 1898. Cap. £700,000, in £20 shs. All shs. taken up. £3 per sh. called, £105,000 paid. Dirs., F. L. Harrop, E. Drabble, J. Gibbs, F. Wheatley, J. C. Smith.

CAM GEAR SYNDICATE, Ltd. Regd. June 11, 1898. Cap. £12,000 in £1 shs. Regd. by W. T. Hick, 2, Church-court, Clement's-lane, E.C. No office or returns filed.

CAPSULE BATTERY Co., Ltd., 32, Great St. Helens, E.C. Regd. Sept. 25, 1894. Cap. £100,000, in £1 shs. 33,157 shs. taken up. 30,000 issued as paid. £3,150 paid, £7 unpaid.

CARMONT'S NOISELESS SHIELDED RUBBER TYRE Co., Ltd., Trafalgar Works, Murphy-st., Westminster Bridge-rd., S.E. Regd. Aug. 27, 1897. Cap. £10,000, in £1 shs. All shs. taken up and issued as fully paid.

CHALLINER & WILLOUGHBY CARRIAGE TYRE Co., Ltd., 1, Kay-st., Ardwick-green, Manchester. Regd. May 16, 1898. Cap. £50,000, in £10 shs. 1,200 shs. taken up, and £12,000 paid.

CHALLINER CARRIAGE TYRE SYNDICATE, Ltd., 1A, Kay-st., Ardwick Green, Manchester. Regd. Mar. 2, 1897. Cap. £10,000, in £1 shs. 407 shs. taken up, on 400, £20 paid, £20 unpaid. Resolution passed July 11, 1898, and confirmed July 27, for voluntary liquidation. Dirs., G. Everalt, W. H. Wilson, F. S. Willoughby.

*CHITTY DYNAMO AND MOTOR Co., Ltd., 4, Hythe-rd., Willesden-junction, N.W. Regd. Dec. 15, 1897. Cap. £200,000, in £5 shs. (24,000 cum. Pref.). 6,036 Ord. shs. taken up, 4,921 issued as

paid. £3 per sh. called on 1,108, and nothing on 7. £3,376 paid. Dirs., H. Lane, A. Dawson, W. J. P. Moore, H. Chitty (Man. Dir.), Sec., F. Martin.

*Chloride Electrical Storage Syndicate, Ltd., Clifton Junction, near Manchester. Regd. Dec. 12, 1891. Cap. £262,500, in 80,000 " A," 30,000 " B," 140,000 " C," and 12,500 Founders' shs. of £1 each. All " A," " B," and Founders', and 100,000 " C " shs. taken up. 157,500 issued as paid, £65,000 paid. 7 per cent. Pref. Cum. Div. paid Nov. 4, 1898, on " A " shs. for 1893. Dirs., F. H. Bowman, D.Sc., &c., Ed. Hopkinson, M.A., &c., A. R. Harvey, W. Bannister, J.P., J. S. Baker. Manager, G. A. Grindle. Sec., Holland Dell. (T.A.: Accumulate, Pendlebury.) Accumulators.

Clarkson & Capel Steam Car Syndicate, Ltd., 34, Queen-st., E.C. Regd. Feb. 13, 1897. Cap. £20,000, in £1 shs. (10,000 Pref.). 8,289 Pref. and all Ord. shs. taken up. All Ord. and 3,500 Pref. issued as paid. £1 per sh. called on 4,789. £4,789 paid.

*Clyde Cycle and Motor Car Co., Ltd., Wyvern Buildings, London-rd., Leicester. Regd. Feb. 2, 1897. Cap. £25,000, in £1 shs. (10,000 Pref.). 10,125 shs. taken up, 7,000 issued as paid, £3,125 paid. Purchase consideration, £15,000. Dirs., Sir J. F. L. Rolleston, A. E. Burnaby, G. Parr, G. H. Wait. Div., 1897, 10 per cent.

*Compound Hydro-Carbon Motor Syndicate, Ltd., Guildford-st., Luton, Beds. Regd. Aug. 4, 1898. Cap. £12,000 in £1 shs. No returns. Dirs., J. Holroyd, M.I.M.E., E. Wiseman, J. Tearle.

Co-operative Cycle Manufacturing Co., Ltd., 11, Clerkenwell-green, E.C. Regd. Jan. 13, 1898. Cap. £10,000, in £1 shs. No returns.

Cosmopolitan Cycle and Motor Works, Ltd., 52, Queen Victoria-street, E.C. Regd. Sept. 20, 1897. Cap. £2,000, in £1 shs. 7 shs. taken up, £7 paid.

Coventry Accessories, Ltd., Triangle-chambers, Martineau-st., Birmingham. Reg. Feb. 9, 1898. Cap. £5,000, in £1 shs. 3,007 shs. taken up. 3,000 issued as paid, £7 received.

Coventry Motor Co., Ltd., 40, Holborn Viaduct, E.C. Regd. Oct. 5, 1896. Cap. £250,000, in £1 shs. 7 shs. taken up, £7 paid.

Craven Cycle Co., Ltd., Hill-st., Coventry. Regd. Oct. 5, 1897. Cap. £2,000, in £1 shs. 1,207 shs. taken up. 1,200 issued as paid, No calls on 7.

Crawford Cycle and Motor Co., Ltd., 4, Mesnes-st., Wigan. Regd. July 3, 1897. Cap. £10,000, in £1 shs. 4,715 shs. taken up, 3,550 issued as paid, £1,165 paid. Dirs., R. Ffarrington, W. Thom, A. Hewlett, T. M. Dixon, J. Wood, T. J. S. Clepham, O. Gee.

CREANCHE AUTOMOBILE AND CYCLE SYNDICATE, Ltd., 75, Queen Victoria-st., E.C. Regd. Aug. 17, 1897. Cap. £4,000, in £1 shs. Resolution passed on Nov. 19, 1897, for voluntary liquidation, with A. Pajol, of 5, Rue Scribe, Paris, as liquidator.

CREWDSON, HARDY & Co., Ltd., Yorkshire Tube Works, Middlesbrough. Regd. July 16, 1898. Cap. £55,000, in £5 shs. No returns. Dirs., Sir Raylton Dixon, J.P., John Livingston, W. H. Hardy.

CROLL'S IMPROVED BRAKE HOLDER Co., Ltd., 34 and 36, Gresham-st., E.C. Regd. Oct. 1, 1897. Cap. £10,000, in £1 shs. No returns. Report of Post Office, " Gone away."

*CROSSLEY BROS., Ltd., Pottery-lane, Openshaw, Manchester. Regd. April 5, 1897. Cap. £973,700, in £10 shs. (40,339 Pref.). All shs. taken up and paid. 12,519 Pref., and 57,031 Ord. issued as paid. Dirs., W. J. Crossley, D. H. Irwin, H. P. Holt, R. Wilson, A. Simpson. Sec., W. S. Huffson. (T.A.: Crossleys, Openshaw.) Gas and Oil Engines.

CROWDUS ACCUMULATOR SYNDICATE, Ltd., 34, Victoria-st., S.W. Regd. Sept. 29, 1898. Cap. £50,000, in 35,000 shs. of £1 and 30,000 shs. of 10s. each. No returns.

*CRYPTO WORKS Co., Ltd., 29, Clerkenwell-rd., E.C. Regd. April 13, 1888. Cap. £20,000, in £1 shs. 11,543 shs. taken up, £11,543 paid.

*CYCLE COMPONENTS MANUFACTURING Co , Ltd., Bournebrook, Birmingham. Regd. Jan. 29, 1894. Cap. £175,000, in £1 shs. All taken up. Dirs., H. Du Cros, H. Du Cros, Jun., A. Du Cros. S. F. Edge, F. Warwick, C. Sangster. Sec., J. Carter. (T.A.: Components, Selly Oak.) Component Parts. Divs., 1895-6, 20 per cent.; 1896-7, 20 per cent.

CYCLE AND MOTOR ACCESSORIES Co., Ltd., 7, Southampton-row, W.C. Regd. Nov. 26, 1896. Cap. £10,000, in £1 shs. Now in liquidation.

CYCLE AND MOTOR CAR IMPROVEMENT CORPORATION, Ltd. Struck off Register, Oct. 4, 1898.

CYCLE, MOTOR VEHICLE, AND ACCIDENT INSURANCE Co., Ltd. Struck off Register, Oct. 4, 1898.

*CYCLES AND AUTOMOBILES MICHAUX, Ltd., 7, Gt. St. Helens, E.C. Regd. June 24, 1897. Cap. £100,000, in £1 shs. 62.082 shs. taken up, 55,000 issued as paid, £7,082 paid. Dirs., B. Dunkelsbuhler, D. O. Murray.

CYCLES, Ltd., 21, St. Mary-axe, E.C. Regd. Jan. 10, 1898. Cap. £10,000, in £1 shs. No returns.

CYCLISTS' CHALET Co., Ltd., 3, Kensington-place, Brislington, Bristol. Regd. Oct. 7, 1897. Cap. £30,000, in £1 shs. 2,796 shs. taken up. 140 issued as paid, 5s. per sh. called on 2,656, £667 15s. paid.

*DAIMLER MOTOR Co., Ltd., 219 to 229 Shaftesbury-avenue, W.C. Regd. Jan. 7, 1896. Cap. £100,000. in £10 shs. All shs. taken up (37 forfeited). £99,685 10s. paid. Purchase consideration, £40,000. Dirs., J. A. Bradshaw, Hon. E. H. Ellis, H. E. S. Holt, J. H. Mace, J. J. H. Sturmey, W. Wright. Gen. Man., A. H. D. Altree; Wks. Man., J. S. Critchley; Sec., E. M. C. Instone. (T.A.: Daimler, London or Coventry.) Oil Engines, Component Parts, Frames, Ignition Apparatus. Steering Gear, Wheels, and complete Motor Vehicles and Launches of all descriptions.

*D. P. BATTERY Co., Ltd., 66, Victoria-st., S.W. Regd. May 11, 1895. Cap. £10,000, in £1 shs. All shs. taken up, 14s. per sh. called on 9,992, and £1 per sh. on 8. £7,002 8s. paid.

DARE MANUFACTURING Co., Ltd., 14, Borough High-st., S.E. Regd. Mar. 17, 1898. Cap. £2,000, in £1 shs. No returns.

*DARLINGTON CYCLE AND MOTOR CAR Co., Ltd., 5, Northgate, Darlington. Regd. Feb. 26, 1897. Cap. £5,000. in £25 shs. 70 shs. taken up, £25 per sh. called, £1,750 paid. Dirs., J. Latham, T. Summersen, S. J. Summersen, A. von Bergen, R. B. Summersen, R. M. McLachlan, J. G. Harbottle.

*DAVID MARTYN & Co., Ltd., Engine Works, Glen-st., Hebburn-on-Tyne. Regd. Sept. 25, 1897. Cap. £3,000, in £10 shs. 170 shs. taken up. 90 issued as paid, £7 10s. called, £550 paid, £50 unpaid. Dirs., R. Hodge, R. Eeles, R. Y. McIntosh. Gen. Man., David Martyn. (T.A.: Martyn's, Hebburn.) Steam Vehicles.

DAVIDSON'S AIR CAR CONSTRUCTION SYNDICATE, Ltd., 59, Jermyn-st., S.W. Regd. Oct. 20, 1897. Cap. £20,000, in £1 shs. 10,750 shs. taken up. 10,000 issued as paid, £600 paid, £150 in arrears.

DAVIES MOTOR Co., Ltd. Name changed to NALDER BROS. & Co., Ltd. (q.v.).

DEFIANCE CYCLE AND MOTOR CAR Co., Ltd., 15, Temple-st., Swansea. Regd. Dec. 24, 1896. Cap. £10,000, in £10 shs. 250 shs. taken up, £2,500 paid.

*DELECROIX MOTOR SYNDICATE, Ltd., 15, Copthall-avenue, E.C. Regd. Jan. 19, 1898. Cap. £60,000, in £1 shs. 3,307 shs. taken up. £3,300 paid, £7 unpaid, 28,900 issued as fully paid. Dirs., E. Nadler, B. Weiser, X. de le Croix, Ad. de le Croix. (T.A.: Upupa.)

DEVON TRACTION AND MOTOR Co., Ltd., 1, Budge-row, E.C. Regd. Mar. 1, 1898. Cap. £25,000, in £1 shs. No returns. Dirs., R. C. Fenton, J. E. Parnell, W. J. Dart.

*DRAKE AND GORHAM ELECTRIC POWER AND TRACTION Co., Ltd., 66, Victoria-st., S.W. Regd. Sept. 28, 1898. Cap. £250,000, in £1 shs. No returns. Man. Dirs., J. F. Albright, B. M. Drake. Sec., R. Dand. (T.A.: Trainoirs, London.)

*DRAKE AND GORHAM ELECTRIC POWER AND TRACTION (PIONEER) SYNDICATE, Ltd., 66, Victoria-st., S.W. Regd. May 14, 1898.

Cap. £20,000, in £10 shs. 1,107 shs. taken up. £5 per sh. called.
Man. Dirs., J. F. Albright, B. M. Drake. Sec., R. Dand. (T.A. :
Trainoirs, London.)

DRUID CYCLE Co., Ltd. Regd. Nov. 23, 1898, by T. T. Hull,
22, Chancery-lane, W.C. Cap. £1,000, in £1 shs. No returns.

*DUNLOP MOTOR Co., Ltd., 14, Regent-st., London, S.W. Regd.
Oct. 16, 1897. Cap. £25,000, in £1 shs. No official returns filed.
Dirs., S. F. Edge (Chairman), Harvey du Cros, H. J. Lawson.
Sec., L. M. Bergin.

DUNLOP PNEUMATIC TYRE Co., Ltd., 14, Regent-st., London, S.W.
Regd. May 6, 1896. Cap. £4,000,000, in 1,000,000 Pref., 1,000,000
Ord., and 2,000.000 Def. shs., of £1 each. All shs. taken up,
full amount called, £3,999,024 10s. paid, £975 10s. unpaid.
Debs.. £550,000. Purchase consideration, £5,000,000. Dirs., Earl
de la Warr, The Duke of Somerset, The Earl of Albemarle, Harvey
Du Cros, Arthur Du Cros.

*E. C. CLARK, Ltd., Irongate, Derby. Regd. Nov. 11, 1897. Cap.
£7,000, in £1 shs. 4,651 shs. taken up. 2,625 issued as paid,
£2,001 12s. 6d. received, £24 7s. 6d. in arrears. Dirs., P. B.
Chadfield (Chairman), E. C. Clarke and W. N. Hallam. Man.
Dirs., R. W. Spriggs, C. E. Oliver.

ECLIPSE TYRE AND RIM Co., Ltd., 58, Broad-st., Birmingham.
Regd. Oct. 22, 1898. Cap. £16,000, in £1 shs. No returns.

EDWARD FOSTER & SON, Ltd., Central Brass Works, Woolshops,
Halifax. Regd. Oct. 14, 1897. Cap. £50,000, in £5 shs. 8,400
shs. taken up. 3,000 issued as paid, £27,000 received. Dirs.,
W. H. Foster (Chairman, Man. Dir.), R. Irvine, jun., H. H. Stocks,
J. M. Jackson, J. Frobisher, J. Barlow.

EDWARD PRESTON & SONS, Ltd., 21, Whittall-st., Birmingham.
Regd. Jan. 19, 1898. Cap. £50,000, in £1 shs. 21,500 shs. taken
up, and all issued as paid. Dirs., E. Preston, J. E. Preston, C. H.
Preston, F. W. Preston.

*EDWIN CLARK & Co., Ltd., Brimscombe, Rodborough, Gloucester.
Regd. Oct. 8, 1897. Cap. £3,500, in £1 shs. 1,086 shs. taken up.
£1,086 paid. Dirs., J. W. Earle, T. H. Fisher, F. S. Saunders.
Water-tube boilers, &c.

EGDELL CYCLE AND MANUFACTURING Co., Ltd., 59, Holborn-
viaduct, E.C. Regd. June 18, 1898. Cap. £2,500, in £1 shs.
7 shs. taken up. £7 in arrears.

ELECTRICAL CAB Co., Ltd. (see London Electrical Cab Co.. Ltd.).

ELECTRICAL LIGHT AND POWER Co., Ltd., 20, Victoria-st., S.W. Regd.
April 1, 1898. Cap. £6,000, in £1 shs. 7 shs. taken up. £7 paid.

*ELECTRICAL POWER STORAGE Co., Ltd., 4, Gt. Winchester-st., E.C.
Regd. Dec. 3, 1889. Cap. £100,500, in £5 shs. (100 Founders').
66 Founders', and 18,590 Ord. shs. taken up. 15,880 Ord.

issued as paid. £5 per sh. called on 66 Founders', and £3 per sh. on 3,132 Ord. £9,618 7s. 4d. has been paid, £121 15s. 6d. is unpaid. £400 has been paid on 404 shs. forfeited. Debentures £28,400 (5 per cent.) issued and taken up (part of £30,000 authorised). Div. 5 per cent. for past 6 years. Dirs., I. Irving Courtenay (Chairman), Sir Daniel Cooper, Bart., G.C.M.G., Sir James Render, Bart., M.P., F. Green, and Frank King. Chief Engr., H. W. Butler. Sec., Davis Smith.

ELECTRICAL TRAFFIC SYNDICATE, Ltd., 6, Old Jewry, E.C. Regd. Dec. 11, 1896. Cap. £1,000, in £1 shs. Now in liquidation.

ELECTRIC AUTOMOBILE SYNDICATE, Ltd., 1, St. Swithin's-lane, E.C. Regd. Nov. 29, 1898. Cap. £900, in £10 shs. No returns.

ELECTRIC CYCLE SYNDICATE, Ltd., 37, Walbrook, E.C. Regd. Apr. 12, 1892. Cap. £3,000, in £1 shs. 2,827 shs. taken up, 1,000 issued as paid, £1,742 10s. paid, £84 10s. unpaid.

ELECTRIC HANSOM CAB AND CARRIAGE SYNDICATE, Ltd., 28, Brook-st., Grosvenor-square, W. Regd. Dec. 11, 1897. Cap. £2,000, in £1 shs. No returns.

ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS, Ltd., 13, Spring - gardens, Manchester. Regd. Apr. 25, 1898. Cap. £150,000, in £5 shs. 16,087 shs. taken up. £2 per sh. called, £32,174 paid. £11,019 has been paid in advance of calls. Dirs., G. Flett, G. F. Fry, J. Kerr, R. H. Prestwich, G. Richardson.

ELECTRIC STREET CAR MANUFACTURING SYNDICATE, Ltd., Wednesfield-rd., Wolverhampton. Regd. Dec. 3. 1897. Cap. £25,000, in £1 shs. 7,130 shs. taken up, 10s. called, £3.552 10s. paid, £12 10s. unpaid. Dirs., S. Craddock, T. Parker, E. Lisle, S. Flood Page, T. H. Parker.

ELECTRIC TRACTION Co., Ltd., 16, Gt. George-st., Westminster. Regd. Mar. 22, 1894. Cap. £300,000, in 1,200 sh. of £1, and 29,880 shs. of £10 each. All shares taken up. £1 per sh. called on £1 shs., and 10s. per sh. on 29,880 £10 shs. £300,000 paid.

ELECTRIC VEHICLE SYNDICATE, Ltd., 6, Old Jewry, E.C. Regd. Sept. 21, 1897. Cap. £25,000, in £1 shs. All taken up. 13,000 issued as paid, 10s. called, £5,993 16s. 8d. paid, £1 3s. 4d. unpaid.

*ELIESON LAMINA ACCUMULATOR Co., Ltd., 4, Greenland-place, Camden Town, N.W. Regd. Aug. 14, 1897. Cap. £65,000, in £1 shs. No returns. Dirs., Martin Fradd, Earl of Galloway, K.T., C. P. Elieson, H. Mackenzie. Sec., W. S. Naylor. (T.A.: Emancipist, London.) Accumulators, Carriage Bodies, Chains, Frames, Gearing. Receiver for Deb. holders appointed, Nov., 1898.

ENDURANCE MOTOR Co., Ltd., 18, Hertford-st.. Coventry. Regd. Jan. 28, 1898. Cap. £1,000, in £1 shs. 192 shs. taken up. £182 issued as paid, £10 received.

ENGLISH SERPOLLET MOTOR SYNDICATE, Ltd., 7, Poultry, E.C. Regd. Nov. 18, 1896. Cap. £100,000, in £1 shs. 7 shs. taken up, £7 paid.

*ESSON MOTOR, Ltd., 8, Old Jewry, E.C. Regd. Sept. 29, 1896. Cap. £20,000, in £200 shs. 14 shs. taken up, called up and paid. Resolution passed July 12, and confirmed Aug. 5, 1898, for voluntary liquidation.

F. JACKSON & Co., Ltd., 77, Oxford-st., W. Regd. Dec. 13, 1897. Cap. £5,000, in £1 shs. 2,250 shs. taken up. 1,000 issued as paid, and £1,250 received.

FARLEY-CARTMAN Co., Ltd., 25, Miles-st., Wandsworth-rd., S.W. Regd. Aug. 29, 1898. Cap. 20,000, in £1 shs. No returns.

FELSCHE'S PATENT TUBE JOINT SYNDICATE, Ltd., 15, Copthall-avenue, E.C. Regd. Mar. 31, 1898. Cap. £700, in £1 shs. Resolution passed July 4, and confirmed July 27, 1898, for winding up voluntarily.

FLUID PRESSURE ENGINE SYNDICATE, Ltd. Regd. Nov. 26, 1898, by Mann & Taylor, 109, New Oxford-st., W.C. Cap. £15,000, in £1 shs. No returns. Dirs., W. Bonnie, H. E. Samble.

FORWARD ENGINEERING Co., Ltd., 67, Scholefield-st., Birmingham. Regd. Oct. 4, 1898. Cap. £50,000, in £5 shs. No returns. Dirs., L. W. Hodson, F. B. Barker, J. D. Garrett.

FOWNES FORGE AND ENGINEERING Co., Ltd., 37, Lime-st., E.C. Regd. Aug. 13, 1898. Cap. £50,000, in £10.shs. No returns.

FRISWELL, Ltd., 8, New Bridge-st., E.C. Regd. June 8, 1896. Cap. £40,000, in £1 shs. 7 shs. taken up. No calls.

FRANCO-ENGLISH MOTOR-CAR FACTORY Co., Ltd., 4, Copthall-chmbrs., E.C. Regd. July, 3, 1897. Cap. £22,000, in £1 shs. (20,000 Pref.). No returns or business done.

FRANKLIN'S CYCLE & MOTOR CARRIAGE MANUFACTURING Co., Ltd. Struck off Register on Oct. 4, 1898.

G. AND J. SMITH, Ltd., Tunbridge Wells. Regd. Dec. 13, 1898. Cap. £25,000, in £1 shs. No returns. Dirs., G. Smith, J. Smith, D. G. Cornwell, E. E. Smith.

*G. R. BLOT & Co., Ltd., 33, St. Swithin's-lane, E.C. Regd. Oct. 16, 1897. Cap. £75,000, in £1 shs. 30,693 shs. taken up, 14,400 issued as paid, £16,293 paid. Dirs., Th. Parker (Chairman), E. Honey, G. R. Blot. Sec., W. W. Aubanel. (T.A.: Microster, London.) Accumulators.

*GARRARD MANUFACTURING Co., Ltd., 111, Ryland-st., Birmingham. Regd. July 3, 1896. Cap. £25,000, in £1 shs. 8,000 shs. taken up, 5s. per sh. called, £2,000 paid. Debs. £5,000. Man. Dir., O. R. Garrard. (T.A.: Gearing, Birmingham.) Chains.

GEORGE F. MILNES & Co., Ltd., 43, Castle-st., Liverpool. Regd.
Sept. 10, 1898. Cap. £150,000, in £10 shs. No returns. Dirs.,
G. F. Milnes, W. H. Edwards, A. Bruce, W. Busch.

GIRLING CYCLE & MOTOR CAR, Co., Ltd., 185, Western-rd., Brighton.
Regd. Dec. 7, 1896. Cap. £20,000, in £1 shs. 11,960 shs. taken
up, 10,000 issued as paid, £1 per sh. called on 1,960. £1,507 10s.
paid, £452 10s. unpaid. Dirs., T. W. Girling, H. A. Arnold, C. B.
Stoner, F. J. Cully, H. J. Funnell, W. S. Ratcliffe, J. C.
Stringer.

GLEW'S STEEL-SHIELDED RUBBER TYRE SYNDICATE, Ltd., 17, Tower
Royal, Cannon-st., E.C. Regd. Sept. 22, 1898. Cap. £10,000, in
£1 shs. No returns.

*GLORIA CYCLE Co., Ltd., Priory-st., Coventry. Regd. Feb. 5, 1898.
Cap. £100, in £1 shs. 7 shs. taken up. No calls.

GREAT HORSELESS CARRIAGE Co., Ltd., 47, Holborn-viaduct, E.C.
Regd. May 14, 1896. Cap. £750,000, in £10 shs. 61,502 shs. taken
up, 25,000 issued as paid, £10 per sh. called on 36,502.
£327,546 10s. paid, £37,473 10s. unpaid. Purchase consideration,
£500,000. Dirs., H. J. Lawson, J. C. Mace, E. J. Pennington,
— Robinson, T. H. Lambert. (Resolution passed Dec. 22, 1897,
and confirmed Jan. 7, 1898, for voluntary liquidation, with John
Baker, of Chiswell House, E.C., as liquidator. Re-constructed
accordingly by the British Motor Syndicate, Ltd., under the title
of the "Motor Manufacturing Co., Ltd.")

"HART" ACCUMULATOR Co., Ltd., 75, Coleman-st., E.C. Regd.
Dec. 23, 1898. Cap. £40,000, in £1 shs.

*HASTINGS AND ST. LEONARDS ENGINEERING, CYCLE, AND MOTOR
CAR Co., Ltd., Seaside-rd., St. Leonards. Regd. Nov. 18, 1896.
Cap. £2,500, in £1 shs. 2,409 shs. taken up, 700 issued as paid,
£1,711 10s. paid (including £2 10s. paid on 20 forfeited shares).
Dirs., R. H. Gaby, L. O. Glenister, N. Chennells, T. C. Miller,
W. Slade, Jun. The whole undertaking purchased by the Victor
Engineering Co., St. Leonards.

*HEADLANDS' PATENT ELECTRIC STORAGE BATTERY Co., Ltd., 12,
Pall Mall, S.W. Cap. £20,000, in £1 shs. 19,663 shs. taken up,
14,993 issued as paid, £2,389 10s. paid. (See Advt. p. xviii.)

*HEARL & TONKS, 1897, Ltd., Victoria and Albert Works, Sampson-
rd. North, Birmingham. Regd. Mar. 18, 1897. Cap. £160,000, in
£1 shs. (50,000 Pref.). No office or return filed officially. Purchase
consideration, £160,000. Dirs., Col. Cox, A. E. Sayer, E. H.
Hearl, W. W. Tonks, H. J. Tonks. (T.A.: Peerago, Birming-
ham.)

HENRY WHITE & Co., Ltd., Pontymister Steel and Iron Foundries
and Engineering Works, near Newport, Mon. Regd. Oct. 1, 1897.
Cap. £50,000, in £1 shs. No returns.

HEWETSON'S, Ltd., 77, Oxford-st., W. Regd. Oct. 31, 1898. Cap. £25,000, in £1 shs. No returns.

HILLSDON & STONES, Ltd., Alexandra Works, Alexandra-gardens, Folkestone. Regd. Mar. 25, 1898. Cap. £6,000, in £1 shs. 3,558 shs. taken up. 3,550 issued as paid, £8 received.

HOFFMANN MANUFACTURING Co., Ltd., King's Head Court, Beech-st., Barbican, E.C. Works, Chelmsford. Regd. Jan. 11, 1898. Cap. £100,000, in £1 shs. (40,000 Pref.). 20,035 Pref. and 40,000 Ord. shs. taken up. 20,000 of each issued as paid, £1 per sh. called on the Pref., and 8s. per sh. on the Ord. £8,035 received. Man. Dirs., E. G. Hoffmann and C. A. Barrett. (T.A.: Hoffmann, Chelmsford.)

HOME AND COLONIAL CYCLE SUPPLY Co, Ltd., 16, High-st., Borough, S.E. Regd. Jan. 14, 1898. Cap. £5,000, in 5s. shs. 811 shs. taken up. £202 15s. paid.

*HOPKINS, TAYLOR, & Co., Ltd., Holloway Head, and 49 to 51, Ellis-st., Birmingham. Regd. Mar. 1, 1898. Cap. £2,000, in £1 shs. 1,008 shs. taken up. 1,000 issued as paid, £8 received. Dirs., R. C. Hopkins (Man. Dir.), P. Everitt. Sec., R. C. Hopkins. (T.A.: Fenders, Birmingham.)

HULL & DISTRICT CYCLE TRADES ASSOCIATION, Ltd., Grosvenor Hotel, Carr-lane, Hull. Regd. Oct. 31, 1898. Cap. £500, in £1 shs. No returns.

HUMBER & Co., Ltd., 32, Holborn-viaduct, E.C. Regd. Feb., 1895. (Reconstruction of "Humber & Co., Ltd.," regd. June 14, 1887.) Cap. £500,000 (250,000 Pref.), in £1 shs. All shs. taken up, 475,000 issued as paid, £25,000 paid. Dirs., A. R. Marten, C. N. Baker, T. H. Lambert, F. Goddard, M. D. Rucker, J. Ellis.

HUMBURTO PATENT CYCLE & ENGINEERING Co., Ltd., 31, Market-st., Nottingham. Regd. June 1, 1898. Cap. £100, in £1 shs. No returns.

*HYDRO - PNEUMATIC TRACTION SYNDICATE, Ltd., 181, Queen Victoria-st., E.C. Regd. Dec. 9, 1897. Cap. £3,000, in £1 shs. 1,503 shs. taken up. 750 issued as paid, 5s. per sh. called on 753. £187 10s. paid, 15s. in arrears. Dirs., T. J. Perrett, W. H. Liver-sidge, M. W. Shaw, H. Lane, J. Liversidge, and P. B. Liversidge. Sec., A. L. Wise. (T.A.: Inclined, London.)

IDRIS WHEEL SYNDICATE, Ltd., 14, Bartlett's-buildings, Holborn-circus, E.C. Regd. Nov. 11, 1898. Cap. £10,000, in £1 shs. No returns.

*I.E.S. ACCUMULATOR Co., Ltd., 78 and 79, Palace-chmbrs., Bridge-st., Westminster. Regd. July 26, 1895. Cap. £100,000, in £1 shs. 55,000 shs. taken up. 50,000 issued as paid, £5,000 paid, Debs. £6,000. Dirs., E. Mann, A. G. New. Sec., H. Woodfield. In liquidation, but no returns officially filed.

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INDIAN CYCLE & GENERAL ENGINEERING Co., Ltd., 2, Gresham-buildings, Basinghall-st., E.C. Regd. Nov. 23, 1897. Cap. £10,000, in £1 shs. 2,267 shs. taken up and issued as paid.

*INDIARUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS Co., Ltd. 106, Cannon-st., E.C. Works, Silvertown, E. Cap. £812,000, in £1 shs. 500,000 taken up and paid. Dirs., S. W. Silver, Hon. H. Marsham, A. Scott, A. W. Jarvis, Major L. Darwin, Matthew Gray (Man. Dir.). Sec., T. J. Lloyd. (T.A., Silvergray, London.) Divs., 1896, 1897, 10 per cent.; 1898, 2½ per cent. interim, balance due Feb., 1899.

*INSTITUTE OF BRITISH CARRIAGE MANUFACTURERS, 30, Moorgate-st., E.C. Regd. May 3, 1883, as a guarantee Company, not for profit (the word "limited" being omitted by permission of the Board of Trade), the liability of members in event of liquidation being £1. (T.A : Stenia, London.)

*INTERNATIONAL ENGINE PATENTS DEVELOPMENT Co., Ltd., 33, St. Swithin's-lane, E.C. Regd. Feb. 17, 1898. Cap. £3,750, in 1s. shs. 7 shs. taken up, 7s. unpaid. Dirs., R. Hunt, W. Shrimpton, A. G. New.

INTERNATIONAL STEAM CARRIAGE SYNDICATE, Ltd., 18, Hertford-st., Coventry. Regd. Dec. 11, 1897. Cap. £1,083, in £1 shs. All shs. taken up. 883 issued as paid, £200 received.

J. & L. LACY, Ltd., 35, Parr-st., Liverpool. Regd. Sept. 10, 1898. Cap. £50,000, in £1 shs. No returns. Dirs., L. Lacy, L. Lacy, Jun., J. J. Lacy.

JACKSON & HARRISON, Ltd., Bon Marché, New Briggate, Leeds. Regd. Aug. 24, 1898. Cap. £3,000, in £5 shs. No returns. Dirs., H. R. Webster, B. Mountain, R. R. France, G. H. Jackson, W. C. Harrison.

JESSE ELLIS & Co., Ltd., Invicta Works, Maidstone. Regd. Mar. 4, 1898. Cap. £60,000, in £1 shs. 33,165 shs. taken up. 19,793 issued as paid, £13,372 paid. Dirs., F. J. Beadle, R. J. Fremlin, J. Ellis, T. Scott.

J. J. HAGAN & Co., Ltd., (Irish Co.)., 46, Carlisle-rd., Londonderry. Reg. Dec. 7, 1898. Cap. £3,000, in £1 shs. No returns. Dirs., E. A. Hamilton (Man.), C. M. Boyton, J. H. Welch, C. O'Neill, and J. J. Hagan.

JOSEPH LUCAS, Ltd., Little King-st., Birmingham. Regd. Nov. 12, 1897. Cap. £225,000, in £5 shs. 40,000 shs. taken up. 12,151 issued as paid, £139,245 received.

*KELHAM ROLLING MILLS Co., Ltd., Kelham Island, Sheffield. Regd. May 17, 1873. Cap. £100,000, in £10 shs. All shs. issued, £4 10s. paid up, £45,000; mortgages £25,685. Dirs., J. Gamble,

J. Rhodes, F. R. Booth. (T. A.: Kelham, Sheffield.) Divs., 1893–4 to 1895–6, 2s. per sh.; 1896–7, 3s. per sh.; 1897–8, 4s. per sh. Tyre Bars, Steel Springs, &c.

KENDAL BICYCLE Co., Ltd., Beezon-lane, Kendal. Regd. May 27, 1898. Cap. £20,000, in £1 shs. 5,673 shs. taken up. 5,666 issued as paid. £7 received. Dirs., W. Iliffe, C. J. Cropper, W. H. Saurey, W. Gaddum, P. Manning.

LANCASHIRE AND WEST COAST MOTOR Co., Ltd., 78, Gorton-st. Blackpool. Regd. Nov. 23, 1898. Cap. £5,000, in £1 shs. No returns. Dirs., A. W. Goodall and W. B. Brown.

LEATHER SHOD WHEEL Co., Ltd. Regd. Feb. 12, 1897. Cap. £300,000, in £1 shs. No office filed. 230,087 shs. taken up, 120,000 issued as paid. £1 per sh. called on 110,087. £37,127 6s. paid. £72,959 14s. unpaid. Purchase consideration, £240,000. Dirs., Major J. E. Jameson, M.P., W. Lambert, C. N. Baker, F. Hall Kirby, J. H. Mace. Reconstructing.

LEYLAND AND BIRMINGHAM RUBBER Co., Ltd., Golden Hill Works, Leyland, Lancs. Regd. May 18, 1898. Cap. £300,000, in £1 shs. 233,557 shs. taken up, 233,550 issued as paid. £7 in arrears. Dirs., J. A. Baxter, A. S. Morrison, R. T. Byrne, J. W. Browne, S. Whitehead.

LICENSED TYRE SYNDICATE, Ltd., 33, Cornhill, E.C. Regd. Oct. 5, 1897. Cap. £10,000, in £1 shs. 507 shs. taken up. £507 paid.

*LITHANODE ELECTRIC STORAGE Co., Ltd., 3, Harvey's-bldgs., Strand, W.C. Regd. Sept. 23, 1895. Cap. £12,000, in £1 shs. 8,157 shs. taken up. 5,500 issued as paid, £2,657 paid. Dirs., J. M. Richardson, J. T. Niblett. Sec., F. G. Burles. (T.A.: Lithanode, London.) Divd., 1897, 5 per cent. Accumulators.

LIVERPOOL CYCLE AND MOTOR SHOW, Ltd. Regd. Aug. 3, 1898, Cap. £1,000, in £1 shs. Regd. by Hulse, Trustram & Co., 61. Cheapside, E.C. No office or returns filed. Dirs., J. C. Robinson, R. MacLennan, C. Coops, C. Hughes, M. Maclumpha, H. Robinson.

LIVERPOOL AND DISTRICT CYCLE TRADES ASSOCIATION, Ltd., 72, Duke-st., Liverpool. Regd. Sept. 5, 1898. Cap. £1,000, in £1 shs. No returns.

LONDON AND PROVINCIAL MOTOR SYNDICATE, Ltd., 52, Queen Victoria-st., E.C. Regd. Mar. 6, 1897. Cap. £5,000, in £1 shs. No returns. Post Office report "not known."

LONDON AUTO-CAR Co. Ltd., 7, Greek-st., Leeds. Regd. Nov. 28, 1898. Cap. £20,000, in £1 shs. No returns. Dirs., G. E. Stringer, C. W. Fennell, R. R. King. (See Advt. p. xxvi.)

*LONDON ELECTRIC OMNIBUS Co.,Ltd., Room 526 and 7, No. 11, Queen Victoria-street, E.C. Regd. May 18, 1896. Cap. £250,000, in £1 shs. (80,000 Def.). 17,118 Ord. and 80,000 Def. shs. taken

up. All Def. issued as paid. 19s. 6d. per sh. called on 50,007.
£33,274 2s. 6d. paid, £15,500 9s. unpaid. £16,520 8s. 6d. paid
on 32,189 forfeited shs. Dirs., Major Flood Page, M.I.E.E.,
Chairman, Lt.-Col. Turnbull (Man. Dir.), H. Fox, T. S. Flack,
J. B. W. Maunder. Sec., F. S. Tomkins.

LONDON ELECTRICAL CAB CO., Ltd., 7, Juxon Street, Lambeth,
S.E. Regd. Nov. 12, 1896. Cap. £150,000, in £1 shs. 62,523
shs. taken up. £61,223 10s. paid, £1,229 10s. unpaid. Purchase
consideration, £50,000. Dirs., H. R. Paterson, Hon. Reg.
Brougham, H. H. Mulliner, J. H. Mace.

*LONDON MOTOR CAR WORKS CO., Ltd., Albert Mills, Beavor-lane,
Hammersmith, W. Regd. Nov. 6, 1896. Cap. £10,000, in £1 shs.
5,800 shs. taken up, 4,000 issued as paid. £1,775 paid, £25 unpaid.
Dirs., A. Brown, J. R. Rickard. (T.A.: Motionist, London.)
Motors, Controlling Gear, Parts built to order.

*LONDON MOTOR VAN AND WAGON CO., Ltd., 86, Chiswell-st.,
E.C. Regd. Feb. 10, 1897. Cap. £300,000, in £5 shs. 32,400
shs. taken up, 27,600 issued as paid, £5 per sh. called on 4,800.
£23,984 paid, £16 unpaid. Purchase consideration, £150,000.

*LONDON STEAM OMNIBUS CO., Ltd., 133, Finsbury Pavement, E.C.
Regd. June, 30, 1898. Cap. £420,000, in £10 shs. 14,087 shs.
taken up (623 Founders'), £2 per sh. called; 13,960 (665 Founders'
and 13,295 Ord.) shs. issued as fully paid. Dirs., E. H. Bayley, J.P.
(Chairman), R. Gresley Hall (Vice-Chairman), J. H. Mace,
Thos. Robinson, Geo. Iden, H. J. Lawson. Sec, R. M. Blaikie.
(T.A.: Proof, London)

MANCHESTER ACETYLENE GAS AND CARBIDE CO., Ltd., St. Simon-st.,
Salford, Manchester. Regd. Feb. 15, 1898. Cap. £40,000, in £10
shs. 1,624 shs. taken up. 600 issued as paid, £5 per sh. called on
1,024. £5,300 received, and £420 in arrears.

MANNESMANN TUBE CO., Ltd., 110, Cannon-street, E.C. Regd. Jan.
6, 1888. Cap. £582,830, in £10 shs. 54,923 taken up, 20,783
issued as paid. £341,400 paid. Dirs., Carl Heinrich von Siemens,
G. A. Barkley, A. von Siemens, G. W. von Siemens, F. von
Siemens, C. G. R. Charnbin, C. Herbert (Manager). Sec., R. V.
Tulloch.

*MANSFIELD MOTOR CAR CO., Ltd., 24, Leeming-st., Mansfield, Notts.
Regd. Apr. 9, 1898. Cap. £5,000, in £10 shs. 105 shs. taken up.
£1,050 paid. Dirs., W. J. Chadburn, F. A. Robinson (Man. Dir.).
Sec., F. Hameyer.

*MARQUAND ACCUMULATOR CO., Ltd., 2, Dock Chambers, East Moors.
Cardiff. Regd. Sept. 26, 1898. Cap. £20,000, in £10 shs.
(£9,000 Pref.). £1,875 subscribed. £2 10s. per share called.
£1,500 Pref. and £11,000 Ord. shs. issued as fully paid. Dirs.,
Rt. Hon. Lord Wm. Beresford, Marcus Gunn, H. B. Marquand,

F. Marson, T. M. Heywood, J. W. Palmer, D. B. Atkinson, A. J. Marquand. Sec., G. T. Llewelyn. (T.A. : Accumulate, Cardiff.)

MARTIN NOISELESS SAFETY MOTOR SYNDICATE, Ltd. Regd. Mar. 2, 1897. Cap. £24,000, in £10 shs. No office or returns filed. No business has been done, and it is not intended to proceed with the Company.

MARTINI OZONE Co., Ltd., 8, Princes-st., E.C. Regd. Aug. 22, 1898. Cap. £10,000, in £1 shs. No returns. Dirs., D. Martini, J. Dunham-Massey.

MAXIM AUTOCAR SYNDICATE, Ltd., 6 and 8, Eastcheap, E.C. Regd. Jan. 27, 1898. Cap. £5,000, in £1 shs. 3,757 shs. taken up. 2,500 issued as paid. 15s. per sh. called on 1,257, £780 paid. £162 15s. in arrears.

*MAXIM FOREIGN AND COLONIAL MOTOR SYNDICATE, Ltd., 151, Wool Exchange, Coleman-st., E.C. Regd. July 6, 1897. Cap. £35,000, in £1 shs. No returns. No shs. issued yet.

MIDDLESEX RAILWAYS EXTENSION (MOTOR SCHEME), Ltd., 40, Holborn-viaduct, E.C. Regd. Dec. 15, 1897. Cap. £100, in £1 shs. 7 shs. taken up. £7 in arrears.

MIDLAND CYCLE AND MOTOR CAR EXHIBITION Co., Ltd., 174, Corporation-st., Birmingham. Regd. Oct. 23, 1896. Cap. £1,000, in £10 shs. All shs. taken up. £1,000 paid.

*MIDLAND MOTOR CARRIAGE SYNDICATE, Ltd., 37, Vittoria-st., Birmingham. Regd. Feb. 27, 1897. Cap. £13,000, in £5 shs. 2,274 shs. taken up, 1,810 issued as paid, £5 per sh. called on 464. £1,516 paid, £804 unpaid. 50 shs. forfeited. Dirs., W. Somers, J.P., J. A. Cooke, C. C. H. Millar, H. Levetus, E. L. Levetus. Sec., A. Levetus. Steam Motor Vehicles, Rotary Valves (Schumacher Patents).

MILLET'S PATENT MOTOR WHEEL Co., Ltd., 17, Newington-cause-way, S.E. Regd. Dec. 18, 1896. Cap. £100,000, in £1 shs. No returns, and nothing done beyond registration.

MILVER PORTABLE ELECTRIC BATTERY SYNDICATE, Ltd., 24, Harleyford-rd., Vauxhall, London. Regd. May 4, 1895. Cap. £22,000, in £5 shs. 4,381 shs. taken up, £21,869 paid, £36 unpaid.

MODEL CYCLE COMPANY, Ltd., 3, Earl-st., Coventry. Regd. Oct. 26, 1898. Cap. £5,000, in £1 shs. No returns.

MOLAX MOTOR SYNDICATE, Ltd. Regd. Nov. 17, 1898, by Day & Co., 37, Norfolk-st., E.C. Cap. £2,000, in £10 shs. No returns.

MONARCH MANUFACTURING Co., Ltd., 12, Cherry-st., Birmingham. Regd. Mar. 31, 1898. Cap. £20,000, in £1 shs. No returns.

*MONOPOLE CYCLE AND CARRIAGE Co., Ltd., Union Mills, Foleshill, near Coventry. Regd. Sept. 18, 1896. Cap. £50,000, in £1 shs. (10,000 Pref.). 24,510 shs. taken up, 10,000 issued as paid, 2,000 shs. surrendered. Full amount called up and paid. Dirs.

R. Illingworth, J. Crowle, G. Naylor, J. Clough, J. W. Reacher, J. W. Maude. Sec., T. L. Husselby. (T.A.: Monopole, Coventry.) Three-speed Driving Gears.

*Mossberg Roller Bearings, Ltd., 6, Victoria-st., S.W. Regd. May 18, 1898. Cap. £80,000, in £1 shs. 32,007 shs. taken up. 2,000 issued as paid. 5s. per sh. called on 30,007. £7,501 15s. received. Dirs., H. P. Holt, S. Lowe, E. P. Bainbridge. Sec. and Man., George Bargate. (T.A.: Mossberg, London.) (*See Advt.* p. viii.)

*Motor Attachment Syndicate, Ltd., The Works, Ceres-rd., Kingston-on-Thames. Regd. Feb. 15, 1897. Cap. £10,000, in £10 shs. 606 shs. taken up. 500 issued as paid. Dirs., H. Rayné, S. H. Terry, W. H. Carmont (Man. Dir.).

Motor Car Components Co., Ltd. Regd. Dec. 24, 1896. Cap. £7, in £1 shs. No office or returns filed. £990 paid, and £70 in arrear. Never proceeded beyond registration.

*Motor Car Emporium, Ltd., 7, Princes Road, Holland Road, West Kensington. Cap. £5,000, in £1 shs. Dirs., E. E. Lehwess, H. C. E. Zacharias. 7 shs. taken up, £7 paid. (T.A.: Motorium, London.)

Motor Car Syndicate of Australia, Ltd., 120, Chancery-lane, W.C. Regd. July 31, 1896. Cap. £5,000, in £1 shs. 7 shs. taken up, £7 paid.

Motor Carriage and Cycle Patents, Ltd., 3, Delahay-st., Westminster. Regd. April 21, 1896. Cap. £5,000, in £50 shs. 33 shs. taken up, and £1,650 paid.

*Motor Carriage Supply Co., Ltd., Donington House, Norfolk-st., Strand. Regd. Jan. 5, 1898. Cap. £12,000, in £1 shs. 6,000 shs. taken up. 15s. per sh. called, £3,000 paid. Dirs., F. R. Simms (Chairman), C. H. Moore, Col. J. R. Lee, and A. J. White. Man., G. E. Lefebvre, A.M.I.C.E. (T.A.: Motemus, London.) Ignition Apparatus, Motors, Oil Engines, Steering Gear, Magnets, &c. (*See Advt.* p. xiv.)

Motor and Cycle Trades Club, Ltd., 26, Corporation-st., Birmingham. Regd. Sept. 6, 1898. Cap. £5,000, in £5 shs. No returns.

Motor Char-a-Banc Co., Ltd. Regd. Nov. 25, 1898, by Ashurst & Co., 17, Throgmorton-avenue, E.C. Cap. £20,000, in £1 shs. No returns.

*Motor Development Corporation, Ltd., 28, Victoria-st., S.W. Works: 36, St. George's-sq., Regents Park, N.W. Regd. Nov. 24, 1896. Cap. £25,000, in £1 shs. 20,007 shs. taken up, 15,000 issued as paid, £1 per sh. called on 7, and 10s. per sh. on 5,000, £2,507 paid. Dirs., H. C. Rigaud, J. V. Sherrin, H. Sartoris, J.P., W. Malcolm Burnie, F. Sartoris, J.P. Sec., H. T. Turner, Motors, Ignition Tubes, General Motor business.

*MOTOR MANUFACTURING Co., Ltd., 47, Holborn-viaduct, E.C. Works: Motor Mills, Coventry. Regd. Jan. 12, 1898. Cap. £300,000, in £1 shs. 201,681 shs. taken up, and all issued, with 17s. per sh. considered as paid. 3s. per sh. called and paid on each. Dirs., John H. Gretton (Chairman), R. Hoffmann, M. H. Buckea, T. Robinson (Man. Dir.), J. H. Mace, H. J. Lawson. Sec., Alfred Burgess. (T.A.: Propel, London or Coventry.) Oil Motors, Oil Engines, Motor Car Makers, Brakes, Frames, Wheels, Steering Gear and all component parts. (See Advt. p. xxiii.)

MOTOR OMNIBUS SYNDICATE, Ltd., 27, Chancery-lane, W.C. Regd. Mar. 29, 1898. Cap. £6,000, in £1 shs. 4,097 shs. taken up. 3,560 issued as paid. £517 paid. Dirs., Messrs. C. Hayles, A. V. England, R. Manning, E. Gillett.

MOTOR PATENT FUEL Co., Ltd, 8, Cambrian-place, Swansea. Regd. Oct. 14, 1898. Cap. £20,000, in £10 shs. No returns.

*MOTOR TOURING Co., Ltd., 20, Jubilee-st., Llandudno, and 68, Broad-st., Birmingham. Regd. Sept. 6, 1898. Cap, £5,000, in £1 shs. No returns. Dirs., J. J. Horne, W. M. Geddes, A. C. Cragg. (T.A.: Motors, Llandudno.) Motor Agents and Contractors, Repairs, &c.

MOTOR VAN SYNDICATE, Ltd., 5, Lancaster-place, Strand, W.C. Regd. Mar. 25, 1898. Cap. £2,000, in £1 shs. 807 shs. taken up. 300 issued as paid. £1 per sh. called on 7, and 5s. per sh. on 500. £132 paid. Dirs., M. Fairclough, T. C. Palmer, A. Fairclough.

MOTORS, Ltd., 12, Camomile-st., E.C. Regd. July 28, 1896. Cap. £5,000, in £1 shs. 3,414 shs. taken up, 1,100 issued as paid, £2,314 paid.

*MULLINER, LONDON, Ltd., 28, Brook-st., W. Regd. May 12, 1897. Cap. £10,000, in £10 shs. 250 shs. taken up, £8 per sh. called. £2,000 paid. Dirs., A. F. Mulliner, A. G. Mulliner.

MULLINERS, Ltd., 10, Gas-st., Birmingham. Regd. Apl. 25, 1895. Cap. £42,000, in 2,400 Pref. shs. of £5, and 30,000 Ord. shs. of £1 each. 800 Pref. and 13,192 Ord. shs. taken up. Full amount called, £17,192 paid.

NATIONAL CARRIAGE WHEEL (PARENT SYNDICATE), Ltd., Victoria-buildings, Albert-street, Birmingham. Regd. Oct. 10, 1898. Cap. £30,000, in £1 shs. No returns.

NATIONAL CYCLE AND MOTOR CAR INSURANCE Co., Ltd., 33, King William-st., E.C. Regd. May 6, 1896. Cap. £250,000, in £1 shs. 16,001 shs. taken up, 3,000 issued as paid; £1 called on 11,164, 8s. called on 1,837. £10,041 5s. paid, £1,857 11s. unpaid. Dirs., Col. C. W. Wilson, C. A. Ravenscroft, D. F. Carmichael, C. H. Tindel, Sydney Lee, Sir Edward Lee.

*NATIONAL MOTOR CARRIAGE SYNDICATE, Ltd., 37, Walbrook, E.C. Regd. May 25, 1897. Cap. £30,000, in £1 shs. (12,000 Def.).

18,000 Ord. issued as paid, 6,000 Def. taken up and paid. Dirs., A. A. Common, LL.D., &c., A. Maxwell Tod, F. Fanta, W. Potter, A.M.I.C.E., H. F. Joel, A.M.I.C.E. Sec., V. C. Doubleday, C.A. (T.A.: Safety beams, London.) Electric Vehicles.

*NEAL CYCLE Co., Ltd., Bordesley Green-rd., Birmingham. Regd. Mar. 9, 1897. Cap. £20,000, in £1 shs. 10,000 shs. taken up, £10,000 paid. Dirs., H. Huggins, J. Neal, H. Neal, F. Huggins, E. Palethorpe.

*NEW BROTHERTON TUBE Co., Ltd., Excelsior Works, Commercial-rd., Wolverhampton. Regd. Mar. 29, 1897. Cap., £65,000, in £1 shs. All shs. taken up and paid. Purchase consideration, £50,000. Dirs., E. Lisle, S. Gorton, J. Griffiths, E. T. Hargraves, E. White. Div., 1897, 2¼ per cent. (T.A.: Weldless, Wolverhampton.) Weldless Steel Tubes.

NEW ELECTRICITY SUPPLY SYNDICATE, Ltd., 23, Throgmorton-st., E.C. Regd. Apr. 2, 1898. Cap. £40,000, in £1 shs. 35,000 shs. taken up. 30,000 issued as paid, £5,000 received.

*NEW GENERAL TRACTION Co., Ltd., 35, Parliament-st., Westminster. Regd. Mar. 24, 1896. Cap. £270,000, in £5 shs. (30,000 Pref.). 30,000 Pref. and 24,000 Ord. shs. taken up, all Ord. issued as paid, £5 per sh. called on 30,000 Pref., and paid. Dirs., F. Pavy, A. Brand, Baron D'Erlanger, E. A. Hopkins.

NEW MOTIVE POWER SYNDICATE, Ltd., 11, Pancras-lane, E.C. Regd. Dec. 22, 1896. Cap. £15,000, in £1 shs. All shs. taken up, 10,000 issued as paid, £4,850 paid, £150 paid.

NEW POWER SYNDICATE, Ltd. Regd. Feb. 9, 1898. Cap. £15,000, in £1 shs. Regd. by R. I. Pelman, 143, Cannon-st., E.C. No office or returns filed. Post Office report, "Gone away."

NEW RALEIGH CYCLE Co. (Spain), Ltd., Brougham-chambers, Wheeler Gate, Nottingham. Regd. Dec. 22, 1897. Cap. £100,000, in £1 shs. 7 shs. taken up. No calls.

NEW ROCK CYCLE MANUFACTURING Co., Ltd., Rock Cycle Works, John-st., Sheffield. Regd. Jan. 12, 1898. Cap. £10,000, in £1 shs. 4,175 shs. taken up. 3,000 issued as paid, £1,175 paid.

NORTHAMPTON CYCLE TRADES ASSOCIATION, Ltd., 18, Market-st., Northampton. Regd. Dec. 16, 1897. Cap. £250, in £1 shs. 140 shs. taken up. 10s. per sh. called, £70 paid.

NORTHERN COUNTIES ELECTRIC AND MOTOR Co., Ltd., 13, Crossley-st., Halifax. Regd. Jan. 7, 1898. Cap. £10,000, in £1 shs. 1,100 shs. taken up. 10s. per sh. called, and £550 paid.

*NOTTINGHAM AND DISTRICT CYCLE, MOTOR CAR AND ACCESSORIES EXHIBITION Co., Ltd., Bentinck-buildings, Wheeler Gate, Nottingham. Regd. Apr. 29, 1898. Cap. £1,000, in £5 shs. 36 shs. taken up. £2 10s. per sh. called. £90 paid. Sec., W. J. Barton.

ORPINGTON, CUDHAM, AND TATSFIELD LIGHT RAILWAY Co., Ltd. Regd. Nov. 16, 1898, by Dollman & Co., 39, King-st., E.C. Cap. £1,000, in £1 shs. No returns.

PARIS AUTOMOBILE CAB Co., Ltd., 142–3, Palmerston - buildings, Old Broad-st., E.C. Regd. Mar. 1, 1898. Cap. £10,000, in £1 shs. No returns. Man. Dir., J. P. Juvenet. Sec., W. J. Thornhill. In course of being re-registered in another name.

*PARIS SINGER, Ltd., Park Mansions, Knightsbridge. Regd. Sept. 21, 1898. Cap. £100,000, in £10 shs. No returns. Dirs., Paris E. Singer (Chairman), F. R. Cheeswright, S. F. Edge, R. J. Beadon. (See Advt. pp. x., xi.)

PATENT FOLDING PERAMBULATOR Co., Ltd., 16A, Limes-road, Croydon. Regd. Dec. 8, 1897. Cap. £10,000, in £1 shs. 6,008 shs. taken up, £6,008 paid. Dirs., J. F. Tee, P. Gillespie.

PATENT WHEEL AND AXLE Co., Ltd., 50, George-st., Newport, Mon. Regd. July 6, 1898. Cap. £25,000, in £1 shs. No returns.

PEERLESS ACCUMULATOR SYNDICATE, Ltd., 63, High-st., Tooting. Regd. May 28, 1897. Cap. £15,000, in £10 shs. No returns.

PENNINGTON MOTOR Co., Ltd. Regd. Jan. 21, 1897. Cap. £100,000, in £1 shs. No office or returns filed. Regd. by Jordan & Sons, Ltd., 120, Chancery-lane, W.C.

*PENNINGTON MOTOR FOREIGN PATENTS SYNDICATE, Ltd., 5 and 6, Gt. Winchester-st., E.C. Regd. May 14, 1896. Cap. £100,000, in £1 shs. 99,142 shs. taken up. 80,000 issued as paid, 5s. per sh. called on 19,142. £4,503 15s. paid, £281 15s. unpaid. Dirs., Sir T. Fry, Bart., Sir E. Sullivan, Bart., J. J. H. Sturmey, J. H. Mace, J. H. Toulmin, W. Baines, G. J. Leslie, E. J. Pennington. (T.A.: Compact, London.) Oil Engines.

PERAMBULATOR AND MANUFACTURING Co., Ltd., Bromsgrove-st., Halesowen, Worcs. Regd. Oct. 5, 1897. Cap. £10,000, in £1 shs. 1,630 shs. taken up. £1,592 10s. paid, £37 10s. in arrears.

*PIONEER ELECTRO CARRIAGE Co., Ltd., 4, Great Winchester-st., E.C. Regd. June 8, 1893. Cap. £20,000, in £50 shs. 64 shs. taken up. £3,200 paid.

PIONEER MOTOR CAR SYNDICATE, Ltd. Regd. Nov. 11, 1896. Cap. £10,000, in £1 shs. No office or returns filed. Regd. by S. H. Fry, 8, Devonshire-chambers, Bishopsgate, E.C. (Post office report "not known.")

*PLATT BROTHERS & Co., Ltd., Hartford New Works, Oldham. Regd. Nov. 10, 1898. Cap. £3,091,800, in 20,612 4½ per cent. Cum. Pref. shs. of £60 each, and 20,612 Ord. shs. of £90 each. No returns. Private Company.

PNEUMATIC DIRECT PROPULSION SYNDICATE, Ltd., 2, Basinghall-st., E.C. Regd. July 21, 1898. Cap. £5,000, in £5 shs. No returns. (Post office report "not known.")

*Porous Accumulator Co., Ltd., 24, Queen Victoria-st., E.C. Regd. May 26, 1898. Cap. £3,000, in £1 shs. All shs. taken up. 1,993 issued as paid, and £1,007 received.

*Power and Traction, Ltd., 79, Palace-chambers, Westminster, S.W. Reg. Nov. 8, 1897. Cap. £10,000, in £1 shs. 5,707, shs. taken up. 1,600 issued as paid. 10s. on 4,107. £1,800 paid, £507 unpaid. Dirs., J. Browne-Martin, A. Greenwood, H. C. Walker, R. A. Smith (Man. Dir.). Sec., C. J. F. Sevier. (T.A.: Emissivity, London.)

Preston and Beck, Ltd., 8 & 12, William-st., Deritend, Birmingham. Regd. Dec. 3, 1897. Cap. £11,000, in £1 shs. Resolution passed Aug. 15, 1898, for voluntary liquidation, with E. M. Sharp, of Colmore-row, Birmingham, as liquidator. Dir., W. E. Preston.

Pretot Motor Syndicate, Ltd., 24, Budge-row, E.C. Regd. April 27, 1898. Cap. £25,000, in £1 shs. 18,105 shs. taken up. 13,500 issued as paid, 15s. per sh. called on 4,605, £3,453 15s. paid (including £50 in advance). £50 in arrears. Dirs., W. Conolly, A. C. Newstead, J. H. H. Rolfe, J. S. Dismor.

Primary Engineering and Development Syndicate. Ltd., 22, Chancery-lane, W.C. Regd. Sept. 16, 1898. Cap. £5,000, in £1 shs. No returns.

Prince Motor Syndicate, Ltd. Regd. Nov. 30, 1896. Cap. £50,000, in £1 shs. Resolution to wind up voluntarily passed Dec. 29, 1897, and confirmed Jan. 18, 1898. Final meeting held Oct. 8, 1898.

Railway Developments, Ltd., 34, Victoria-st., S.W. Regd. July 23, 1898. Cap. £100,000, in £1 shs. No returns.

*Ramsay's Horse, Carriage, Cycle and Autocar Repository, Ltd. Regd. Nov. 11, 1896. Cap. 60,000, in £1 shs. (30,000 Pref.). No office or returns filed. Regd. by T. Bore, 91, Finsbury-pavement, E.C. Dirs., Sir E. Lee, C. Fox, R. Johnson, W. D. Ramsay. Did not go to allotment.

Reavell & Co., Ltd., Ranelagh Works, Ipswich. Regd. June 11, 1898. Cap. £50,000, in £10 shs. 3,300 shs. taken up. 600 issued as paid, £5 per sh. called on 2,700, £12,261 paid, and £1,239 in arrears. Dirs., W. Reavell, C. Gaskell, W. H. Scott.

Recreation Motor Cars, Ltd. Regd. Sept. 8, 1898. Cap. £10,000, in £1 shs. Regd. by F. Scott, Devonshire-chambers. Bishopsgate. No office or returns filed. Dirs., W. M. Gow, A. Eliot, H. Johnson.

Redditch District Electric Traction Co., Ltd., 37, Waterloo-street, Birmingham. Regd. May 26, 1898. Cap. £2,000, in £10 shs. No returns.

RIBBESDALE CYCLE Co., Ltd., Whalley Banks, Blackburn. Regd. Mar. 17, 1898. Cap. £25,000, in £1 shs. 11,180 shs. taken up. 10,173 issued as paid, £1,007 paid.

ROAD TRACTION, Ltd., 16, Craven-st., Strand, W.C. Regd. Mar. 10, 1897. Cap. £4,000, in £1 shs. 7 shs. taken up. No calls.

ROBERTSON BROS. & Co., Ltd. Regd. Oct. 27, 1898. Cap. £1,000, in £1 shs. Regd. by Waterlow Bros. & Layton, Ltd., Birchin-lane, E.C. · No returns.

ROLAND ELASTIC WHEEL SYNDICATE, Ltd., 20, Bucklersbury, E.C. Regd. June 22, 1898. Cap. £12,000, in £1 shs. No returns. Post office report " gone away."

*ROOTS' OIL MOTOR AND MOTOR CAR, Ltd., 100, Westminster Bridge-rd., London. Regd. July 15, 1897. Cap. £30,000, in £1 shs. 7 shs. taken up. No calls. Dirs., A. McDonnell, F. D. C. Shaw-Kennedy, J. D. Roots, C. E. Venables. Sec., Chas. E. Dorreil. (T.A.: Petroline, London.) Oil Engines, Frames, Motor Cars. (*See Advt.* p. xx.)

ROSSER CYCLE AND VEHICLE BRAKE Co., Ltd., 23, College-hill, E.C. Regd. Oct. 20, 1896. Cap. £50,000, in £1 shs. (since reduced to £10,000, in 4s. shs., but the certificate for such reduction has not · yet been granted). 29,007 shs. taken up, 27,507 shs. taken up, 15s. per sh. called on 1,500, £1,125 paid. Dirs., E. Edeveain, H. H. Griffin, T. Lambert. Resolution passed Mar. 31, 1898, for voluntary liquidation. H. R. Smith, 23, College Hill, E.C., liquidator.

S. GOODBY & SONS, Ltd., Petit-st., Wolverhampton. Regd. Oct. 31, 1898. Cap. £15,000, in £1 shs. No returns.

SAFETY MOTOR SYNDICATE, Ltd., 49A, Lincoln's Inn-fields, W.C. Regd. June 21, 1897. Cap. £1,500, in £1 shs. 125 shs. taken up. £118 paid. No calls on 7 shs.

SAMUEL WESTON, Ltd., Barclay's Bank-chambers, Terminus-rd., Eastbourne. Regd. Nov. 15, 1897. Cap. £52,000, in £10 shs. 49 shs. taken up. £10 per sh. called on 9, and £5 per sh. on 40, £290 paid.

SAXTON & DAVIES, Ltd., 52 and 53, Newgate-st., E.C. Regd. Jan. 12, 1898. Cap. £10,000, in £1 shs. 4,064 shs. taken up. 10s. per sh. called, £1,259 5s. paid, £772 15s. unpaid. Dirs., F. T. A. Davies, E. C. Lucas, W. P. Johnson, B. F. A. Bayspoole, J. Tourunen, A. Saxon.

SCOTT'S ENGINE SYNDICATE, Ltd., Gothic Works, Norwich. Regd. Aug. 26, 1897. Cap. £2,000, in £1 shs. 1,200 shs. taken up. 500 issued as paid, 15s. per sh. called and paid on 700 shs. Dirs., W. H. Scott, W. B. Sisling, R. Laurence, C. Wilson.

SELF-CHARGING ELECTRICAL TRACTION Co., Ltd., 40, Holborn-viaduct, E.C. Regd. Feb. 10, 1898. Cap. £100, in £1 shs. 7 shs taken up, £7 paid.

SELF-GENERATING ELECTRIC VEHICLE LIGHT SYNDICATE, Ltd., 3 and 4, Crooked-lane, King William-st., E.C. Regd. Oct. 13, 1897. Cap. £5,000, in £1 shs. No returns.

*SELF-PROPELLED TRAFFIC ASSOCIATION, 30, Moorgate-st., E.C. Regd. Apl. 1, 1896, as a Guarantee Company, not for profit (the word "Limited" being omitted by permission of the Board of Trade). Unlimited number of members, each liable for £1 in event of liquidation. No returns necessary. Amalgamated with the Automobile Club of Great Britain and Ireland, 4, Whitehall Court, S.W.

SHAKESPEARE, KIRKLAND & FROST, Ltd., 114, Bradford-st., Birmingham. Regd. Oct. 19, 1897. Cap. £15,000, in £1 shs. 5,821 shs. taken up. 5,814 issued as paid, £7 paid.

*SHEFFIELD CYCLE, MOTOR CAR AND ACCESSORIES EXHIBITIONS Co., Ltd., Sports Office, High-st., Sheffield. Regd. Feb. 12, 1897. Cap. £1,000, in £10 shs. All shs. taken, £1 per sh. called. £100 paid. Dirs., C. D. Leng, C. Clifford, J. T. Thompson, T. G. Evans, W. S. Moiser, H. Guest, F. Vick, J. H. Stainton, R. Hagen. Sec., R. Hagen.

SHIPPEY BROTHERS, Ltd., 13 and 14, King-st., Cheapside, E.C. Regd. Dec. 30, 1887. Cap. £30,000, in £5 shs. 2,412 shs. taken up, £3,060 paid. 1,800 issued as paid. Dirs., A. Beckwith, Fred J. Shippey, Arthur Shippey. (T.A.: Shippey Bros., London.) Accumulators, Electric Motors and Vehicles, Ignition Coils, Dynamos, Brakes, Steering Gear, Controllers, &c., &c. (*See Advt.* p. xxix.)

SIMPSON, STRICKLAND & Co., Ltd., Noss, Brixham, South Devon. Regd. Mar. 3, 1891. Cap. £32,000, in £5 shs. 6,039 shs. taken up, 5,410 issued as paid, £5 per sh. called on 629, £3,145 paid.

SMITH, PARFREY, & Co., Ltd., 141, Buckingham Palace-rd., S.W. Regd. Oct. 3, 1898. Cap. £250,000, in £5 shs. No returns. Dirs., T. V. Smith, R. W. M. Walker, R. Bearcroft, G. F. White. (*See Advt.* p. xxxvii.)

*SMITH, SIMPSON, & Co., Ltd., 49, Deansgate, Manchester. Regd. Nov. 3, 1898. Cap. £2,000, in £1 shs. No returns. Dirs., J. F. Simpson (Man. Dir.), Harold Smith. (T.A.: Mittimus, Manchester. A B C Code.) Oil Engines, Electric Motors, Accumulators, &c.

*SOCIÉTÉ INTERNATIONAL DE CONSTRUCTION D'AUTOMOBILES, Ltd. Regd. Sept. 1, 1898. Cap. £50,000, in 5,000 shs. of £1, and 11,250 shs. of £4 each. Regd. by G. St. G. D. Massey, 8, Princes-st., E.C. No office or returns filed. Communications *to be addressed* to Mr. A. B. Brandreth, 24 r. Taitbout, Paris.

SOUTH AFRICAN EXPRESS SYNDICATE, Ltd. Regd. Nov. 2, 1898.
Cap. £5,000, in £100 shs. No office or returns filed.

SOUTH WALES MOTOR AND CYCLE Co., Ltd. Regd. Dec. 11, 1896.
Cap. £5,000, in £5 shs. Resolution passed July 30, 1898, for
voluntary liquidation, as the debenture holders had foreclosed.
J. J. Murphy was appointed liquidator.

SPIDER MOTOR CAR SYNDICATE, Ltd. Regd. July 15, 1897.
Cap. £1,000, in £1 shs. Regd. office not filed. Vendor, J. C.
Stevenson, 80, Peach-st., Liverpool. No returns.

SPEED INDICATOR Co., Ltd., 60, Watling-st., E.C. Regd. Jan. 14,
1898. Cap. £10,000, in £1 shs. No returns.

STARLEY'S, Ltd., Aiken-chambers, Cannon-st., Birmingham. Regd.
Oct. 14, 1897. Cap. £1,000, in £1 shs. No returns.

*STEEL NUT & TUBE Co., Ltd., Openshaw, Lancashire. Regd.
Nov. 9, 1898. Cap. £50,000, in £1 shs. No returns. (T.A.:
Steel Nuts, Manchester.) Forgings, Nuts, &c.

*STEAM CARRIAGE AND WAGON Co., Ltd.. Homefield, Chiswick.
Regd. Oct. 8, 1896. Cap. £10,000, in £1 shs. All shs. taken up.
500 issued as paid. £1 per sh. called on 1,000, £1,000 paid.
(T.A.: Manageable, London and Basingstoke.) Sec., H. Niblett.
Boilers, Air Condensers, Steam Motors, Wagons, Drays, Omnibuses,
Friction Clutches. (See Advt. p. xxiv.)

STIRLING'S MOTOR CARRIAGES, Ltd., 105, West George-st., Glasgow.
Cap. £100,000, in £1 shs. 25,000 issued as fully paid. Purchase
consideration, £25,000. No official returns. Dirs., R. Crawford,
J.P., &c., R. Thomson, H. G. Cooper, H. A. Mavor, J. T. Boyd,
M.I.M.E., John Stirling. Oil Motor Vehicles. Scotch Co.

*SURREY MACHINISTS' Co., Ltd., 71, Mansion House-chambers,
Bucklersbury, E.C. Regd. Mar. 16, 1898. Cap. £1,000, in
£1 shs. 7 shs. taken up, £7 paid. Cycle makers only.

*SWANSEA MOTOR OMNIBUS Co., Ltd., 102, Oxford-st., Swansea.
Regd. Dec., 1898. Cap. £20,000, in £10 shs. No returns. Dirs.,
T. P. Thomas, J. C. Morris, J. Williams, E. H. Leeder, O. Walters.
Sec., John Roberts.

TAVERNIER SAFETY MOTOR SYNDICATE, Ltd., 61, Cheapside, E.C.
Regd. July 25, 1896. Cap. £4,000, in 60 shs. of £50 and 1,000 shs.
of £1 each. 60 shs. of £50 each taken up, and issued as paid.

*TAXAMETER SYNDICATE, Ltd., Clun House, Surrey-st., W.C. Regd.
Feb. 26, 1898. Cap. £20,000, in £1 shs. 16,500 shs. taken up.
10,500 issued as paid. 15s. per sh. called, £4,878 paid, £5 in
arrears. Dirs., F. R. Simms, H. Sherwin Holt, C. Harrington
Moore. Sec., J. W. Scott. (T.A.: Taxameter, London.) Fare
Indicators.

THAMES RUBBER Co., Ltd., 14, Coventry-st., Piccadilly, W. Regd. Oct. 8, 1897. Cap. £25,000, in £1 shs. 17 shs. taken up. No calls.

THOMAS KENDRICK, Ltd., Summer Works, Summer-lane, Birmingham. Regd. Dec. 22, 1897. Cap. £70,000, in £5 shs. Dirs., T. H. Kendrick, E. H. Kendrick (Man. Dirs.)

*THOMAS PARKER, Ltd., Wednesfield-rd., Wolverhampton. Regd. April 19, 1894. Cap. £75,000, in £10 shs. All shs. taken up and paid. 1,750 issued as paid. Debs. £15,000. Dirs., C. T. Mander, W. Thomas, R. Armistead, T. Parker. Sec., F. Walton. (T.A.: Coils, Wolverhampton.) Divs., 1896, 5 per cent., 1897, 7 per cent. Dynamos and Motors.

THOMAS AND WILLIAM CALDWELL SYNDICATE, Ltd., 3, Winwick-st., Warrington. Regd. Apr. 23, 1898. Cap. £3,000, in £10 shs. All shs. taken up. £5 per sh. called, and £1,500 paid.

THORNTON MOTOR Co., Ltd., Worsley Mills, Worsley-st., Hulme, Manchester. Regd. May 1, 1897. Cap. £1,000, in £1 shs. All shs. taken up. £1,000 paid. Dirs., J. E. Thornton, J. P. Lea, R. Higham.

TRAFFIC SYNDICATE, Ltd., 6, Old Jewry, E.C. Regd. Nov. 4, 1896. Cap. £10,000, in £1 shs. 9,007 shs. taken up. £9,000 paid, £7 unpaid. Final meeting held on Oct. 17, 1898.

*TUDOR ACCUMULATOR Co., Ltd., 16, Victoria-st., Westminster. Regd. Sept. 16, 1897. Cap. £50,000, in £10 shs. 4,000 shs. taken up. 1,200 issued as fully paid, and 1,200 issued with £7 10s. per sh. considered as paid. £10 per sh. called on all shs. issued. £19,000 paid. (T.A.: Subconical, London.) Accumulators.

TWENTIETH CENTURY DEVELOPMENT SYNDICATE, Ltd., 21, Baker-st., Portman-sq., W. Regd. Mar. 10, 1897. Cap. £25,000, in £10 shs. 1,757 shs. taken up, £10 per sh. called, £17,570 paid.

UNIVERSAL MOTOR CARRIAGE AND CYCLE Co., Ltd., 30, Moorgate-st., E.C. Regd. June 5, 1896. Cap. £200,000, in £1 shs. 119,010 shs. taken up. 90,820 issued as paid. £11,743 received, £16,447 in arrears. Dirs., Earl of Aylesford, C. N. Baker, J. Barker, G. E. Jarvis, E. S. Lancaster, F. Ludlow, E. T. Read.

W. C. BERSEY & Co., Ltd., 39, Victoria-st., Westminster. Regd. Nov. 28, 1898. Cap. £5,000, in £1 shs. No returns. Dirs., W. C. Bersey, G. E. Thompson, G. G. T. Bromfield, C. Davis.

WERNER CADMIUM ELECTRIC ACCUMULATOR SYNDICATE, Ltd., Devonshire - chambers, Bishopsgate - st. - without, E.C. Regd. May 19, 1898. Cap. £6,000, in £1 shs. 4,515 shs. taken up. 4,100 issued as paid, £415 received.

Westminster Cycle Works, Ltd., Doris-yard, Doris-st., Kennington, S.E. Regd. Aug. 13, 1897. Cap. £20,000, in £1 shs. 5,007 shs. taken up. 5,000 issued as paid. No calls on the 7 shs. Dirs., E. P. Lawrence, A. D. Southam, J. R. Rickard (Man. Dir.).

Westralian Motor Carrying Co., Ltd., 28, Basinghall-st., E.C. Regd. Nov. 21, 1896. Cap. £7, in £1 shs. Final meeting held on June 6, 1898. Report of post office, "not known."

Wheel Manufacturing Co., Ltd. Regd. Nov. 25, 1897. Cap. £90,000, in £1 shs. Regd. by Ashwell & Co., 30, Ely-place, E.C. No returns or office filed.

White and Middleton Gas Engine Co., Ltd., 7, Fenchurch-av., E.C. Regd. Nov. 19, 1897. Cap. £200,000, in £1 shs. 7 shs. taken up. £7 paid.

Whitehead's Auto Cycle Co., Ltd., 11, Cross-sq., Wakefield, Regd. Nov. 13, 1896. Cap. £2,000, in £1 shs. All shs. taken up and £2,000 paid.

White's Carriage Co., Ltd., 5, Bentley-road, Liverpool. Regd. Sept. 1, 1898. Cap. £50,000, in £1 shs. No returns. Dirs., R. B. Crowe, W. White.

Woodward Electrical Storage Battery, Co., Ltd., Trafalgar-bldgs., 6, Northumberland-av., W.C. Regd. June 11, 1897. Cap. £60,000, in £1 shs. No returns.

Wolverhampton Tyre Syndicate, Ltd., Blakenhall Works, Villiers-st., Wolverhampton. Regd. Jan. 27, 1898. Cap. £1,000, in £1 shs. 850 shs. taken up. 75 issued as paid, 5s. called, £193 15s. paid. Dirs., J. Marston, C. Marston, F. H. Parkyn, H. H. Chiltern, J. H. Herbert, W. Clarke.

*Yeovil Motor Car and Cycle Co., Ltd., Bank Chambers, and Reckleford, Yeovil. Regd. Nov. 5, 1896. Cap. £1,000, in £1 shs. All shs. taken up, £1,000 paid. (T.A. : Motor Company, Yeovil).

*Yorkshire Motor Co., Ltd., Albert-buildings, Horton-lane, Bradford. Regd. Mar. 24, 1897. Cap. £2,500, in £1 shs. (500 Def.). 1,492 Ord. and 500 Def. shs. taken up, 170 Ord. and 500 Def. issued as paid, £1 per sh. called on 1,322 Ord. £1,147 paid. £175 unpaid. Dirs., E. H. Hutton, Thos. Craig, J. Mollete, — Skelton, J. E. Tuke. (T.A. : Motor Co., Bradford.) Steam and Petrol Cars, Petrol Stores, Accumulators charged, Motors, Vehicles on hire and sale, and Sundries supplied, &c.

FOREIGN
MANUFACTURERS AND ENGINEERS.

Except where specified to the contrary, the specialities of all the firms and Companies included in this list are Oil (Petrol, &c.) Motor Vehicles or Motors.

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* Distinguishes firms also making Electrical Motor Vehicles and Accessories.

†   ,,   ,,   ,,   Steam   ,,   ,,   ,,

‡   ,,   ,,   which do NOT make Oil Motor Vehicles.

AUSTRIA.

Lohner, Jacob, & Co., Vienna.

BELGIUM.

Bovy, J., et fils., Herstal.

Comp. Belge de Construction d'Automobiles, 4, pl. Louise, Brussels.

Construction Liégeoise d'Automobiles, 83, r. Lairesse, Liége.

Fabrication de Velocipèdes et Automobiles (Soc. an., capital, 500,000 francs), 23, r. Van der Keilen, Antwerp.

Février frères, Couillet.

Gerkinet, H., et Cⁱᵉ., Herstal-lez-Liege.

*‡Jenatzy (Camille), 222, r. du Progrès, Brussels.

Linon, L., Verviers.

Matthys, J., 533, Av. Louise, Brussels.

Poste Electrique Internationale (La) Brussels. Capital £370,000 (Electric Charging and Posting Stations).

Société Anonyme des Ateliers Germain, Monceau-sur-Sambre.

Société Anonyme des Cycles et Automobiles Belgica, 14, r. van der Straeten, Brussels.

Société Anonyme des Etablissements Piéper Automobiles, &c., Liége and Nessonvaux.

Société de Manuf. Belge de Velos Automobiles et Pièces Détachées, Herstal, Liége.

Société Générale des Automobiles, Brussels.

Taulez et Cie., Lokeren.

Vincke (Nestor), 78, r. Léopold, Malines.

Vivinus et Cie., 244, r. du Progrès, Brussels.

FRANCE (Paris).

*‡**Accumulateur Fulmen,** 139, de Clichy.

Amiot et Peneau, 47, r. du Chateau, Asinères (Seine).

Archdeacon, E., 11, r. du Pont-Suresnes.

Astresse, P., 10, av. de Madrid, Neuilly.

Audin, H., 21, r. Morand.

Augé, 184, r. d'Allemagne.

Augé, D., et Cie., 92, r. des Arts, Levallois-Perret.

Baille-Lemaire, 22, r. Oberkampf and Crosnes (S. et. O.).

Balincourt (Comte de) et Richard, Ch., 17, r. Blanche.

Barrière et Cie., 22, r. St.-Sabin.

*‡**Barthelemy et Cie.,** 13, r. Descombes.

Battaiellie, H., 32, r. de Tilsitt.

Belvallette, A., et Cie., 21, av. des Champs-Elysées.

Bollée, 163, av. Victor-Hugo (See *Société Anonyme*).

Boyer et Cie., Noé, 30, av. de la Grande Armée. Works: Suresnes.

Brosse, F., et Cie., 22, r. Bérenger. Works: Jeumont (Nord).

Brulé, H., et Cie., 31, r. Boinod.

Cambier, Th., et Cie., 34, r. d'Hauteville. Works: Lille-Saint-Maurice.

Chaudun, 93, r. Richelieu, & r. St.-Maur.

Chenard, E., 7, r. de Normandie, Asnieres.

**Clement, A., 9, Michelet, Levallois.

Clément et Cie., 20, r. Brunel.

†**Cohendet et Cie.,** 166, q. Jemmapes.

Cie. Anglo-Française de voitures automobiles (E. Roger patents), 52, r. des Dames.

Cie. des Automobiles et Moteurs Henriod, 5 and 7, r. de Sablonville-Neuilly.

Cie. des Moteurs et Automobiles M.L.B., 54, r. Erlanger (Système Landry et Beyroux). Works: 54, r. d'Erlanger, Passy, and Hondouville-Sure.

Cie. des **Moteurs Duplex**, 130, r. Lafayette.

Cie. des **Moteurs Niel**, 22, r. Lafayette.

Cie. des **Moteurs Universels** (Grob Motor), 56, r. Lafayette.

*‡Cie. **Electrique O. Patin**, 3, r. du Chateaux, Puteaux.

Cie. **Francaise des Cycles et Automobiles**, 7, r. Darboy (Système Gaulois).

Cie. **Francaise des Moteurs à Gazet des Constructions Mechanique**, 155, r. Croix-Nivert (Système Otto).

*‡C^{ic}. **Francaise des Voitures Electromobiles**, 20, r. Taitbout (Capital 10,000,000 francs).

Cie. **Générale des Automobiles** (*Société anonyme*), 2, r. de Compiègne. Works : 65, boul. Soult.

Cie. **Générale des Cycles** (Capital 2,000,000 francs), 23, av. des Champs Elysées (Système Rochet).

Cie. **Générale des Petites Voitures**, Paris.

*‡Cie. **Générale des Transports Automobiles**, 56, r. de la Victoire (Système Jenatzy). Works : 225, boul. de Strasbourg, Boulogne-sur-Seine.

Crouan et Cie., 21, boul. National, Clichy.

†**Dalifol et Cie.**, 183*bis*, faub. Poissonnière.

Damas, J., et Cie., 64, r. de Villiers, Levallois (Système Sphinz).

David et Bourgeois, 19, r. Geoffroy-St.-Hilaire (Système Gautier).

†‡**Decauville-Aîné**, 13, boul. Malesherbes.

De Dietrich et Cie., 20, r. Louis-le-Grand. Works : Lunéville. (Amédée Bollée fils Patents.)

†**De Dion, Bouton et Cie.**, r. de la Grande Armée, 12, r. Ernest Puteaux.

Delahaye, E., et Cie., 10, r. du Banquier.

Deleau, H., 27, quai d'Asnieres, Asnieres.

†‡**Demont**, 144, av. Victor-Hugo.

Diligeon et Cie., 54, r. St.-Maur, & Albert (Somme) (Système Hurtu).

***Doré, L. G.**, 179, r. de Courcelles.

Dorey, W. H., 14, r. Torricelli.

Dumas (Alexandre) fils, 129, av. Philippe-Auguste.

Fageot, P., 2, r. Boutard, Neuilly.

Farman, D. J., Micot et Cie., 15, r. des Epinettes, St. Maurice. (Seine).

Faugère, 25, r. des Mathusius.

Fisson, L., et Cie., 14, r. Maublanc.

Forest o; Surcouf, 76, q. de la Râpée.
Foucher et Delachanal, 3, r. Taylor.
†‡Fouque et Cⁱᵉ., 12, r. de Crimée.
Girardet, L.-P., 8, r. Breguet.
Gouirand, 128, r. du Bois, Levallois.
Goujon frères, 7, r. des Acacias.
Goyet et Legros, Neuilly.
†‡Gros, F., 188, boul. Pereire.
Guyenet et Balvay, 83, av. de la Grande-Armée.
Herlicq et Cⁱᵉ., 59, r. de Flandre (Capitaine-Motor).
Humber et Cⁱʳ., 19, r. du 4-Septembre.
Hurtu, 5), r. St.-Maur.
Huzelstein et Cⁱᵉ., 39, r. Rivay, Levallois.
Japy, frères et Cⁱᵉ., 7, r. du Château-d'Eau.   Works: Beaucort.
*‡Jeanteaud, Ch., 51, r. de Ponthieu.
Journaux, J., 56, r. des Cévennes.
Kellner et ses fils, 125, av. Malakoff (Système Kellner & Faugère).
Klàus, 42-44, r. de Paris, Boulogne-sur-Seine.
Koch, 6, r. Martel.
*‡Krieger, 80, r. Taitbout.
Lapsolu et Cⁱᵉ., 33, r. du Faubourg St.-Antoine.
Larippe, A., 11, r. Tesson.
†‡Le Blant (Maurice), 10, av. de l'Opera.
Le Blon frères, de la Forest e; Maus, 56, r. du Vieux-Pont-de-
Sèvres, Billancourt (Système Lynx).
Lefebvre, A., et Cⁱᵉ., 18, r. Simart.
Lefebvre, Léon, 4, r. de Commines (Système Pygníee).
Lepape, H., 23, r. Montaigne.
Longuemare (Vᵛᵉ. L.), 12, r. du Buisson-St.-Louis (Burners).
Loyal, A., 204, r. St.-Maur.
Maison Parisienne de Voitures Automobiles (Système Benz),
71, av. de la Grande-Armèe.
Marot, Ph., Gardon et Cⁱᵉ., 33, r. Brunel. Works: Levallois-
Perret (Système Créanche).
*‡Mildé. C., et Cⁱᵉ., 60, r. Desrenaudes.
Monin, H., 3, boul. Poissonnière.
Mors, 48, r. du Théâtre, Grenelle (Système Mors).

†‡**Nègre, H.,** 21, av. du Maine, and r. Rembault, Amiens (Somme).

Nicolas, P., et Cie., 14, ímpasse Gaudelet (114, r. Oberkampf).

Panhard et Levassor, 19, av. d'Ivry (Daimler & Phœnix Motors).

*‡**Patin,** 3 & 7, r. du Chateau, Puteaux.

Petitjean, H., et Sevette, F., 196, r. St.-Maur.

Petréano, E., 12, r. Lantounet. Works : Vaugirard.

Peugeot frères (Les fils de), 22, av. de la Grande-Armée. **Works:** Valentigney (Doubs).

Peugeot (Société Anonyme des Automobiles), 83, boul. Gouvion-St.-Cyr. Works : Audincourt (Doubs).

Philippon et Cie., 8, r. du Débarcadère.

Popp et fils, 80, r. Taitbout.

*‡**Postel, Vinay et Cie.,** 41, r. des Volontaires.

Prétot, 42–46, av. Philippe-Auguste.

Ravasse, E., 99, r. de Crimée.

Ravel, J., 7. r. Fromentin.

*‡**Reynaud et Cie., H.** (capital 70,000 frcs.), 49, boul. Gouvion-St.-Cyr.

Rhéda, 68, r. de la Folie-Mericourt.

Riancey, H. de, 3, place Daumesnil.

Richard, G., 13, r. Théophile-Gautier, Passy.

Rolland, Vinot et Deguinand, 22, q. National, Puteaux.

Rose, L., 23, r. Fontaine.

Roser, N., 38, r. de la Briche, St.-Denis.

Rosier et Cie., 115, r. des Frères Herbert, Levallois (Seine).

Roussat, J., 131, boul. Murat.

Rupalley, G., Rouxel et Cie., 36, av. de Wagram. **Works:** Suresnes.

†‡**Santenard et Cie.,** 59 *bis*, r. Popincourt.

Séguin, L., 44, r. Lafayette. Works : Petit Gennevilliers (Le Gnome Motor).

Société anonyme de Construction de Cycles et d'Automobiles de la marque Georges Richard, 13, r. Théophile-Gautier, Passy.

Société anonyme des Accumulateurs Fulmen, 18, q. de Clichy.

Société anonyme des Anciens Etablissements Panhard et Levassor, 19, av. d'Ivry.

Société anonyme des Automobiles Elan, 64, av. de la Grande Armée.

Société anonyme des Automobiles Peugeot, 83, boul. Gouvion-St. Cyr.   Works : Audincourt (Doubs), &c.

*Société anonyme d'Electricité et d'Automobiles Mors (capital 2,000,000 francs), 48, r. du Theatre, Grenelle.

Société anonyme des Moteurs Niel, 22, r. Lafayette.   Works : Evreux.

Société anonyme des Voiturettes Automobiles Leon Bollée, 163, av. Victor-Hugo.

†‡Société anonyme Franco-Belge (Système le Blant), 10, av. de l'Opera.   Works : Raismes & la Croyère (Belgium).

Société anonyme l'Automobile, 146, boul. Haussmann.

Société Continentale d'Automobiles (capital 2,500,000 francs), Etablissements Gautier & Wherlé, 31, r. Cavé-Levallois.

*‡Société d'Eclairage Électrique, 15, pl. Vendôme.

†‡Société de Chaudières et Voitures a vapeur (Système Scotte), 56, r. de Provence.

Société de Construction et d'Exploitation des Moteurs Auriol, 23, r. Godot-de-Mauroi.

Société de Constructions mécaniques des Vélocipèdes Michaux et de Vehicules Automobiles, 14, r. Favart. Works : 12 et 12 *bis*, av. de Madrid, à Neuilly.

*‡Société de la Voiture Electrique Bouquet-Schrivre, 34, r. Taitbout.

Société des Automobiles et Automobilettes Rhéda, 68, r. de la Folie-Mericourt, and 23, r. du President Carnot, Saint Cloud (S. et O.).

Société des Automobiles et Moteurs Henriod, 5 & 7, r. de Sablonville, Neuilly.

Société des Automobiles Koch (capital 300,000 francs), 38, r. de Berlin.

†‡Société des Générateurs a vaporisation instantée (Système Serpollet), 61, r. Caumartin.

†‡Société des Moteurs et Voitures Automobiles (Système Filz), 13, boul. Malesherbes.

Société des Moteurs Gobron et Brillé, 17, r. Philippe de Gerard.

Sociéte des Voitures Automobiles " La Parisienne," 71, av. de la Grande Armée.

*‡Société des Voitures Electriques (capital 4,000,000 francs), (Système Krieger), 80, r. Taitbout.

Société des Voiturettes Automobiles (Système Léon Bollée), 163, av. Victor-Hugo.

Société Française des Cycles et Automobiles Liberator, 47, r. Curtier-Bresson (Seine).

Société Française du Moteur équilibré, 41, r. de Chabrol.

Société Gladiator, 18, boul. Montmartre. Works : au Pré-St.-Gervais.

*‡Société Gramme, 20, r. d'Hautpoul.

*†‡Société industrielle de Moteurs electriques et a Vapeur, 38, r. de Laborde. Works : Havre. (Système J. J. Heilmann.)

Société Nouvelle d'Études Commerciales et Industrielles, Th. Cornie et Cie., Bourse du Commerce, r. du Louvre (Système D. Nault).

†‡Société Nouvelle des Etablissements Decauville aîné, 13, boul. Malesherbes. Works : Petit Bourg (S. et O.).

*‡Société Postel-Vinay, 41, r. des Voltaires.

Syndicat de l'Autocycle de Lecroix, 35, boul. Haussmann.

Tenting, H. (La Nationale Société de Constructions de Moteurs et Automobiles, H. Tenting), 46, r. Curial.

Tourey, J., 66, r. de Sevres.

Vallée, Mans (Sarthe) and 19, r. des Arts, Levallois.

†Weidknecht, 1, boul. MacDonald.

Werner, frères et Cie., 85, r. Richelieu.

FRANCE (Provinces).

Ateliers Diederichs, Bourgoin (Isère).

Aubert, E., 15, ter. pl. de l'Eperon, Le Mans (Sarthe).

Audibert, Lavirotte et Cie., 12, ch. des Quatre-Maisons, Lyon (Rhone).

Baud, E., 53, boul. du Nord Lyon (Rhone).

Bebeli et Cie., 24, boul. Carnot, Toulouse (Hte.-Gar.).

Belville, H., Vervins (Aisne).

Blondel, Amiens (Somme).

*‡Bogard, 10, r. St.-Martin (Versailles).

†Bollée (Amédée), fils aîné, 99, av. de Paris, Le Mans (Sarthe).

†Bollée (Léon), 104, av. de Paris, Le Mans (Sarthe).

Bonneville, 60, boul. Carnot, Toulouse.

Briest et Armand, Villers-Cotterets (Aisne).

Briest frères, 109, r. de Rennes, Nantes (Loire-Inf.).

Brouhout et Cⁱᵉ., Vierzon, Cher.

†‡Buffaud, B., et Robatel, T., 29, r. de Baraban, Lyon.

Cassan fils, Bourgoin (Isère).

Crombez, Numa, Raismes (Nord).

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Benz & Co., Mannheim.

Bergmanns Industrie Werke, Gaggenau.

Bitschwiller Motor-Wagen Works (Martinot & Galland), Bitschwiller, Thann (Alsace).

Cudell & Co., Aix-la-Chapelle.

Daimler Motoren Gesellschaft, Cannstadt (Wurtemberg).

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STATUTES

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GLOSSARY OF TERMS USED IN AUTOMOBILISM.

FRENCH—ENGLISH.

Acier, steel.
Acier fondu, cast-steel.
Aiguille, needle.
Aile d'hélice, blade of a screw-propeller.
Ailette, flange, projection, studs.
Alliage, alloy.
Aimant, magnet.
Alleré, drawn in.
Amiante, asbestos.
Angle oblique, bevel.
Appareil, gear, works, arrangement.
Appareil à chauffer l'eau d'alimentation, feed-water heater.
Arbre, shaft.
Arbre à manivelle, crank-shaft.
Arrière, astern, backwards.
Aspiration, exhausting, suction.
Avant, ahead, forward.
Avarié, damage.

Bagnolet, waterproof cover, tarpaulin.
Bague de piston, piston ring.
Baille, bucket.
Banc, seat.
Banquière, clamp.
Barre
Barre de gouvernail } steering-handle or tiller.
Basse pression, low pressure.
Bec, candle, stack.
Bielle, connecting rod.
Bielle d'excentrique, eccentric rod.
Bielles pendentes, side rods.
Blanc de céruse, white-lead.
Blindage en fer, iron sheeting.
Boîte à tiroir, slide-valve chest.
Boîte à vapeur, steam trap.
Boulon, bolt, pin.
Brinqueballe, pump-handle.

Brise circuit, circuit breaker.
Broche, spindle.
Bronze de canon, gun-metal.
Bruit, noise.

Caillebottis, grating.
Caisse à eau, water tank.
Caisse à petrole, petrol tank.
Caisson, box.
Carneaux de chaudière, boiler flues.
Chaîne, chain.
Chaîne à la vaucauson, pitch chain.
Chaîne sans fin, endless chain.
Chaloupe à vapeur, steam-launch.
Charnières, hinges.
Chassis, frame of a vehicle.
Chaudiere, boiler, generator.
Chaudronnier, boiler-maker.
Chavirer, capsize.
Chemin, road, track.
Cheminée, chimney.
Cheval vapeur, horsepower.
Cheville, bolt.
Cheville à œillet, eye-bolt.
Clapet, clack valve.
Cloison étanche, watertight bulkhead.
Clou, nail.
Collerette, flange.
Collet, neck, collar.
Collier d'excentrique, eccentric strap.
Composé explosif, explosive compound.
Compteur, meter or counter.
Condenseur, condenser.
Cornet à longuin, foghorn.
Cornière, angle-iron.
Côté, side.
Cou de cygne, gooseneck.
Coulisseun, groove.

Courbaton, bracket.
Courie joint, butt joint.
Couronne à empreviente, sprocket wheel.
Courroie, belting.
Course, stroke.
Course de piston, length of piston stroke.
Coussinet, bush.
Crampe de fer, iron staple.
Crapaudine, bed plate.
Creux, depth.
Cric à vis, screw-jack.
Cuir, leather.
Cuivre, copper.

Dedans, internally, within.
Defauts, defects.
Dehors, externally, from without.
Dent, ratchet, cog, tooth.
Dessinateur, designer.
Dessous, under, below.
Détente, mechanisme de, expansion gear.
Détente, origine de la, point of cut-off.
Dimanche, Sunday.
Doucement, slowly.

Échappement, escape, exhaust.
Echelle, ladder.
Egouttoir, grating.
Elancé, projecting.
En avant, go ahead, ahead.
Engregage-conique, bevel gear.
Engregages, gearing.
Escarbilles, cinders.
Essieu, axletree.
Etain, tin.
Étrort, narrow.
Evacuation, discharge.
Excentrique, eccentric.

Fanal, lantern.
Fer, iron.
Fer à ruban, hoop-iron.

Fer d'angle, angle-iron.
Fer en barrer, bar-iron.
Fer en T, tee-iron.
Filon, rope.
Fils, wires.
Flotteur, float.
Fonte crue, pig-iron.
Fonte de fer, cast-iron.
Fontes, castings.
Foret, drill.
Fort loin, a great way off.
Fourneau, furnace.
Frein, brake.
Fût, cask.

Garniture étoupe de moteurs, engine packing.
Garniture métallique, metallic packing.
Glissiere, guide.
Gond, hinge.
Gouverner, to steer.
Grue, crane.
Guindaux, windlass.
Guirlande, girder.

Hampe, handle.
Heaume, tiller.
Hélice, screw-propeller.
Hors, without, except, out of.
Houille, fuel.
Huile, oil.

Inflammation, ignition.
Introduction, admission.

Jambes, brackets.
Joint á clin ⎫
Joint superposé ⎬ lapped joint.
Joint á collet, flanged joint.

Léger, light.
Lest, ballast.
Liaisons, strengthening pieces.
Linguets, pawls.
Lundi, Monday.

Machine á basse pression, low-pressure engine.
Machine á haute pression, high-pressure engine.
Machine à percer, drilling machine.
Machine à vapeur, steam engine.
Main d'œuvre, workmanship.
Mamelon, nipple.
Manièle, shuttle.
Manivelle, crank.
Manchons d'embrayage, friction clutch.
Manometre, steam-pressure gauge.
Marteau, hammer.
Mechanisme de détente, slide-valve or expansion gear.
Mèche, spindle, barrel.
Mélange, mixture.
Minium, red-lead.
Motrice, moving, motor.

Niveau, level.

Palier, level, plummer block.
Peinture, paint.
Penture, hinge.
Pile, battery.
Plaque de fondation, sole plate.
Plombe de sûrete, fusible plug.
Pompe à air, air pump.
Pompe à bas, hand pump.
Pont, deck, platform, bridge.
Pontre, girder.
Poulie, pulley.
Presse étoupe, stuffing-box
Pression, pressure.
Presson, crow-bar.
Propulseur, propeller.

Regulateur, governor.
Remorquer, tug-boat.

Reniflard, blow-through valve.
Réservoir, tank.
Ressort, spring.
Robinet, cock, tap, valve.
Roue, wheel.
Roue conique, bevel or mitre wheels.
Roue de gouvernail, steering wheel.
Rouler, to roll.

Saille, cam, projection.
Samedi, Saturday.
Serrures, locks.
Siege, seat.
Son, noise.
Souffleur, blower.
Soupape, valve.
Soupape de sûrete, safety valve.
Soute, bunker.

Tambour, drum or barrel.
Taquet, cleat, clamp.
Tente, awning.
Tige, spindle.
Tille, platform.
Tirage, draught.
Tirage forcè, forced draught.
Tôle, boiler plate.
Tourillon, gudgeon, trunnion.
Toute vitesse, full-speed.
Tube de hireau, water gauge.
Tuyau, pipe.
Tuyau d'asperation, suction pipe.
Tuyau d'ecoulement, delivery pipe.

Vapeur, steam.
Vendredi, Friday.
Ventre à terme, purchase - hire system.
Vitesse, speed.
Volant, flywheel.

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Ahead, en avant.
Air pump, pompe à air.
Air valve, soupape atmospherique.
Alloy, aillage.
Angle iron, fer d'angle.
Apertures, ouvertures.
Asbestos, amiante.
Astern, en arrière.
Awning, tente.

Barrel, tambour.
Battery, pile.
Bearing, portie de l'arbre, coussinets.
Bilge pump, pompe de cale.
Belting, courroie.
Bevel gear, engregage-conique.
Blades (*of a screw*), ailes.
Blow-off cock, robinet d'extraction.
Blow-through valve, reniflard.
Blower, souffleur.
Boiler, chaudiere.
Boiler composition, composition pour chaudieres.
Boiler mountings, accessoires de chaudiere.
Bolts, boulons.
Brackets, jambes.
Brake, frein.
Brass, laiton.
Bridges, ponts.
Buffer, ressort.
Bush, coussinet.
Butt strap, courie joint.

Capsize (*to*) chavirer.
Castings, fontes.
Cement, ciment.
Chest (*slide-valve*), boîte à tiroir.
Cinders, escarbilles.
Circuit breaker, le brise circuit.
Circuit closer, le ferme circuit.
Clack valve, clapet.
Coal, charbon, houille.

Compound engine, machine compose.
Condenser, condenseur.
Condensing engine, machine à condenseur.
Conducting wires, fils, conducteurs.
Connecting rod, bielle.
Crane, grue.
Crank, manivelle.
Crank-shaft, arbre coudé.
Crosshead, un té, une traverse.

Damage, avarié.
Defects, defauts.
Design, devis, dessin.
Draught, tirage.
Draughtsman, dessinateur des machines.
Driving shaft, l'arbre de couche.
Dynamo, dynamometrès.

Ease her, doucement.
Eccentric rod, bielle d'excentrique.
Eccentric strap, collier d'excentrique.
Eduction pipe ⎫ tuyeau d'evacua-
Exhaust pipe ⎭ tion.
Endless chain, chaine sans fin.
Endless screw, vis sans fin.
Exhaust valve, soupape d'evacuation.
Expansion gear, mechanisme de détente.
Explosive compound, composé explosif.

Fan, ventilateur.
Faster, plus vite.
Feed-water heater, appareil a chauffer l'eau d'alimentation.
File, lime.
Fire-box, boîte à feu.
Fire engine, pompe à incendie.
Fire-grate, grille.

Firing battery, pile d'inflamma-
  tion.
Fixed expansion, détente naturelle.
Flange, ailette.
Flues (boiler), carneaux de chau-
  dière
Fog signal, foghorn, cornet à
  longuin.
Forced draught, tirage force.
Force pump, pompe foulante.
Fore axletree, essieu de l'avant.
Forgings, œuvres de forg.
Forward, en avant.
Frame, un couple, chassis.
Friction clutch, manchons
  d'embrayage
Friday, vendredi.
Fuel, combustible.
Full-speed, toute vitesse.
Funnel (chimney), cheminee, tuyou.
Furnace, fourneau.
Fusible plug, plombe de sûrete.

Gauge cock, robinet jauge.
Gauge glass, verres d'indicateurs
  de hauteur d'eau.
Gauge glass, tube de niveau.
Gauge (steam), manometre.
Gas engine, moteur à gaz.
Gearing, engregages.
Girder, guirlande.
Governor, regulateur.
Grease cock, robinet graisseur.
Groove, coulisseon.
Gudgeon, tourillon.
Guide, glissière.

Hammer, marteau.
Heating apparatus, appareils de
  chauffage.
Heating surface, surface de chauffe.
High-pressure engine, machine à
  haute pression.
Hinges, charnières.
Hose, tuyeaux de conduite.

India-rubber, caoutchouc.
Ignition valve, robinet d'inflamma-
  tion.
Injection valve, robinet de prise.
Injector, injecteur.
Iron, fer.
Iron plate, plaque de blindage.
Iron sheeting, blindage en fer.

Joists (steel), solives en acier.

Ladder, échelle.
Lantern, a, un fanal.
Lap (of valve), l'avance à l'evacua-
  tion.
Lead (metal), plomb.
Lead (of valve), l'avance à l'intro-
  duction.
Leak, a, une voie.
Length of piston stroke, course de
  piston.
Lifting jack, crics et virers.
Light, a, une lumière.
Locks, serrures.
Low pressure, basse pression.
Lubricator, graisseur.

Magnets, aimants.
Mean pressure, moyenne pression.
Metallic packing, garniture métal-
  lique.
Meter, compteur.
Mill, moulin.
Mitre wheel, roue conique.
Mixer, mélangeur.
Monday, lundi.

Nail, clou.
Naphtha, naphte.
Narrow, étroit.
Neck, cou, collet.
Needle, aiguille.
Nipple, mamelon.
Noise, son, bruit.
Notch, coche.
Nut, écrou.

Off (*a good way*), fort loin.
Oil, huile.

Pace, pas.
Packing (*engine*), garniture étoupe de moteurs.
Path, chemin.
Pawls, longuets.
Petroleum tank, réservoir à pétrole.
Pig-iron, fonte-crue.
Pipe, tuyau.
Piston ring, bague de piston.
Piston rod, tige du piston.
Piston stroke, coup de piston.
Plummer block, palier.
Point of cut-off, origine de la détente.
Projection, saille.
Propeller, propulseur.
Propelling power, force motrice.
Pulley, poulie.
Pump, pompe.
Purchase hire system, ventre à terme.

Ratchet, dent.
Rear axletree, l'essieu de arrière.
Red-hot, toute rouge.
Red-lead, minium.
Reducing valve, soupape de réduction.
Ring, l'organneau.
Road rollers, rouleaux et compresseurs des routes.
Roll (*to*), rouler.
Rollers, galets.
Rotary, tourvant.
Rope, filon, corde.

Safety valve, soupape de sûreté.
Saturated steam, vapeur saturée.
Saturday, samedi.
Screw, vis.
Seat of valve, siege d'une soupape.
Sentinel valve, soupape d'avertissement.

Shafting, arbre de transmission.
Sheet iron, tôle de fer.
Side rods, bielles pendentes.
Slide-valve, tiroir.
Slow, doucement.
Snifting valve, soupape de purge.
Spanner, clef.
Speed, vitesse.
Spindle, goujon.
Spring, ressort.
Sprocket wheel, couronne à em-previente.
Stalk or stem, tige.
Steam, vapeur.
Steam generator, chaudière à vapeur.
Steam-launch, chaloupe à vapeur.
Steam pipe, tuyau de vapeur.
Steam port, orifice d'introduction.
Steam trap, boîte à vapeur.
Steam whistle, sifflet à vapeur.
Steel, acier.
Steering wheel, roue de gouvernail.
Stoker (*mechanical*), chauffeur mechanique.
Stop, stop.
Stop valve, soupape d'arret.
Stroke, course.
Submarine, sousmarin.
Sunday, dimanche.
Superheated steam, vapeur surchauffer.
Superheater, sur chauffeur.
Surface (*heating*), surface de chauffe.

Tank, citerne, réservoir.
Thursday, jeudi.
Timber, bois.
Tin, etain.
Tools, outils.
Tow (*to*), remorquer.
Traction engine, machines à traction.
Trunnion, tourillon.

Tube expanders, elargisseurs de tubes.
Tubing (flexible metallic) tuyaux en metal élastique.
Tuesday, mardi.
Tyre, bandage, bande d'une Roue.

Upset, renversement.

Valve, soupape.

Washers, rondelles.
Watch, montre.
Wednesday, mercredi.
Wheel-making machinery, charronage méchanique.
Wheels, roues.
Wind, vent.
Windlass, guindaux.
Wire rope, fils métalliques.