Second Edition

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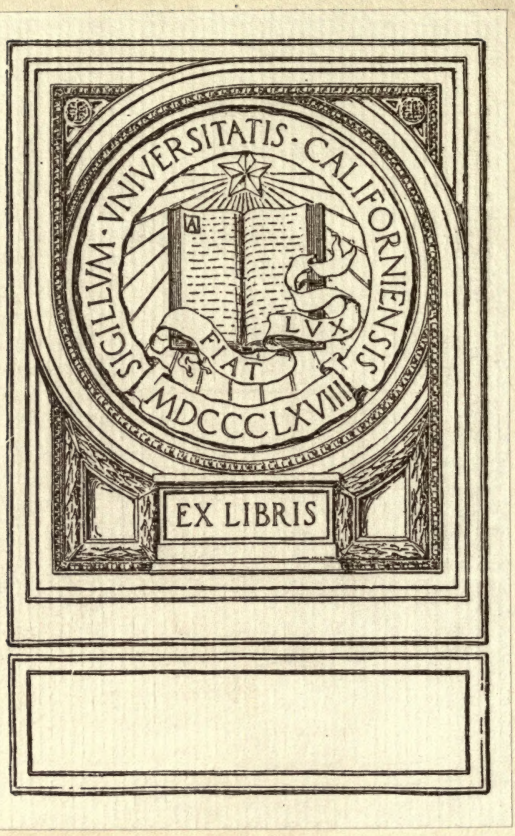
THE AUTOMOBILE ENGINEER REFERENCE BOOK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THE AUTOMOBILE ENGINEER REFERENCE BOOK

THE AUTOMOBILE ENGINEER REFERENCE BOOK

REVISED EDITION

Compiled by the Editorial Staff of "The Automobile Engineer"

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PREFACE

THE present edition of "THE AUTOMOBILE ENGINEER REFERENCE BOOK" constitutes a complete revision of all the standard reference tables, and it embodies also many new and important sections. An unusually complete collection of conversion factors will be found, including, it is believed, every item likely to be required.

The conversion table for cubic inches and cubic centimetres has been enlarged, so that by direct reference the equivalent from 1 cubic inch to 999 is given. This is of course designed to provide immediate comparisons between the capacities of cylinders of inch dimensions with those of metric size.

The horse-power treasury rating tables have been expanded to include eight-cylinder engines. They have been completely recalculated from 50 to 150 mm. bore by 1 millimetre, and from 2 in. to 6 in., rising by $\frac{1}{16}$ in.

Important articles will be found dealing with Supercharging, Piston Clearances, Modulus of Flywheels, Gear Box Calculations, Back Axles, Front Axles, Steering Gear, Brakes, and Laminated Springs.

Opportunity has been taken to completely rearrange the Reference Book, which is now reset in smaller type, in order that much additional matter may be embodied without increase of bulk.

As future editions become necessary, further tables, data, and articles will be included, and criticisms and suggestions will be welcomed.

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CONTENTS

CIRCUMFERENCE AND AREA OF CIRCLES,

from $\frac{1}{32}$ diameter to 27 diameter.

Dia.	Circumf.	Area.	Dia.	Circumf.	Area.	Dia.	Circumf.	Area.	Dia.	Circumf.	Area.
1/32	0.098175	0.00077	1/2	10.9956	9.6211	10	31.4159	78.540	19	59.6903	283.53
1/16	0.147262	0.00173	9/16	11.1919	9.9678	1/4	31.8086	80.516	1/4	60.0830	287.27
3/32	0.196350	0.00307	5/8	11.3883	10.321	1/2	32.2013	82.516	1/2	60.4757	291.04
1/8	0.294524	0.00690	11/16	11.5846	10.680	3/4	32.5940	84.541	3/4	60.8684	294.83
5/32	0.392699	0.01227	3/4	11.7810	11.045	1/8	32.9867	86.590	1/8	61.2611	298.65
3/16	0.490874	0.01917	13/16	11.9773	11.416	1/4	33.3794	88.664	1/4	61.6538	302.49
7/32	0.589049	0.02761	7/8	12.1737	11.793	3/8	33.7721	90.763	3/8	62.0465	306.35
1/4	0.687223	0.03758	15/16	12.3700	12.177	1/2	34.1648	92.886	1/2	62.4392	310.24
9/32	0.785398	0.04909	4	12.5664	12.566	11	34.5575	95.033	20	62.8319	314.16
5/16	0.883573	0.06213	1/16	12.7627	12.962	1/4	34.9502	97.205	1/4	63.2246	318.10
11/32	0.981748	0.07670	1/8	12.9591	13.364	1/2	35.3429	99.402	1/2	63.6173	322.06
3/8	1.07992	0.09281	3/16	13.1554	13.772	3/4	35.7356	101.62	3/4	64.0100	326.05
13/32	1.17810	0.11045	1/4	13.3518	14.186	1/8	36.1283	103.87	1/8	64.4026	330.06
7/16	1.27627	0.12962	5/16	13.5481	14.607	1/4	36.5210	106.14	1/4	64.7953	334.10
15/32	1.37445	0.15033	3/8	13.7445	15.033	3/8	36.9137	108.43	3/8	65.1880	338.16
1/2	1.47262	0.17257	7/16	13.9408	15.466	1/2	37.3064	110.75	1/2	65.5807	342.25
17/32	1.57080	0.19635	1/2	14.1372	15.904	12	37.6991	113.10	21	65.9734	346.36
9/16	1.66897	0.22166	9/16	14.3335	16.349	1/4	38.0918	115.47	1/4	66.3661	350.50
19/32	1.76715	0.24850	5/8	14.5299	16.800	1/2	38.4845	117.86	1/2	66.7588	354.66
5/8	1.86532	0.27688	11/16	14.7262	17.257	3/4	38.8772	120.28	3/4	67.1515	358.84
21/32	1.96350	0.30680	3/4	14.9226	17.721	1/8	39.2699	122.72	1/8	67.5442	363.05
11/16	2.06167	0.33824	13/16	15.1189	18.190	1/4	39.6626	125.19	1/4	67.9369	367.28
23/32	2.15984	0.37122	7/8	15.3153	18.665	3/8	40.0553	127.68	3/8	68.3296	371.54
3/4	2.25802	0.40574	15/16	15.5116	19.147	1/2	40.4480	130.19	1/2	68.7223	375.83
25/32	2.35619	0.44179	5	15.7080	19.635	13	40.8407	132.73	22	69.1150	380.13
13/16	2.45437	0.47937	1/16	15.9043	20.129	1/4	41.2334	135.30	1/4	69.5077	384.46
27/32	2.55254	0.51849	1/8	16.1007	20.629	1/2	41.6261	137.89	1/2	69.9004	388.82
7/8	2.65072	0.55914	3/16	16.2970	21.135	3/4	42.0188	140.50	3/4	70.2931	393.20
29/32	2.74889	0.60132	1/4	16.4934	21.648	1/8	42.4115	143.14	1/8	70.6858	397.61
15/16	2.84707	0.64504	5/16	16.6897	22.166	1/4	42.8042	145.80	1/4	71.0785	402.04
31/32	2.94524	0.69029	3/8	16.8861	22.691	3/8	43.1969	148.49	3/8	71.4712	406.49
1	3.04342	0.73709	7/16	17.0824	23.221	1/2	43.5896	151.20	1/2	71.8639	410.97
1/32	3.14159	0.78540	1/2	17.2788	23.758	14	43.9823	153.94	23	72.2566	415.48
1/16	3.33794	0.88664	9/16	17.4751	24.301	1/4	44.3750	156.70	1/4	72.6493	420.00
3/32	3.53429	0.99402	5/8	17.6715	24.850	1/2	44.7677	159.48	1/2	73.0420	424.56
1/8	3.73064	1.1075	11/16	17.8678	25.406	3/4	45.1604	162.30	3/4	73.4347	429.13
5/32	3.92699	1.2272	3/4	18.0642	25.967	1/8	45.5531	165.13	1/8	73.8274	433.74
3/16	4.12334	1.3530	13/16	18.2605	26.535	1/4	45.9458	167.99	1/4	74.2201	438.36
7/32	4.31969	1.4849	7/8	18.4569	27.109	3/8	46.3385	170.87	3/8	74.6128	443.01
1/4	4.51604	1.6230	15/16	18.6532	27.688	1/2	46.7312	173.78	1/2	75.0055	447.69
9/32	4.71239	1.7671	6	18.8496	28.274	15	47.1239	176.71	24	75.3982	452.39
5/16	4.90874	1.9175	1/16	19.2423	29.465	1/4	47.5166	179.67	1/4	75.7909	457.11
11/32	5.10509	2.0739	1/8	19.6350	30.680	1/2	47.9093	182.65	1/2	76.1836	461.86
3/8	5.30144	2.2365	3/16	20.0277	31.919	3/4	48.3020	185.66	3/4	76.5763	466.64
13/32	5.49779	2.4053	1/4	20.4204	33.183	1/8	48.6947	188.69	1/8	76.9690	471.44
7/16	5.69414	2.5802	5/16	20.8131	34.472	1/4	49.0874	191.75	1/4	77.3617	476.26
15/32	5.89049	2.7612	3/8	21.2058	35.785	3/8	49.4801	194.83	3/8	77.7544	481.11
1/2	6.08684	2.9483	7/16	21.5984	37.122	1/2	49.8728	197.93	1/2	78.1471	485.98
2	6.28319	3.1416	7	21.9911	38.485	16	50.2655	201.06	25	78.5398	490.87
1/32	6.47953	3.3410	1/16	22.3838	39.871	1/4	50.6582	204.22	1/4	78.9325	495.79
1/16	6.67588	3.5466	1/8	22.7765	41.282	1/2	51.0509	207.39	1/2	79.3252	500.74
3/32	6.87223	3.7583	3/16	23.1692	42.718	3/4	51.4436	210.60	3/4	79.7179	505.71
1/8	7.06858	3.9761	1/4	23.5619	44.179	1/8	51.8363	213.82	1/8	80.1106	510.71
5/32	7.26493	4.2000	5/16	23.9546	45.664	1/4	52.2290	217.08	1/4	80.5033	515.72
3/16	7.46128	4.4301	3/8	24.3473	47.173	3/8	52.6217	220.35	3/8	80.8960	520.77
7/32	7.65763	4.6664	7/16	24.7400	48.707	1/2	53.0144	223.65	1/2	81.2887	525.84
1/4	7.85398	4.9087	8	25.1327	50.265	17	53.4071	226.98	26	81.6814	530.93
9/32	8.05033	5.1572	1/16	25.5254	51.849	1/4	53.7998	230.33	1/4	82.0741	536.05
5/16	8.24668	5.4119	1/8	25.9181	53.456	1/2	54.1925	233.71	1/2	82.4668	541.19
11/32	8.44303	5.6727	3/16	26.3108	55.088	3/4	54.5852	237.10	3/4	82.8595	546.35
3/8	8.63938	5.9396	1/4	26.7035	56.745	1/8	54.9779	240.53	1/8	83.2522	551.55
13/32	8.83573	6.2126	5/16	27.0962	58.426	1/4	55.3706	243.98	1/4	83.6449	556.76
7/16	9.03208	6.4918	3/8	27.4889	60.132	3/8	55.7633	247.45	3/8	84.0376	562.00
15/32	9.22842	6.7771	7/16	27.8816	61.862	1/2	56.1560	250.95	1/2	84.4303	567.27
3	9.42478	7.0686	9	28.2743	63.617	18	56.5487	254.47	27	84.8230	572.56
1/32	9.62113	7.3662	1/16	28.6670	65.397	1/4	56.9414	258.02	1/4	85.2157	577.87
1/16	9.81748	7.6699	1/8	29.0597	67.201	1/2	57.3341	261.59	1/2	85.6084	583.21
3/32	10.0138	7.9798	3/16	29.4524	69.029	3/4	57.7268	265.18	3/4	86.0011	588.57
1/8	10.2102	8.2958	1/4	29.8451	70.882	1/8	58.1195	268.80	1/8	86.3938	593.96
5/32	10.4065	8.6179	5/16	30.2378	72.760	1/4	58.5122	272.45	1/4	86.7865	599.37
3/16	10.6029	8.9462	3/8	30.6305	74.662	3/8	58.9049	276.12	3/8	87.1792	604.81
7/32	10.7992	9.2806	7/16	31.0232	76.589	1/2	59.2976	279.81	1/2	87.5719	610.27

TABLE OF AREAS OF SMALL CIRCLES

From .001 to 1, advancing in Thousandths.

Dia.	Area.	Dia.	Area.	Dia.	Area.	Dia.	Area.	Dia.	Area.	Dia.	Area.
.001	.0000008	.071	.0039592	.141	.0156145	.211	.0349667	.281	.0620159	.351	.0967620
.002	.0000031	.072	.0040715	.142	.0158368	.212	.0352990	.282	.0624581	.352	.0973142
.003	.0000071	.073	.0041854	.143	.0160606	.213	.0356328	.283	.0629019	.353	.0978679
.004	.0000126	.074	.0043009	.144	.0162860	.214	.0359681	.284	.0633472	.354	.0984231
.005	.0000196	.075	.0044179	.145	.0165130	.215	.0363051	.285	.0637941	.355	.0989800
.006	.0000283	.076	.0045365	.146	.0167415	.216	.0366436	.286	.0642425	.356	.0995384
.007	.0000385	.077	.0046566	.147	.0169717	.217	.0369837	.287	.0646926	.357	.100098
.008	.0000503	.078	.0047784	.148	.0172034	.218	.0373253	.288	.0651442	.385	.100660
.009	.0000636	.079	.0049017	.149	.0174366	.219	.0376685	.289	.0655973	.359	.101223
.010	.0000785	.080	.0050266	.150	.0176715	.220	.0380133	.290	.0660521	.360	.101787
.011	.0000950	.081	.0051530	.151	.0179079	.221	.0383597	.291	.0665084	.361	.102354
.012	.0001131	.082	.0052810	.152	.0181458	.222	.0387076	.292	.0669663	.362	.102921
.013	.0001327	.083	.0054106	.153	.0183854	.223	.0390571	.293	.0674258	.363	.103491
.014	.0001539	.084	.0055418	.154	.0186265	.224	.0394082	.294	.0678868	.364	.104062
.015	.0001767	.085	.0056745	.155	.0188692	.225	.0397608	.295	.0683494	.365	.104634
.016	.0002011	.086	.0058088	.156	.0191134	.226	.0401150	.296	.0688136	.366	.105209
.017	.0002270	.087	.0059447	.157	.0193593	.227	.0404708	.297	.0692793	.367	.1057841
.018	.0002545	.088	.0060821	.158	.0196067	.228	.0408282	.298	.0697466	.368	.106362
.019	.0002835	.089	.0062212	.159	.0198556	.229	.0411871	.299	.0702155	.369	.106940
.020	.0003142	.090	.0063617	.160	.0201062	.230	.0415476	.300	.0706860	.370	.107521
.021	.0003464	.091	.0065039	.161	.0203583	.231	.0419097	.301	.0711580	.371	.108103
.022	.0003801	.092	.0066476	.162	.0206120	.232	.0422733	.302	.0716316	.372	.108686
.023	.0004155	.093	.0067929	.163	.0208672	.233	.0426385	.303	.0721067	.373	.109271
.024	.0004524	.094	.0069398	.164	.0211241	.234	.0430053	.304	.0725835	.374	.109858
.025	.0004909	.095	.0070882	.165	.0213825	.235	.0433737	.305	.0730618	.375	.110446
.026	.0005309	.096	.0072382	.166	.0216424	.236	.0437436	.306	.0735417	.376	.111036
.027	.0005726	.097	.0073898	.167	.0219040	.237	.0441151	.307	.0740231	.377	.111628
.028	.0006158	.098	.0075430	.168	.0221671	.238	.0444881	.308	.0745061	.378	.112221
.029	.0006605	.099	.0076977	.169	.0224318	.239	.0448628	.309	.0749907	.379	.112815
.030	.0007069	.100	.0078540	.170	.0226980	.240	.0452390	.310	.0754769	.380	.113411
.031	.0007548	.101	.008012	.171	.0229658	.241	.0456168	.311	.0759646	.381	.114009
.032	.0008042	.102	.008171	.172	.0232352	.242	.0459961	.312	.0764539	.382	.114608
.033	.0008553	.103	.008332	.173	.0235062	.243	.0463770	.313	.0769448	.383	.115209
.034	.0009079	.104	.008495	.174	.0237787	.244	.0467595	.314	.0774372	.384	.115811
.035	.0009621	.105	.008659	.175	.0240528	.245	.0471436	.315	.0779313	.385	.116415
.036	.0010179	.106	.008825	.176	.0243285	.246	.0475292	.316	.0784268	.386	.117021
.037	.0010752	.107	.008992	.177	.0246057	.247	.0479164	.317	.0789240	.387	.117628
.038	.0011341	.108	.009161	.178	.0248846	.248	.0483052	.318	.0794227	.388	.118237
.039	.0011946	.109	.009331	.179	.0251650	.249	.0486955	.319	.0799230	.389	.118847
.040	.0012566	.110	.009503	.180	.0254469	.250	.0490875	.320	.0804249	.390	.119459
.041	.0013203	.111	.009677	.181	.0257304	.251	.0494809	.321	.0809284	.391	.120072
.042	.0013854	.112	.009852	.182	.0260155	.252	.0498760	.322	.0814334	.392	.120687
.043	.0014522	.113	.0100287	.183	.0263022	.253	.0502726	.323	.0819399	.393	.121304
.044	.0015205	.114	.0102070	.184	.0265905	.254	.0506708	.324	.0824481	.394	.121922
.045	.0015904	.115	.0103869	.185	.0268803	.255	.0510706	.325	.0829578	.395	.122542
.046	.0016619	.116	.0105683	.186	.0271716	.256	.0514719	.326	.0834691	.396	.123163
.047	.0017349	.117	.0107513	.187	.0274646	.257	.0518748	.327	.0839820	.397	.123786
.048	.0018095	.118	.0109359	.188	.0277591	.258	.0522793	.328	.0844964	.398	.124410
.049	.0018857	.119	.0111220	.189	.0280552	.259	.0526854	.329	.0850124	.399	.125036
.050	.0019635	.120	.0113097	.190	.0283529	.260	.0530930	.330	.0855300	.400	.125664
.051	.0020428	.121	.0114990	.191	.0286521	.261	.0535022	.331	.0860492	.401	.126293
.052	.0021237	.122	.0116898	.192	.0289529	.262	.0539129	.332	.0865699	.402	.126923
.053	.0022062	.123	.0118823	.193	.0292553	.263	.0543253	.333	.0870922	.403	.127556
.054	.0022902	.124	.0120763	.194	.0295593	.264	.0547392	.334	.0876160	.404	.128189
.055	.0023758	.125	.0122718	.195	.0298648	.265	.0551547	.335	.0881415	.405	.128825
.056	.0024630	.126	.0124690	.193	.0301719	.266	.0555717	.336	.0886685	.406	.129462
.057	.0025518	.127	.0126677	.197	.0304805	.267	.0559903	.337	.0891970	.407	.130100
.058	.0026421	.128	.0128679	.198	.0307908	.268	.0564105	.338	.0897272	.408	.130740
.059	.0027340	.129	.0130698	.199	.0311026	.269	.0568323	.339	.0902589	.409	.131382
.060	.0028274	.130	.0132732	.200	.0314160	.270	.0572556	.340	.0907922	.410	.132025
.061	.0029225	.131	.0134782	.201	.0317309	.271	.0576805	.341	.0913270	.411	.132670
.062	.0030191	.132	.0136848	.202	.0320474	.272	.0581070	.342	.0918635	.412	.133316
.063	.0031173	.133	.0138929	.203	.0323655	.273	.0585350	.343	.0924011	.413	.133964
.064	.0032170	.134	.0141026	.204	.0326852	.274	.0589646	.344	.0929410	.414	.134614
.065	.0033183	.135	.0143139	.205	.0330064	.275	.0593958	.345	.0934822	.415	.135265
.066	.0034212	.136	.0145267	.206	.0333292	.276	.0598286	.346	.0940249	.416	.135918
.067	.0035257	.137	.0147411	.207	.0336536	.277	.0602629	.347	.0945692	.417	.136572
.068	.0036317	.138	.0149571	.208	.0339795	.278	.0606988	.348	.0951150	.418	.137228
.069	.0037393	.139	.0151747	.209	.0343070	.279	.0611363	.349	.0956625	.419	.137885
.070	.0038485	.140	.0153938	.210	.0346361	.280	.0615753	.350	.0962115	.420	.138544

TABLE OF AREAS OF SMALL CIRCLES (*Continued*).

Dia.	Area.	Dia.	Area.	Dia.	Area.	Dia.	Area.	Dia.	Area.	Dia.	Area.
.421	.139205	.491	.189345	.561	.247181	.631	.312715	.701	.385946	.771	.466873
.422	.139867	.492	.190117	.562	.248063	.632	.313707	.702	.387048	.772	.468085
.423	.140530	.493	.190890	.563	.248947	.633	.314701	.703	.388151	.773	.469299
.424	.141196	.494	.191665	.564	.249832	.634	.315696	.704	.389256	.774	.470514
.425	.141862	.495	.192442	.565	.250719	.635	.316692	.705	.390363	.775	.471730
.426	.142531	.496	.193220	.566	.251607	.636	.317691	.706	.391471	.776	.472949
.427	.143201	.497	.194000	.567	.252497	.637	.318690	.707	.392581	.777	.474168
.428	.143872	.498	.194782	.568	.253388	.638	.319692	.708	.393692	.778	.475396
.429	.144545	.499	.195565	.569	.254281	.639	.320695	.709	.394805	.779	.476612
.430	.145220	.500	.196350	.570	.255176	.640	.321699	.710	.395920	.780	.477837
.431	.145896	.501	.197136	.571	.256072	.641	.322705	.711	.397036	.781	.479063
.432	.146574	.502	.197923	.572	.256970	.642	.323713	.712	.398153	.782	.480290
.433	.147253	.503	.198713	.573	.257869	.643	.324722	.713	.399273	.783	.481520
.434	.147934	.504	.199504	.574	.258770	.644	.325733	.714	.400393	.784	.482750
.435	.148617	.505	.200296	.575	.259672	.645	.326746	.715	.401516	.785	.483983
.436	.149301	.506	.201090	.576	.260576	.646	.327759	.716	.402640	.786	.485216
.437	.149987	.507	.201886	.577	.261412	.647	.328775	.717	.403765	.787	.486452
.438	.150674	.508	.202683	.578	.262389	.648	.329792	.718	.404892	.788	.478689
.439	.151362	.509	.203482	.579	.263298	.649	.330811	.719	.406021	.789	.488927
.440	.152053	.510	.204282	.580	.264208	.650	.331831	.720	.407151	.790	.490168
.441	.152745	.511	.205084	.581	.265120	.651	.332853	.721	.408283	.791	.491409
.442	.153438	.512	.205887	.582	.266033	.652	.333876	.722	.409416	.792	.492653
.443	.154133	.513	.206692	.583	.266948	.653	.334901	.723	.410551	.793	.493898
.444	.154830	.514	.207499	.584	.267865	.654	.335928	.724	.411687	.794	.495144
.445	.155528	.515	.208307	.585	.268783	.655	.336956	.725	.412825	.795	.496392
.446	.156228	.516	.209117	.586	.269703	.656	.337985	.726	.413965	.796	.497642
.447	.156929	.517	.209928	.587	.270624	.657	.339017	.727	.415106	.797	.498893
.448	.157632	.518	.210741	.588	.271547	.658	.340049	.728	.416249	.798	.500145
.449	.158337	.519	.211556	.589	.272471	.659	.341084	.729	.417393	.799	.501400
.450	.159043	.520	.212372	.590	.273397	.660	.342120	.730	.418539	.800	.502656
.451	.159751	.521	.213189	.591	.274325	.661	.343157	.731	.419687	.801	.503913
.452	.160460	.522	.214008	.592	.275254	.662	.344196	.732	.420836	.802	.505172
.453	.161171	.523	.214829	.593	.276185	.663	.345237	.733	.421986	.803	.506432
.454	.161883	.524	.215651	.594	.277117	.664	.346279	.734	.423138	.804	.507695
.455	.162597	.525	.216475	.595	.278051	.665	.347323	.735	.424292	.805	.508958
.456	.163312	.526	.217301	.596	.278986	.666	.348368	.736	.425448	.806	.510224
.457	.164030	.527	.218128	.597	.279923	.667	.349416	.737	.426604	.807	.511490
.458	.164748	.528	.218956	.598	.280862	.668	.350464	.738	.427763	.808	.512759
.459	.165468	.529	.219787	.599	.281802	.669	.351514	.739	.428923	.809	.514029
.460	.166190	.530	.220618	.600	.282744	.670	.352566	.740	.430085	.810	.515300
.461	.166913	.531	.221452	.601	.283687	.671	.353619	.741	.431248	.811	.516574
.462	.167638	.532	.222287	.602	.284632	.672	.354674	.742	.432412	.812	.517848
.463	.168365	.533	.223123	.603	.285578	.673	.355730	.743	.433579	.813	.519125
.464	.169093	.534	.223961	.604	.286526	.674	.356788	.744	.434747	.814	.520402
.465	.169823	.535	.224801	.605	.287476	.675	.357847	.745	.435916	.815	.521862
.466	.170554	.536	.225642	.606	.288426	.676	.358909	.746	.437087	.816	.512963
.467	.171287	.537	.226485	.607	.289379	.677	.359971	.747	.438260	.817	.524245
.468	.172021	.538	.227329	.608	.290324	.678	.361035	.748	.439434	.818	.525529
.469	.172757	.539	.228175	.609	.291289	.679	.362101	.749	.440610	.819	.526815
.470	.173494	.540	.229022	.610	.292247	.680	.363168	.750	.441787	.820	.528102
.471	.174233	.541	.229871	.611	.293206	.681	.364237	.751	.442966	.821	.529391
.472	.174974	.542	.230722	.612	.294166	.682	.365308	.752	.444146	.822	.530682
.473	.175716	.543	.231574	.613	.295128	.683	.366380	.753	.445328	.823	.531974
.474	.176460	.544	.232428	.614	.296092	.684	.367454	.754	.446512	.824	.533267
.475	.177205	.545	.233283	.615	.297057	.685	.368529	.755	.447697	.825	.534562
.476	.177992	.546	.234140	.616	.298024	.686	.369606	.756	.448884	.826	.535859
.477	.178701	.547	.234998	.617	.298993	.687	.370684	.757	.450072	.827	.537157
.478	.179451	.548	.235858	.618	.299963	.688	.371764	.758	.451262	.828	.538457
.479	.180202	.549	.236720	.619	.300934	.689	.372845	.759	.452454	.829	.539759
.480	.180956	.550	.237583	.620	.301907	.690	.373928	.760	.453647	.830	.541062
.481	.181710	.551	.238448	.621	.302882	.691	.375013	.761	.454841	.831	.542366
.482	.182467	.552	.239314	.622	.303858	.692	.376099	.762	.456037	.832	.543672
.483	.183225	.553	.240182	.623	.304836	.693	.377187	.763	.457235	.833	.544980
.484	.183984	.554	.241051	.624	.305815	.694	.378276	.764	.458435	.834	.546289
.485	.184745	.555	.241922	.625	.306796	.695	.379367	.765	.459635	.835	.547600
.486	.185508	.556	.242795	.626	.307779	.696	.380460	.766	.460838	.836	.548912
.487	.186272	.557	.243669	.627	.308783	.697	.381554	.767	.462042	.837	.550226
.488	.187038	.558	.244545	.628	.309749	.698	.382650	.768	.463247	.838	.551542
.489	.187805	.559	.245422	.629	.310736	.699	.383747	.769	.464454	.839	.552859
.490	.188574	.560	.246301	.630	.311725	.700	.384846	.770	.465663	.840	.554178

TABLE OF AREAS OF SMALL CIRCLES (*Continued*).

Dia.	Area.	Dia.	Area.	Dia.	Area.	Dia.	Area.	Dia.	Area.	Dia.	Area.
.841	.555498	.868	.591739	.894	.627719	.921	.666208	.948	.705842	.974	.745090
.842	.556820	.869	.593103	.895	.629120	.922	.667655	.949	.707332	.975	.746620
.843	.558143	.870	.594469	.896	.630531	.923	.669105	.950	.708823	.976	.784153
.844	.559468	.871	.595836	.897	.631939	.924	.670555	.951	.710316	.977	.749687
.845	.560795	.872	.597205	.898	.633349	.925	.672007	.952	.711811	.978	.751222
.846	.562123	.873	.598576	.899	.634761	.926	.673461	.953	.713307	.979	.752759
.847	.563453	.874	.599948	.900	.636174	.927	.674916	.954	.714805	.980	.754298
.848	.564784	.875	.601321	.901	.637588	.928	.676373	.955	.716304	.981	.755838
.849	.566117	.876	.602697	.902	.639004	.929	.677832	.956	.717805	.982	.757380
.850	.567451	.877	.604073	.903	.640422	.930	.679292	.957	.719307	.983	.758923
.851	.568787	.878	.605452	.904	.641841	.931	.680754	.958	.720811	.984	.760468
.852	.570125	.879	.606832	.905	.643262	.932	.682217	.959	.722317	.985	.762014
.853	.571464	.880	.608213	.906	.644684	.933	.683682	.960	.723824	.986	.763562
.854	.572804			.907	.646108	.934	.685148			.987	.765119
.855	.574147	.881	.609596	.908	.647534	.935	.686616	.961	.725333	.988	.766663
.856	.575490	.882	.610981	.909	.648961	.936	.688085	.962	.726843	.989	.768216
.857	.576836	.883	.612367	.910	.650389	.937	.689556	.963	.728355	.990	.769770
.858	.578183	.884	.613755			.938	.691029	.964	.729869		
.859	.579531	.885	.615144	.911	.651819	.939	.692503	.965	.731384	.991	.771326
.860	.580881	.886	.616535	.912	.653251	.940	.693979	.966	.732900	.992	.772883
		.887	.617928	.913	.654685			.967	.734418	.993	.774442
.861	.582233	.888	.619322	.914	.656120	.941	.695456	.968	.735938	.994	.776003
.862	.583586	.889	.620718	.915	.657556	.942	.696935	.969	.737459	.995	.777565
.863	.584941	.890	.622115	.916	.658994	.943	.698416	.970	.738982	.996	.779129
.864	.586297			.917	.660434	.944	.699898			.997	.780694
.865	.587655	.891	.623514	.918	.661875	.945	.701381	.971	.740507	.998	.782261
.866	.589015	.892	.624914	.919	.663318	.946	.702867	.972	.742033	.999	.783829
.867	.590376	.893	.626316	.920	.664762	.947	.704353	.973	.743560	1.000	.785400

CIRCUMFERENCES AND AREAS, SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, LOGARITHMS, AND RECIPROCALS OF NOS. FROM 1 to 1,000

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
1	3.142	0.7854	1	1	1.0000	1.0000	0.00000	1000.000
2	6.283	3.1416	4	8	1.4142	1.2599	0.30103	500.000
3	9.425	7.0686	9	27	1.7321	1.4422	0.47712	333.333
4	12.566	12.5664	16	64	2.0000	1.5874	0.60206	250.000
5	15.708	19.6350	25	125	2.2361	1.7100	0.69897	200.000
6	18.850	28.2743	36	216	2.4495	1.8171	0.77815	166.667
7	21.991	38.4845	49	343	2.6458	1.9129	0.84510	142.857
8	25.133	50.2655	64	512	2.8284	2.0000	0.90309	125.000
9	28.274	63.6173	81	729	3.0000	2.0801	0.95424	111.111
10	31.416	78.5398	100	1000	3.1623	2.1544	1.00000	100.000
11	34.558	95.0332	121	1331	3.3166	2.2240	1.04139	90.9091
12	37.699	113.097	144	1728	3.4641	2.2894	1.07918	83.3333
13	40.841	132.732	169	2197	3.6056	2.3513	1.11394	76.9231
14	43.982	153.938	196	2744	3.7417	2.4101	1.14613	71.4286
15	47.124	176.715	225	3375	3.8730	2.4662	1.17609	66.6667
16	50.265	201.062	256	4096	4.0000	2.5198	1.20412	62.5000
17	53.407	226.980	289	4913	4.1231	2.5713	1.23045	58.8235
18	56.549	254.469	324	5832	4.2426	2.6207	1.25527	55.5556
19	59.690	283.529	361	6859	4.3589	2.6684	1.27875	52.6316
20	62.832	314.159	400	8000	4.4721	2.7144	1.30103	50.0000
21	65.973	346.361	441	9261	4.5826	2.7589	1.32222	47.6190
22	69.115	380.133	484	10648	4.6904	2.8020	1.34242	45.4545
23	72.257	415.476	529	12167	4.7598	2.8439	1.36173	43.4783
24	75.398	452.389	576	13824	4.8990	2.8845	1.38021	41.6667
25	78.540	490.874	625	15625	5.0000	2.9240	1.39794	40.0000
26	81.681	530.929	676	17576	5.0990	2.9625	1.41497	38.4615
27	84.823	572.555	729	19683	5.1962	3.0000	1.43136	37.0370
28	87.965	615.752	784	21952	5.2915	3.0366	1.44716	35.7143
29	91.106	660.520	841	24389	5.3852	3.0723	1.46240	34.4828
30	94.248	706.858	900	27000	5.4772	3.1072	1.47712	33.3333
31	97.389	754.768	961	29791	5.5678	3.1414	1.49136	32.2581
32	100.531	804.248	1024	32768	5.6569	3.1748	1.50515	31.2500
33	103.673	855.299	1089	35937	5.7446	3.2075	1.51851	30.3030
34	106.814	907.920	1156	39304	5.8310	3.2396	1.53148	29.4118
35	109.956	962.113	1225	42875	5.9161	3.2711	1.54407	28.5714
36	113.097	1017.88	1296	46656	6.0000	3.3019	1.55630	27.7778
37	116.239	1075.21	1369	50653	6.0828	3.3322	1.56820	27.0270
38	119.381	1134.11	1444	54872	6.1644	3.3620	1.57978	26.3158
39	122.522	1194.59	1521	59319	6.2450	3.3912	1.59106	25.6410

CIRCUMFERENCES AND AREAS, SQUARES, etc. (*Continued*).

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
40	125.66	1256.64	1600	64000	6.3246	3.4200	1.60206	25.0000
41	128.81	1320.25	1681	68921	6.4031	3.4482	1.61278	24.3902
42	131.95	1385.44	1764	74088	6.4807	3.4760	1.62325	23.8095
43	135.09	1452.20	1849	79507	6.5574	3.5034	1.63347	23.2558
44	138.23	1520.53	1936	85184	6.6332	3.5303	1.64345	22.7273
45	141.37	1590.43	2025	91125	6.7082	3.5569	1.65321	22.2222
46	144.51	1661.90	2116	97336	6.7823	3.5830	1.66276	21.7391
47	147.65	1734.94	2209	103823	6.8557	3.6088	1.67210	21.2766
48	150.80	1809.56	2304	110592	6.9282	3.6342	1.68124	20.8333
49	153.94	1885.74	2401	117649	7.0000	3.6593	1.69020	20.4082
50	157.08	1963.50	2500	125000	7.0711	3.6840	1.69897	20.0000
51	160.22	2042.82	2601	132651	7.1414	3.7084	1.70757	19.6078
52	163.36	2123.72	2704	140608	7.2111	3.7325	1.71600	19.2308
53	166.50	2206.18	2809	148877	7.2801	3.7563	1.72428	18.8679
54	169.65	2290.22	2916	157464	7.3485	3.7798	1.73239	18.5185
55	172.79	2375.83	3025	166375	7.4162	3.8030	1.74036	18.1818
56	175.93	2463.01	3136	175616	7.4833	3.8259	1.74819	17.8571
57	179.07	2551.76	3249	185193	7.5498	3.8485	1.75587	17.5439
58	182.21	2642.08	3364	195112	7.6158	3.8709	1.76343	17.2414
59	185.35	2733.97	3481	205379	7.6811	3.8930	1.77085	16.9492
60	188.50	2827.43	3600	216000	7.7460	3.9149	1.77815	16.6667
61	191.64	2922.47	3721	226981	7.8102	3.9365	1.78533	16.3934
62	194.78	3019.07	3844	238328	7.8740	3.9579	1.79239	16.1290
63	197.92	3117.25	3969	250047	7.9373	3.9791	1.79934	15.8730
64	201.06	3216.99	4096	262144	8.0000	4.0000	1.80618	15.6250
65	204.20	3318.31	4225	274625	8.0623	4.0207	1.81291	15.3846
66	207.35	3421.19	4356	287496	8.1240	4.0412	1.81954	15.1515
67	210.49	3525.65	4489	300763	8.1854	4.0615	1.82607	14.9254
68	213.68	3631.68	4624	314432	8.2462	4.0817	1.83251	14.7059
69	216.77	3739.28	4761	328509	8.3066	4.1016	1.83885	14.4928
70	219.91	3848.45	4900	343000	8.3666	4.1213	1.84510	14.2857
71	223.05	3959.19	5041	357911	8.4261	4.1408	1.85126	14.0845
72	226.19	4071.50	5184	373248	8.4853	4.1602	1.85733	13.8889
73	229.34	4185.39	5329	389017	8.5440	4.1793	1.86332	13.6986
74	232.48	4300.84	5476	405224	8.6023	4.1983	1.86923	13.5135
75	235.62	4417.86	5625	421875	8.6603	4.2172	1.87506	13.3333
76	238.76	4536.46	5776	438976	8.7178	4.2358	1.88081	13.1579
77	241.90	4656.63	5929	456533	8.7750	4.2543	1.88649	12.9870
78	245.04	4778.36	6084	474552	8.8318	4.2727	1.89209	12.8205
79	248.19	4901.67	6241	493039	8.8882	4.2908	1.89763	12.6582
80	251.33	5026.55	6400	512000	8.9443	4.3089	1.90300	12.5000
81	254.47	5153.00	6561	531441	9.0000	4.3267	1.90849	12.3457
82	257.61	5281.02	6724	551368	9.0554	4.3445	1.91381	12.1951
83	260.75	5410.61	6889	571787	9.1104	4.3621	1.91908	12.0482
84	263.89	5541.77	7056	592704	9.1652	4.3795	1.92428	11.9048
85	267.04	5674.50	7225	614125	9.2195	4.3968	1.92942	11.7647
86	270.18	5808.18	7396	636056	9.2736	4.4140	1.93450	11.6279
87	273.32	5944.68	7569	658503	9.3274	4.4310	1.93952	11.4943
88	276.46	6082.12	7744	681472	9.3808	4.4480	1.94448	11.3636
89	279.60	6221.14	7921	704969	9.4340	4.4647	1.94939	11.2360
90	282.74	6361.73	8100	729000	9.4868	4.4814	1.95424	11.1111
91	285.88	6503.88	8281	753571	9.5394	4.4979	1.95904	10.9890
92	289.03	6647.61	8464	778688	9.5917	4.5144	1.96379	10.8696
93	292.17	6792.91	8649	804357	9.6437	4.5307	1.96848	10.7527
94	295.31	6939.78	8836	830584	9.6954	4.5468	1.97313	10.6383
95	298.45	7088.22	9025	857375	9.7468	4.5629	1.97772	10.5263
96	301.59	7238.23	9216	884736	9.7980	4.5789	1.98227	10.4167
97	304.73	7389.81	9409	912673	9.8489	4.5947	1.98677	10.3093
98	307.88	7542.96	9604	941192	9.8995	4.6104	1.99123	10.2041
99	311.02	7697.69	9801	970299	9.9499	4.6261	1.99564	10.1010
100	314.16	7853.98	10000	1000000	10.0000	4.6416	2.00000	10.00000
101	317.30	8011.85	10201	1030301	10.0499	4.6570	2.00432	9.90099
102	320.44	8171.28	10404	1061208	10.0995	4.6723	2.00860	9.80392
103	323.58	8332.29	10609	1092727	10.1489	4.6875	2.01284	9.70874
104	326.73	8494.87	10816	1124864	10.1980	4.7027	2.01703	9.61538
105	329.87	8659.01	11025	1157625	10.2470	4.7177	2.02119	9.52381
106	333.01	8824.73	11236	1191016	10.2956	4.7326	2.02531	9.43396
107	336.15	8992.02	11449	1225043	10.3441	4.7475	2.02938	9.34579
108	339.29	9160.88	11664	1259712	10.3923	4.7622	2.03342	9.25926
109	342.43	9331.32	11881	1295029	10.4403	4.7769	2.03743	9.17431

CIRCUMFERENCES AND AREAS, SQUARES, etc. (*Continued*).

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
110	345.58	9503.32	12100	1331000	10.4881	4.7914	2.04139	9.09091
111	348.72	9676.89	12321	1367631	10.5357	4.8059	2.04532	9.00901
112	351.86	9852.03	12544	1404928	10.5830	4.8203	2.04922	8.92857
113	355.00	10028.7	12769	1442897	10.6301	4.8346	2.05308	8.84956
114	358.14	10207.0	12996	1481544	10.6771	4.8488	2.05690	8.77193
115	361.28	10386.9	13225	1520875	10.7238	4.8629	2.06070	8.69565
116	364.42	10568.3	13456	1560896	10.7703	4.8770	2.06446	8.62069
117	367.57	10751.3	13689	1601613	10.8167	4.8910	2.06819	8.54701
118	370.71	10935.9	13924	1643032	10.8628	4.9049	2.07188	8.47458
119	373.85	11122.0	14161	1685159	10.9087	4.9187	2.07555	8.40336
120	376.99	11309.7	14400	1728000	10.9545	4.9324	2.07918	8.33333
121	380.13	11499.0	14641	1771561	11.0000	4.9461	2.08279	8.26446
122	383.27	11689.9	14884	1815848	11.0454	4.9597	2.08636	8.19672
123	386.42	11882.3	15129	1860867	11.0905	4.9732	2.08991	8.13008
124	389.56	12076.3	15376	1906624	11.1355	4.9866	2.09342	8.06452
125	392.70	12271.8	15625	1953125	11.1803	5.0000	2.09691	8.00000
126	395.84	12469.0	15876	2000376	11.2250	5.0133	2.10037	7.93651
127	398.98	12667.7	16129	2048383	11.2694	5.0265	2.10380	7.87402
128	402.12	12868.0	16384	2097152	11.3137	5.0397	2.10721	7.81250
129	405.27	13069.8	16641	2146689	11.3578	5.0528	2.11059	7.75194
130	408.41	13273.2	16900	2197000	11.4018	5.0658	2.11394	7.69231
131	411.55	13478.2	17161	2248091	11.4455	5.0788	2.11727	7.63359
132	414.69	13684.8	17424	2299968	11.4891	5.0916	2.12057	7.57576
133	417.83	13892.9	17689	2352637	11.5326	5.1045	2.12385	7.51880
134	420.97	14102.6	17956	2406104	11.5758	5.1172	2.12710	7.46269
135	424.12	14313.9	18225	2460375	11.6190	5.1299	2.13033	7.40741
136	427.26	14526.7	18496	2515456	11.6619	5.1426	1.13354	7.35294
137	430.40	14741.1	18769	2571353	11.7047	5.1551	2.13672	7.29927
138	433.54	14957.1	19044	2628072	11.7473	5.1676	2.13988	7.24638
139	436.68	15174.7	19321	2685619	11.7898	5.1801	2.14301	7.19424
140	439.82	15393.8	19600	2744000	11.8322	5.1925	2.14613	7.14286
141	442.96	15614.5	19881	2803221	11.8743	5.2048	2.14922	7.09220
142	446.11	15836.8	20164	2863288	11.9164	5.2171	2.15229	7.04225
143	449.25	16060.6	20449	2924207	11.9583	5.2293	2.15534	6.99301
144	452.39	16286.0	20736	2985984	12.0000	5.2415	2.15836	6.94444
145	455.53	16513.0	21025	3048625	12.0416	5.2536	2.16137	6.89655
146	458.67	16741.5	21316	3112136	12.0830	5.2656	2.16435	6.84932
147	461.81	16971.7	21609	3176523	12.1244	5.2776	2.16732	6.80272
148	464.96	17203.4	21904	3241792	12.1655	5.2896	2.17026	6.75676
149	468.10	17436.6	22201	3307949	12.2066	5.3015	2.17319	6.71141
150	471.24	17671.5	22500	3375000	12.2474	5.3133	2.17609	6.66667
151	474.38	17907.9	22801	3442951	12.2882	5.3251	2.17898	6.62252
152	477.52	18145.8	23104	3511808	12.3288	5.3368	2.18184	6.57895
153	480.66	18385.4	23409	3581577	12.3693	5.3485	2.18469	6.53595
154	483.81	18626.5	23716	3652264	12.4097	5.3601	2.18752	6.49351
155	486.95	18869.2	24025	3723875	12.4499	5.3717	2.19033	6.45161
156	490.09	19113.4	24336	3796416	12.4900	5.3832	2.19312	6.41026
157	493.23	19359.3	24649	3869893	12.5300	5.3947	2.19590	6.36943
158	496.37	19606.7	24964	3944312	12.5698	5.4061	2.19866	6.32911
159	499.51	19855.7	25281	4019679	12.6095	5.4175	2.20140	6.28931
160	502.65	20106.2	25600	4096000	12.6491	5.4288	2.20412	6.25000
161	505.80	20358.3	25921	4173281	12.6886	5.4401	2.20683	6.21118
162	508.94	20612.0	26244	4251528	12.7279	5.4514	2.20952	6.17284
163	512.08	20867.2	26569	4330747	12.7671	5.4626	2.21219	6.13497
164	515.22	21124.1	26896	4410944	12.8062	5.4737	2.21484	6.09756
165	518.36	21382.5	27225	4492125	12.8452	5.4848	2.21748	6.06061
166	521.50	21642.4	27556	4574296	12.8841	5.4959	2.22011	6.02410
167	524.65	21904.0	27889	4657463	12.9228	5.5069	2.22272	5.98802
168	527.79	22167.1	28224	4741632	12.9615	5.5178	2.22531	5.95238
169	530.93	22431.8	28561	4826809	13.0000	5.5288	2.22789	5.91716
170	534.07	22698.0	28900	4913000	13.0384	5.5397	2.23045	5.88235
171	537.21	22965.8	29241	5000211	13.0767	5.5505	2.23300	5.84795
172	540.35	23235.2	29584	5088448	13.1149	5.5613	2.23553	5.81395
173	543.50	23506.2	29929	5177717	13.1529	5.5721	2.23805	5.78035
174	546.64	23778.7	30276	5268024	13.1909	5.5828	2.24055	5.74713
175	549.78	24052.8	30625	5359375	13.2288	5.5934	2.24304	5.71429
176	552.92	24328.5	30976	5451776	13.2665	5.6041	2.24551	5.68182
177	556.06	24605.7	31329	5545233	13.3041	5.6147	2.24797	5.64972
178	559.20	24884.6	31684	5639752	13.3417	5.6252	2.25042	5.61798
179	562.35	25164.9	32041	5735339	13.3791	5.6357	2.25285	5.58659

CIRCUMFERENCES AND AREAS, SQUARES, etc. (*Continued*).

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
180	565.49	25446.9	32400	5832000	13.4164	5.6462	2.25527	5.55556
181	568.63	25730.4	32761	5929741	13.4536	5.6567	2.25768	5.52486
182	571.77	26015.5	33124	6028568	13.4907	5.6671	2.26007	5.49451
183	574.91	26302.2	33489	6128487	13.5277	5.6774	2.26245	5.46448
184	578.05	26590.4	33856	6229504	13.5647	5.6877	2.26482	5.43478
185	581.19	26880.3	34225	6331625	13.6015	5.6980	2.26717	5.40541
186	584.34	27171.6	34596	6434856	13.6382	5.7083	2.26951	5.37634
187	587.48	27464.6	34969	6539203	13.6748	5.7185	2.27184	5.34759
188	590.62	27759.1	35344	6644672	13.7113	5.7287	2.27416	5.31915
189	593.76	28055.2	35721	6751269	13.7477	5.7388	2.27646	5.29101
190	596.90	28352.9	36100	6859000	13.7840	5.7489	2.27875	5.26316
191	600.04	28652.1	36481	6967871	13.8203	5.7590	2.28103	5.23560
192	603.19	28952.9	36864	7077888	13.8564	5.7690	2.28330	5.20833
193	606.33	29255.3	37249	7189057	13.8924	5.7790	2.28556	5.18135
194	609.47	29559.2	37636	7301384	13.9284	5.7890	2.28780	5.15464
195	612.61	29864.8	38025	7414875	13.9642	5.7989	2.29003	5.12821
196	615.75	30171.9	38416	7529536	14.0000	5.8088	2.29226	5.10204
197	618.89	30480.5	38809	7645373	14.0357	5.8186	2.29447	5.07614
198	622.04	30790.7	39204	7762392	14.0712	5.8285	2.29667	5.05051
199	625.18	31102.6	39601	7880599	14.1067	5.8383	2.29885	5.02513
200	628.32	31415.9	40000	8000000	14.1421	5.8480	2.30103	5.00000
201	631.46	31730.9	40401	8120601	14.1774	5.8578	2.30320	4.97512
202	634.60	32047.4	40804	8242408	14.2127	5.8675	2.30535	4.95050
203	637.74	32365.5	41209	8365427	14.2478	5.8771	2.30750	4.92611
204	640.89	32685.1	41616	8489664	14.2829	5.8868	2.30963	4.90196
205	644.03	33006.4	42025	8615125	14.3178	5.8964	2.31175	4.87805
206	647.17	33329.2	42436	8741816	14.3527	5.9059	2.31387	4.85437
207	650.31	33653.5	42849	8869743	14.3875	5.9155	2.31597	4.83092
208	653.45	33979.5	43264	8998912	14.4222	5.9250	2.31806	4.80769
209	656.59	34307.0	43681	9129329	14.4568	5.9345	2.32015	4.78469
210	659.73	34636.1	44100	9261000	14.4914	5.9439	2.32222	4.76190
211	662.88	34966.7	44521	9393931	14.5258	5.9533	2.32428	4.73934
212	666.02	35298.9	44944	9528128	14.5602	5.9627	2.32634	4.71698
213	669.16	35632.7	45369	9663597	14.5945	5.9721	2.32838	4.69484
214	672.30	35968.1	45796	9800344	14.6287	5.9814	2.33041	4.67290
215	675.44	36305.0	46225	9938375	14.6629	5.9907	2.33244	4.65116
216	678.58	36643.5	46656	10077696	14.6969	6.0000	2.33445	4.62963
217	681.73	36983.6	47089	10218313	14.7309	6.0092	2.33646	4.60829
218	684.87	37325.3	47524	10360232	14.7648	6.0185	2.33846	4.58716
219	688.01	37668.5	47961	10503459	14.7986	6.0277	2.34044	4.56621
220	691.15	38013.3	48400	10648000	14.8324	6.0368	2.34242	4.54545
221	694.29	38359.6	48841	10793861	14.8661	6.0459	2.34439	4.52489
222	697.43	38707.6	49284	10941048	14.8997	6.0550	2.34635	4.50450
223	700.58	39057.1	49729	11089567	14.9332	6.0641	2.34830	4.48431
224	703.72	39408.1	50176	11239424	14.9666	6.0732	2.35025	4.46429
225	706.86	39760.8	50625	11390625	15.0000	6.0822	2.35218	4.44444
226	710.00	40115.0	51076	11543176	15.0333	6.0912	2.35411	4.42478
227	713.14	40470.8	51529	11697083	15.0665	6.1002	2.35603	4.40529
228	716.28	40828.1	51984	11852352	15.0997	6.1091	2.35793	4.38596
229	719.42	41187.1	52441	12008989	15.1327	6.1180	2.35984	4.36681
230	722.57	41547.6	52900	12167000	15.1658	6.1269	2.36173	4.34783
231	725.71	41909.6	53361	12326391	15.1987	6.1358	2.36361	4.32900
232	728.85	42273.3	53824	12487168	15.2315	6.1446	2.36549	4.31034
233	731.99	42638.5	54289	12649337	15.2643	6.1534	2.36736	4.29185
234	735.13	43005.3	54756	12812904	15.2971	6.1622	2.36922	4.27350
235	738.27	43373.6	55225	12977875	15.3297	6.1710	2.37107	4.25532
236	741.42	43743.5	55696	13144256	15.3623	6.1797	2.37291	4.23729
237	744.56	44115.0	56169	13312053	15.3948	6.1885	2.37475	4.21941
238	747.70	44488.1	56644	13481272	15.4272	6.1972	2.37658	4.20168
239	750.84	44862.7	57121	13651919	15.4596	6.2058	2.37840	4.18410
240	753.98	45238.9	57600	13824000	15.4919	6.2145	2.38021	4.16667
241	757.12	45616.7	58081	13997521	15.5242	6.2231	2.38202	4.14938
242	760.27	45996.1	58564	14172488	15.5563	6.2317	2.38382	4.13223
243	763.41	46377.0	59049	14348907	15.5885	6.2403	2.38561	4.11523
244	766.55	46759.5	59536	14526784	15.6205	6.2488	2.38739	4.09836
245	769.69	47143.5	60025	14706125	15.6525	6.2573	2.38917	4.08163
246	772.83	47529.2	60516	14886936	15.6844	6.2658	2.39094	4.06504
247	775.97	47916.4	61009	15069223	15.7162	6.2743	2.39270	4.04858
248	779.12	48305.1	61504	15252992	15.7480	6.2828	2.39445	4.03226
249	782.26	48695.5	62001	15438249	15.7797	6.2912	2.39620	4.01606

CIRCUMFERENCES AND AREAS, SQUARES, etc. (*Continued*).

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
250	785.40	49087.4	62500	15625000	15.8114	6.2996	2.39794	4.00000
251	788.54	49480.9	63001	15813251	15.8430	6.3080	2.39967	3.98406
252	791.68	49875.9	63504	16003008	15.8745	6.3164	2.40140	3.96825
253	794.82	50272.6	64009	16194277	15.9060	6.3247	2.40312	3.95257
254	797.96	50670.7	64516	16387064	15.9374	6.3330	2.40483	3.93701
255	801.11	51070.5	65025	16581375	15.9687	6.3413	2.40654	3.92157
256	804.25	51471.9	65536	16777216	16.0000	6.3496	2.40824	3.90625
257	807.39	51874.8	66049	16974593	16.0312	6.3579	2.40993	3.89105
258	810.53	52279.2	66564	17173512	16.0624	6.3661	2.41162	3.87597
259	813.67	52685.3	67081	17373979	16.0935	6.3743	2.41330	3.86100
260	816.81	53092.9	67600	17576000	16.1245	6.3825	2.41497	3.84615
261	819.96	53502.1	68121	17779581	16.1555	6.3907	2.41664	3.83142
262	823.10	53912.9	68644	17984728	16.1864	6.3988	2.41830	3.81679
263	826.24	54325.2	69169	18191447	16.2173	6.4070	2.41996	3.80228
264	829.38	54739.1	69696	18399744	16.2481	6.4151	2.42160	3.78788
265	832.52	55154.6	70225	18609625	16.2788	6.4232	2.42325	3.77358
266	835.66	55571.6	70756	18821096	16.3095	6.4312	2.42488	3.75940
267	838.81	55990.3	71289	19034163	16.3401	6.4393	2.42651	3.74532
268	841.95	56410.4	71824	19248832	16.3707	6.4473	2.42813	3.73134
269	845.09	56832.2	72361	19465109	16.4012	6.4553	2.42975	3.71747
270	848.23	57255.5	72900	19683000	16.4317	6.4633	2.43136	3.70370
271	851.37	57680.4	73441	19902511	16.4621	6.4713	2.43297	3.69004
272	854.51	58106.9	73984	20123648	16.4924	6.4792	2.43457	3.67647
273	857.66	58534.9	74529	20346417	16.5227	6.4872	2.43616	3.66300
274	860.80	58964.6	75076	20570824	16.5529	6.4951	2.43775	3.64964
275	863.94	59395.7	75625	20796875	16.5831	6.5030	2.43933	3.63636
276	867.08	59828.5	76176	21024576	16.6132	6.5108	2.44091	3.62319
277	870.22	60262.8	76729	21253933	16.6433	6.5187	2.44248	3.61011
278	873.36	60698.7	77284	21484952	16.6733	6.5265	2.44404	3.59712
279	876.50	61136.2	77841	21717639	16.7033	6.5343	2.44560	3.58423
280	879.65	61575.2	78400	21952000	16.7332	6.5421	2.44716	3.57143
281	882.79	62015.8	78961	22188041	16.7631	6.5499	2.44871	3.55872
282	885.93	62458.0	79524	22425768	16.7929	6.5577	2.45025	3.54610
283	889.07	62901.8	80089	22665187	16.8226	6.5654	2.45179	3.53357
284	892.21	63347.1	80656	22906304	16.8523	6.5731	2.45332	3.52113
285	895.35	63794.0	81225	23149125	16.8819	6.5808	2.45484	3.50877
286	898.50	64242.4	81796	23393656	16.9115	6.5885	2.45637	3.49650
287	901.64	64692.5	82369	23639903	16.9411	6.5962	2.45788	3.48432
288	904.78	65144.1	82944	23887872	16.9706	6.6039	2.45939	3.47222
289	907.92	65597.2	83521	24137569	17.0000	6.6115	2.46090	3.46021
290	911.06	66052.0	84100	24389000	17.0294	6.6191	2.46240	3.44828
291	914.20	66508.3	84681	24642171	17.0587	6.6267	2.46389	3.43643
292	917.35	66966.2	85264	24897088	17.0880	6.6343	2.46538	3.42466
293	920.49	67425.6	85849	25153757	17.1172	6.6419	2.46687	3.41297
294	923.63	67886.7	86436	25412184	17.1464	6.6494	2.46835	3.40136
295	926.77	68349.3	87025	25672375	17.1756	6.6569	2.46982	3.38983
296	929.91	68813.5	87616	25934336	17.2047	6.6644	2.47129	3.37838
297	933.05	69279.2	88209	26198073	17.2337	6.6719	2.47276	3.36700
298	936.19	69746.5	88804	26463592	17.2627	6.6794	2.47422	3.35570
299	939.34	70215.4	89401	26730899	17.2916	6.6869	2.47567	3.34448
300	942.48	70685.8	90000	27000000	17.3205	6.6943	2.47712	3.33333
301	945.62	71157.9	90601	27270901	17.3494	6.7018	2.47857	3.32226
302	948.76	71631.5	91204	27543608	17.3781	6.7092	2.48001	3.31126
303	951.90	72106.6	91809	27818127	17.4069	6.7166	2.48144	3.30033
304	955.04	72583.4	92416	28094464	17.4356	6.7240	2.48287	3.28947
305	958.19	73061.7	93025	28372625	17.4642	6.7313	2.48430	3.27869
306	961.33	73541.5	93636	28652616	17.4929	6.7387	2.48572	3.26797
307	964.47	74023.0	94249	28934443	17.5214	6.7460	2.48714	3.25733
308	967.61	74506.0	94864	29218112	17.5499	6.7533	2.48855	3.24675
309	970.75	74990.6	95481	29503629	17.5784	6.7606	2.48996	3.23625
310	973.89	75476.8	96100	29791000	17.6068	6.7679	2.49136	3.22581
311	977.04	75964.5	96721	30080231	17.6352	6.7752	2.49276	3.21543
312	980.18	76453.8	97344	30371328	17.6635	6.7824	2.49415	3.20513
313	983.32	76944.7	97969	30664297	17.6918	6.7897	2.49554	3.19489
314	986.46	77437.1	98596	30959144	17.7200	6.7969	2.49693	3.18471
315	989.60	77931.1	99225	31255875	17.7482	6.8041	2.49831	3.17460
316	992.74	78426.7	99856	31554496	17.7764	6.8113	2.49969	3.16456
317	995.88	78923.9	100489	31855013	17.8045	6.8185	2.50106	3.15457
318	999.03	79422.6	101124	32157432	17.8326	6.8256	2.50243	3.14465
319	1002.2	79922.9	101761	32461759	17.8606	6.8328	2.50379	3.13480

CIRCUMFERENCES AND AREAS, SQUARES, etc. (*Continued*).

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000× Recip.
	Circum.	Area.						
320	1005.3	80424.8	102400	32768000	17.8885	6.8399	2.50515	3.12500
321	1008.5	80928.2	103041	33076161	17.9165	6.8470	2.50651	3.11527
322	1011.6	81433.2	103684	33386248	17.9444	6.8541	2.50786	3.10559
323	1014.7	81939.8	104329	33698267	17.9722	6.8612	2.50920	3.09598
324	1017.9	82448.0	104976	34012224	18.0000	6.8683	2.51055	3.08642
325	1021.0	82957.7	105625	34328125	18.0278	6.8753	2.51188	3.07692
326	1024.2	83469.0	106276	34645976	18.0555	6.8824	2.51322	3.06749
327	1027.3	83981.8	106929	34965783	18.0831	6.8894	2.51455	3.05810
328	1030.4	84496.3	107584	35287552	18.1108	6.8964	2.51587	3.04878
329	1033.6	85012.3	108241	35611289	18.1384	6.9034	2.51720	3.03951
330	1036.7	85529.9	108900	35937000	18.1659	6.9104	2.51851	3.03030
331	1039.9	86049.0	109561	36264691	18.1934	6.9174	2.51983	3.02115
332	1043.0	86569.7	110224	36594368	18.2209	6.9244	2.52114	3.01205
333	1046.2	87092.0	110889	36926037	18.2483	6.9313	2.52244	3.00300
334	1049.3	87615.9	111556	37259704	18.2757	6.9382	2.52375	2.99401
335	1052.4	88141.3	112225	37595375	18.3030	6.9451	2.52504	2.98507
336	1055.6	88668.3	112896	37933056	18.3303	6.9521	2.52634	2.97619
337	1058.7	89196.9	113569	38272753	18.3576	6.9589	2.52763	2.96736
338	1061.9	89727.0	114244	38614472	18.3848	6.9658	2.52892	2.95858
339	1065.0	90258.7	114921	38958219	18.4120	6.9727	2.53020	2.94985
340	1068.1	90792.0	115600	39304000	18.4391	6.9795	2.53148	2.94118
341	1071.3	91326.9	116281	39651821	18.4662	6.9864	2.53275	2.93255
342	1074.4	91863.3	116964	40001688	18.4932	6.9932	2.53403	2.92398
343	1077.6	92401.3	117649	40353607	18.5203	7.0000	2.53529	2.91545
344	1080.7	92940.9	118336	40707584	18.5472	7.0068	2.53656	2.90698
345	1083.8	93482.0	119025	41063625	18.5742	7.0136	2.53782	2.89855
346	1087.0	94024.7	119716	41421736	18.6011	7.0203	2.53908	2.89017
347	1090.1	94569.0	120409	41781923	18.6279	7.0271	2.54033	2.88184
348	1093.3	95114.9	121104	42144192	18.6548	7.0338	2.54158	2.87356
349	1096.4	95662.3	121801	42508549	18.6815	7.0406	2.54283	2.86533
350	1099.6	96211.3	122500	42875000	18.7083	7.0473	2.54407	2.85714
351	1102.7	96761.8	123201	43243551	18.7350	7.0540	2.54531	2.84900
352	1105.8	97314.0	123904	43614208	18.7617	7.0607	2.54654	2.84091
353	1109.0	97867.7	124609	43986977	18.7883	7.0674	2.54777	2.83286
354	1112.1	98423.0	125316	44361864	18.8149	7.0740	2.54900	2.82486
355	1115.3	98979.8	126025	44738875	18.8414	7.0807	2.55023	2.81690
356	1118.4	99538.2	126736	45118016	18.8680	7.0873	2.55145	2.80899
357	1121.5	100098.0	127449	45499293	18.8944	7.0940	2.55267	2.80112
358	1124.7	100660.0	128164	45882712	18.9209	7.1006	2.55388	2.79330
359	1127.8	101223.0	128881	46268279	18.9473	7.1072	2.55509	2.78552
360	1131.0	101788.0	129600	46656000	18.9737	7.1138	2.55630	2.77778
361	1134.1	102354.0	130321	47045881	19.0000	7.1204	2.55751	2.77008
362	1137.3	102922.0	131044	47437928	19.0263	7.1269	2.55871	2.76243
363	1140.4	103491.0	131769	47832147	19.0526	7.1335	2.55991	2.75482
364	1143.5	104062.0	132496	48228544	19.0788	7.1400	2.56110	2.74725
365	1146.7	104635.0	133225	48627125	19.1050	7.1466	2.56229	2.73973
366	1149.8	105209.0	133956	49027896	19.1311	7.1531	2.56348	2.73224
367	1153.0	105785.0	134689	49430863	19.1572	7.1596	2.56467	2.72480
368	1156.1	106362.0	135424	49836032	19.1833	7.1661	2.56585	2.71739
369	1159.2	106941.0	136161	50243409	19.2094	7.1726	2.56703	2.71003
370	1162.4	107521.0	136900	50653000	19.2354	7.1791	2.56820	2.70270
371	1165.5	108103.0	137641	51064811	19.2614	7.1855	2.56937	2.69542
372	1168.7	108687.0	138384	51478848	19.2673	7.1920	2.57054	2.68817
373	1171.8	109272.0	139129	51895117	19.3132	7.1984	2.57171	2.68097
374	1175.0	109858.0	139876	52313624	19.3391	7.2048	2.57287	2.67380
375	1178.1	110447.0	140625	52734375	19.3649	7.2112	2.57403	2.66667
376	1181.2	111036.0	141376	53157376	19.3907	7.2177	2.57519	2.65957
377	1184.4	111628.0	142129	53582633	19.4165	7.2240	2.57634	2.65252
378	1187.5	112221.0	142884	54010152	19.4422	7.2304	2.57749	2.64550
379	1190.7	112815.0	143641	54439939	19.4679	7.2368	2.57864	2.63852
380	1193.8	113411.0	144400	54872000	19.4936	7.2432	2.57978	2.63158
381	1196.9	114009.0	145161	55306341	19.5192	7.2495	2.58093	2.62467
382	1200.1	114608.0	145924	55742968	19.5448	7.2558	2.58206	2.61780
383	1203.2	115209.0	146689	56181887	19.5704	7.2622	2.58320	2.61097
384	1206.4	115812.0	147456	56623104	19.5959	7.2685	2.58433	2.60417
385	1209.5	116416.0	148225	57066625	19.6214	7.2748	2.58546	2.59740
386	1212.7	117021.0	148996	57512456	19.6469	7.2811	2.58659	2.59067
387	1215.8	117628.0	149769	57960603	19.6723	7.2874	2.58771	2.58398
388	1218.9	118237.0	150544	58411072	19.6977	7.2936	2.58883	2.57732
389	1222.1	118847.0	151321	58863869	19.7231	7.2999	2.58995	2.57069

CIRCUMFERENCES AND AREAS, SQUARES, etc. (*Continued*).

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
390	1225.2	119459	152100	59319000	19.7484	7.3061	2.59106	2.56410
391	1228.4	120072	152881	59776471	19.7737	7.3124	2.59218	2.55755
392	1231.5	120687	153664	60236288	19.7990	7.3186	2.59329	2.55102
393	1234.6	121304	154449	60698457	19.8242	7.3248	2.59439	2.54453
394	1237.8	121922	155236	61162984	19.8494	7.3310	2.59550	2.53807
395	1240.9	122542	156025	61629875	19.8746	7.3372	2.59660	2.53165
396	1244.1	123163	156816	62099136	19.8997	7.3434	2.59770	2.52525
397	1247.2	123786	157609	62570773	19.9249	7.3496	2.59879	2.51889
398	1250.4	124410	158404	63044792	19.9499	7.3558	2.59988	2.51256
399	1253.5	125036	159201	63521199	19.9750	7.3619	2.60097	2.50627
400	1256.6	125664	160000	64000000	20.0000	7.3681	2.60206	2.50000
401	1259.8	126293	160801	64481201	20.0250	7.3742	2.60314	2.49377
402	1262.9	126923	161604	64964808	20.0499	7.3803	2.60423	2.48756
403	1266.1	127556	162409	65450827	20.0749	7.3864	2.60531	2.48139
404	1269.2	128190	163216	65939264	20.0998	7.3925	2.60638	2.47525
405	1272.3	128825	164025	66430125	20.1246	7.3986	2.60746	2.46914
406	1275.5	129462	164836	66923416	20.1494	7.4047	2.60853	2.46305
407	1278.6	130100	165649	67419143	20.1742	7.4108	2.60959	2.45700
408	1281.8	130741	166464	67917312	20.1990	7.4169	2.61066	2.45098
409	1284.9	131382	167281	68417929	20.2237	7.4429	2.61172	2.44499
410	1288.1	132025	168100	68921000	20.2485	7.4290	2.61278	2.43902
411	1291.2	132670	168921	69426531	20.2731	7.4350	2.61384	2.43309
412	1294.3	133317	169744	69934528	20.2978	7.4410	2.61490	2.42718
413	1297.5	133965	170569	70444997	20.3224	7.4470	2.61595	2.42131
414	1300.6	134614	171396	70957944	20.3470	7.4530	2.61700	2.41546
415	1303.8	135265	172225	71473375	20.3715	7.4590	2.61805	2.40964
416	1306.9	135918	173056	71991296	20.3961	7.4650	2.61909	2.40385
417	1310.0	136572	173889	72511713	20.4206	7.4710	2.62014	2.39808
418	1313.2	137228	174724	73034632	20.4450	7.4770	2.62118	2.39234
419	1316.3	137885	175561	73560059	20.4695	7.4829	2.62221	2.38664
420	1319.5	138544	176400	74088000	20.4939	7.4889	2.62325	2.38095
421	1322.6	139205	177241	74618461	20.5183	7.4948	2.62428	2.37530
422	1325.8	139867	178084	75151448	20.5426	7.5007	2.62531	2.36967
423	1328.9	140531	178929	75686967	20.5670	7.5067	2.62634	2.36407
424	1332.0	141196	179776	76225024	20.5913	7.5126	2.62737	2.35849
425	1335.2	141863	180625	76765625	20.6155	7.5185	2.62839	2.35294
426	1338.3	142531	181476	77308776	20.6398	7.5244	2.62941	2.34742
427	1341.5	143201	182329	77854483	20.6640	7.5302	2.63043	2.34192
428	1344.6	143872	183184	78402752	20.6882	7.5361	2.63144	2.33645
429	1347.7	144545	184041	78953589	20.7123	7.5420	2.63246	2.33100
430	1350.9	145220	184900	79507000	20.7364	7.5478	2.63347	2.32558
431	1354.0	145896	185761	80062991	20.7605	7.5537	2.63448	2.32019
432	1357.2	146574	186624	80621568	20.7846	7.5595	2.63548	2.31482
433	1360.3	147254	187489	81182737	20.8087	7.5654	2.63649	2.30947
434	1363.5	147934	188356	81746504	20.8327	7.5712	2.63749	2.30415
435	1366.6	148617	189225	82312875	20.8567	7.5770	2.63849	2.29885
436	1369.7	149301	190096	82881856	20.8806	7.5828	2.63940	2.29358
437	1372.9	149987	190969	83453453	20.9045	7.5886	2.64048	2.28833
438	1376.0	150674	191844	84027672	20.9284	7.5944	2.64147	2.28311
439	1379.2	151363	192721	84604519	20.9523	7.6001	2.64246	2.27790
440	1382.3	152053	193600	85184000	20.9762	7.6059	2.64345	2.27273
441	1385.4	152745	194481	85766121	21.0000	7.6117	2.64444	2.26757
442	1388.6	153439	195364	86350888	21.0238	7.6174	2.64542	2.26244
443	1391.7	154134	196249	86938307	21.0476	7.6232	2.64640	2.25734
444	1394.9	154830	197136	87528384	21.0713	7.6289	2.64738	2.25225
445	1398.0	155528	198025	88121125	21.0950	7.6346	2.64836	2.24719
446	1401.2	156228	198916	88716536	21.1187	7.6403	2.64933	2.24215
447	1404.3	156930	199809	89314623	21.1424	7.6460	2.65031	2.23714
448	1407.4	157633	200704	89915392	21.1660	7.6517	2.65128	2.23214
449	1410.6	158337	201601	90518849	21.1896	7.6574	2.65225	2.22717
450	1413.7	159043	202500	91125000	21.2132	7.6631	2.65321	2.22222
451	1416.9	159751	203401	91733851	21.2368	7.6688	2.65418	2.21730
452	1420.0	160460	204304	92345408	21.2603	7.6744	2.65514	2.21239
453	1423.1	161171	205209	92959677	21.2838	7.6801	2.65610	2.20751
454	1426.3	161883	206116	93576664	21.3073	7.6857	2.65706	2.20264
455	1429.4	162597	207025	94196375	21.3307	7.6914	2.65801	2.19780
456	1432.6	163313	207936	94818816	21.3542	7.6970	2.65896	2.19298
457	1435.7	164030	208849	95443993	21.3776	7.7026	2.65992	2.18818
458	1438.9	164748	209764	96071912	21.4009	7.7082	2.66087	2.18341
459	1442.0	165468	210681	96702579	21.4243	7.7138	2.66181	2.17865

CIRCUMFERENCES AND AREAS, SQUARES, etc. (*Continued*).

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
460	1445.1	166190	211600	97336000	21.4476	7.7194	2.66276	2.17391
461	1448.3	166914	212521	97972181	21.4709	7.7250	2.66370	2.16920
462	1451.4	167639	213444	98611128	21.4942	7.7306	2.66464	2.16450
463	1454.6	168365	214369	99252847	21.5174	7.7362	2.66558	2.15983
464	1457.7	169093	215296	99897344	21.5407	7.7418	2.66652	2.15517
465	1460.8	169823	216225	100544625	21.5639	7.7473	2.66745	2.15054
466	1464.0	170554	217156	101194696	21.5870	7.7529	2.66839	2.14592
467	1467.1	171287	218089	101847563	21.6102	7.7584	2.66932	2.14133
468	1470.3	172021	219024	102503232	21.6333	7.7639	2.67025	2.13675
469	1473.4	172757	219961	103161709	21.6564	7.7695	2.67117	2.13220
470	1476.5	173494	220900	103823000	21.6795	7.7750	2.67210	2.12766
471	1479.7	174234	221841	104487111	21.7025	7.7805	2.67302	2.12314
472	1482.8	174974	222784	105154048	21.7256	7.7860	2.67394	2.11864
473	1486.0	175716	223729	105823817	21.7486	7.7915	2.67486	2.11417
474	1489.1	176460	224676	106496424	21.7715	7.7970	2.67578	2.10971
475	1492.3	177205	225625	107171875	21.7945	7.8025	2.67669	2.10526
476	1495.4	177952	226576	107850176	21.8174	7.8079	2.67761	2.10084
477	1498.5	178701	227529	108531333	21.8403	7.8134	2.67852	2.09644
478	1501.7	179451	228484	109215352	21.8632	7.8188	2.67943	2.09205
479	1504.8	180203	229441	109902239	21.8861	7.8243	2.68034	2.08768
480	1508.0	180956	230400	110592000	21.9089	7.8297	2.68124	2.08333
481	1511.1	181711	231361	111284641	21.9317	7.8352	2.68215	2.07900
482	1514.3	182467	232324	111980168	21.9545	7.8406	2.68305	2.07469
483	1517.4	183225	233289	112678587	21.9773	7.8460	2.68395	2.07039
484	1520.5	183984	234256	113379904	22.0000	7.8514	2.68485	2.06612
485	1523.7	184745	235225	114084125	22.0227	7.8568	2.68574	2.06186
486	1526.8	185508	236196	114791256	22.0454	7.8622	2.68664	2.05761
487	1530.0	186272	237169	115501303	22.0681	7.8676	2.68753	2.05339
488	1533.1	187038	238144	116214272	22.0907	7.8730	2.68842	2.04918
489	1536.2	187805	239121	116930169	22.1133	7.7884	2.68931	2.04499
490	1539.4	188574	240100	117649000	22.1359	7.8837	2.69020	2.04082
491	1542.5	189345	241081	118370771	22.1585	7.8891	2.69108	2.03666
492	1545.7	190117	242064	119095488	22.1811	7.8944	2.69197	2.03252
493	1548.8	190890	243049	119823157	22.2036	7.8998	2.69285	2.02840
494	1551.9	191665	244036	120553784	22.2261	7.9051	2.69373	2.02429
495	1555.1	192442	245025	121287375	22.2486	7.9105	2.69461	2.02020
496	1558.2	193221	246016	122023936	22.2711	7.9158	2.69548	2.01613
497	1561.4	194000	247009	122763473	22.2935	7.9211	2.69636	2.01207
498	1564.5	194782	248004	123505992	22.3159	7.9264	2.69723	2.00803
499	1567.7	195565	249001	124251499	22.3383	7.9317	2.69810	2.00401
500	1570.8	196350	250000	125000000	22.3607	7.9370	2.69897	2.00000
501	1573.9	197136	251001	125751501	22.3830	7.9423	2.69984	1.99601
502	1577.1	197923	252004	126506008	22.4054	7.9476	2.70070	1.99203
503	1580.2	198713	253009	127263527	22.4277	7.9528	2.70157	1.98807
504	1583.4	199504	254016	128024064	22.4499	7.9581	2.70243	1.98413
505	1586.5	200296	255025	128787625	22.4722	7.9634	2.70329	1.98020
506	1589.7	201090	256036	129554216	22.4944	7.9686	2.70415	1.97629
507	1592.8	201886	257049	130323843	22.5167	7.9739	2.70501	1.97239
508	1595.9	202683	258064	131096512	22.5389	7.9791	2.70586	1.96850
509	1599.1	203482	259081	131872229	22.5610	7.9843	2.70672	1.96464
510	1602.2	204282	260100	132651000	22.5832	7.9896	2.70757	1.96078
511	1605.4	205084	261121	133432831	22.6053	7.9948	2.70842	1.95695
512	1608.5	205887	262144	134217728	22.6274	8.0000	2.70927	1.95312
513	1611.6	206692	263169	135005697	22.6495	8.0052	2.71012	1.94932
514	1614.8	207499	264196	135796744	22.6716	8.0104	2.71096	1.94553
515	1617.9	208307	265225	136590875	22.6936	8.0156	2.71181	1.94175
516	1621.1	209117	266256	137388096	22.7156	8.0208	2.71265	1.93798
517	1624.2	209928	267289	138188413	22.7376	8.0260	2.71349	1.93424
518	1627.3	210741	268324	138991832	22.7596	8.0311	2.71433	1.93050
519	1630.5	211556	269361	139798359	22.7816	8.0363	2.71517	1.92678
520	1633.6	212372	270400	140608000	22.8035	8.0415	2.71600	1.92308
521	1636.8	213189	271441	141420761	22.8254	8.0466	2.71684	1.91939
522	1639.9	214008	272484	142236648	22.8473	8.0517	2.71767	1.91571
523	1643.1	214829	273529	143055667	22.8692	8.0569	2.71850	1.91205
524	1646.2	215651	274576	143877824	22.8910	8.0620	2.71933	1.90840
525	1649.3	216475	275625	144703125	22.9129	8.0671	2.72016	1.90476
526	1652.5	217301	276676	145531576	22.9347	8.0723	2.72099	1.90114
527	1655.6	218128	277729	146363183	22.9565	8.0774	2.72181	1.89753
528	1658.8	218956	278784	147197952	22.9783	8.0825	2.72263	1.89394
529	1661.9	219787	279841	148035889	23.0000	8.0876	2.72346	1.89036

CIRCUMFERENCES AND AREAS, SQUARES, etc. (*Continued*).

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
530	1665.0	220618	280900	148877000	23.0217	8.0927	2.72428	1.88679
531	1668.2	221452	281961	149721291	23.0434	8.0978	2.72509	1.88324
532	1671.3	222287	283024	150568768	23.0651	8.1028	2.72591	1.87970
533	1674.5	223123	284089	151419437	23.0868	8.1079	2.72673	1.87617
534	1677.6	223961	285156	152273304	23.1084	8.1130	2.72754	1.87266
535	1680.8	224801	286225	153130375	23.1301	8.1180	2.72835	1.86916
536	1683.9	225642	287296	153990656	23.1517	8.1231	2.72916	1.86567
537	1687.0	226484	288369	154854153	23.1733	8.1281	2.72997	1.86220
538	1690.2	227329	289444	155720872	23.1948	8.1332	2.73078	1.85874
539	1693.3	228175	290521	156590819	23.2164	8.1382	2.73159	1.85529
540	1696.5	229022	291600	157464000	23.2379	8.1433	2.73239	1.85185
541	1699.6	229871	292681	158340421	23.2594	8.1483	2.73320	1.84843
542	1702.7	230722	293764	159220088	23.2809	8.1533	2.73400	1.84502
543	1705.9	231574	294849	160103007	23.3024	8.1583	2.73480	1.84162
544	1709.0	232428	295936	160989184	23.3238	8.1633	2.73560	1.83824
545	1712.2	233283	297025	161878625	23.3452	8.1683	2.73640	1.83486
546	1715.3	234140	298116	162771336	23.3666	8.1733	2.73719	1.83150
547	1718.5	234998	299209	163667323	23.3880	8.1783	2.73799	1.82815
548	1721.6	235858	300304	164566592	23.4094	8.1833	2.73878	1.82482
549	1724.7	236720	301401	165469149	23.4307	8.1882	2.73957	1.82149
550	1727.9	237583	302500	166375000	23.4521	8.1932	2.74036	1.81818
551	1731.0	238448	303601	167284151	23.4734	8.1982	2.74115	1.81488
552	1734.2	239314	304704	168196608	23.4947	8.2031	2.74194	1.81159
553	1737.3	240182	305809	169112377	23.5160	8.2081	2.74273	1.80832
554	1740.4	241051	306916	170031464	23.5372	8.2130	2.74351	1.80505
555	1743.6	241922	308025	170953875	23.5584	8.2180	2.74429	1.80180
556	1746.7	242795	309136	171879616	23.5797	8.2229	2.74507	1.79856
557	1749.9	243669	310249	172808693	23.6008	8.2278	2.74586	1.79533
558	1753.0	244545	311364	173741112	23.6220	8.2327	2.74663	1.79211
559	1756.2	245422	312481	174676879	23.6432	8.2377	2.74741	1.78891
560	1759.3	246301	313600	175616000	23.6643	8.2426	2.74819	1.78571
561	1762.4	247181	314721	176558481	23.6854	8.2457	2.74896	1.78253
562	1765.6	248063	315844	177504328	23.7065	8.2524	2.74974	1.77936
563	1768.7	248947	316969	178453547	23.7276	8.2573	2.75051	1.77620
564	1771.9	249832	318096	179406144	23.7487	8.2621	2.75128	1.77305
565	1775.0	250719	319225	180362125	23.7697	8.2670	2.75205	1.76991
566	1778.1	251607	320356	181321496	23.7908	8.2719	2.75282	1.76678
567	1781.3	252497	321489	182284263	23.8118	8.2768	2.75358	1.76367
568	1784.4	253388	322624	183250432	23.8328	8.2816	2.75435	1.76056
569	1787.6	254281	323761	184220009	23.8537	8.2865	2.75511	1.75747
570	1790.7	255176	324900	185193000	23.8747	8.2913	2.75587	1.75439
571	1793.9	256072	326041	186169411	23.8956	8.2962	2.75664	1.75131
572	1797.0	256970	327184	187149248	23.9165	8.3010	2.75740	1.74825
573	1800.1	257869	328329	188132517	23.9374	8.3059	2.75815	1.74520
574	1803.3	258770	329476	189119224	23.9583	8.3107	2.75891	1.74216
575	1806.4	259672	330625	190109375	23.9792	8.3155	2.75967	1.73913
576	1809.6	260576	331776	191102976	24.0000	8.3203	2.76042	1.73611
577	1812.7	261482	332929	192100033	24.0208	8.3251	2.76118	1.73310
578	1815.8	262389	334084	193100552	24.0416	8.3300	2.76193	1.73010
579	1819.0	263298	335241	194104539	24.0624	8.3348	2.76268	1.72712
580	1822.1	264208	336400	195112000	24.0832	8.3396	2.76343	1.72414
581	1825.3	265120	337561	196122941	24.1039	8.3443	2.76418	1.72117
582	1828.4	266033	338724	197137368	24.1247	8.3491	2.74492	1.71821
583	1831.6	266948	339889	198155287	24.1454	8.3539	2.76567	1.71527
584	1834.7	267865	341056	199176704	24.1661	8.3587	2.76641	1.71233
585	1837.8	268783	342225	200201625	24.1868	8.3634	2.76716	1.70940
586	1841.0	269701	343396	201230056	24.2074	8.3682	2.76790	1.70649
587	1844.1	270624	344569	202262003	24.2281	8.3730	2.76864	1.70358
588	1847.3	271547	345744	203297472	24.2487	8.3777	2.76938	1.70068
589	1850.4	272471	346921	204336469	24.2693	8.3825	2.77012	1.69779
590	1853.5	273397	348100	205379000	24.2899	8.3872	2.77085	1.69492
591	1856.7	274325	349281	206425071	24.3105	8.3919	2.77159	1.69205
592	1859.8	275254	350464	207474688	24.3311	8.3967	2.77232	1.68919
593	1863.0	276184	351649	208527857	24.3516	8.4014	2.77305	1.68634
594	1866.1	277117	352836	209584584	24.3721	8.4061	2.77379	1.68350
595	1869.3	278051	354025	210644875	24.3926	8.4108	2.77452	1.68067
596	1872.4	278986	355216	211708736	24.4131	8.4155	2.77525	1.67785
597	1875.5	279923	356409	212776173	24.4336	8.4202	2.77597	1.67504
598	1878.7	280862	357604	213847192	24.4540	8.4249	2.77670	1.67224
599	1881.8	281802	358801	214921799	24.4745	8.4296	2.77743	1.66945

CIRCUMFERENCES AND AREAS, SQUARES, etc. (*Continued*).

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
600	1885.0	282743	360000	216000000	24.4949	8.4343	2.77815	1.66667
601	1888.1	283687	361201	217081801	24.5153	8.4390	2.77887	1.66389
602	1891.2	284631	362404	218167208	24.5357	8.4437	2.77960	1.66113
603	1894.4	285578	363609	219256227	24.5561	8.4484	2.78032	1.65837
604	1897.5	286526	364816	220348864	24.5764	8.4530	2.78104	1.65563
605	1900.7	287475	366025	221445125	24.5967	8.4577	2.78176	1.65289
606	1903.8	288426	367236	222545016	24.6171	8.4623	2.78247	1.65017
607	1907.0	289379	368449	223648543	24.6374	8.4670	2.78319	1.64745
608	1910.1	290333	369664	224755712	24.6577	8.4716	2.78390	1.64474
609	1913.2	291289	370881	225866529	24.6779	8.4763	2.78462	1.64204
610	1916.4	292247	372100	226981000	24.6982	8.4809	2.78533	1.63934
611	1919.5	293206	373321	228099131	24.7184	8.4856	2.78604	1.63666
612	1922.7	294166	374544	229220928	24.7386	8.4902	2.78675	1.63399
613	1925.8	295128	375769	230346397	24.7588	8.4948	2.78746	1.63132
614	1928.9	296092	376996	231475544	24.7790	8.4994	2.78817	1.62866
615	1932.1	297057	378225	232608375	24.7992	8.5040	2.78888	1.62602
616	1935.2	298024	379456	233744896	24.8193	8.5086	2.78958	1.62338
617	1938.4	298992	380689	234885113	24.8395	8.5132	2.79029	1.62075
618	1941.5	299962	381924	236029032	24.8596	8.5178	2.79099	1.61812
619	1944.7	300934	383161	237176659	24.8797	8.5224	2.79169	1.61551
620	1947.8	301907	384400	238328000	24.8998	8.5270	2.79239	1.61290
621	1950.9	302882	385641	239483061	24.9199	8.5316	2.79309	1.61031
622	1954.1	303858	386884	240641848	24.9399	8.5362	2.79379	1.60772
623	1957.2	304836	388129	241804367	24.9600	8.5408	2.79449	1.60514
624	1960.4	305815	389376	242970624	24.9800	8.5453	2.79518	1.60256
625	1963.5	306796	390625	244140625	25.0000	8.5499	2.79588	1.60000
626	1966.6	307779	391876	245314376	25.0200	8.5544	2.79657	1.59744
627	1969.8	308763	393129	246491883	25.0400	8.5590	2.79727	1.59490
628	1972.9	309748	394384	247673152	25.0599	8.5635	2.79796	1.59236
629	1976.1	310736	395641	248858189	25.0799	8.5681	2.79865	1.58983
630	1979.2	311725	396900	250047000	25.0998	8.5726	2.79934	1.58730
631	1982.4	312715	398161	251239591	25.1197	8.5772	2.80003	1.58479
632	1985.5	313707	399424	252435968	25.1396	8.5817	2.80072	1.58228
633	1988.6	314700	400689	253636137	25.1595	8.5862	2.80140	1.57978
634	1991.8	315696	401956	254840104	25.1794	8.5907	2.80209	1.57729
635	1994.9	316692	403225	256047875	25.1992	8.5952	2.80277	1.57480
636	1998.1	317690	404496	257259456	25.2190	8.5997	2.80346	1.57233
637	2001.2	318690	405769	258474853	25.2389	8.6043	2.80414	1.56986
638	2004.3	319692	407044	259694072	25.2587	8.6088	2.80482	1.56740
639	2007.5	320695	408321	260917119	25.2784	8.6132	2.80550	1.56495
640	2010.6	321699	409600	262144000	25.2982	8.6177	2.80618	1.56250
641	2013.8	322705	410881	263374721	25.3180	8.6222	2.80686	1.56006
642	2016.9	323713	412164	264609288	25.3377	8.6267	2.80754	1.55763
643	2020.0	324722	413449	265847707	25.3574	8.6312	2.80821	1.55521
644	2023.2	325733	414736	267089984	25.3772	8.6357	2.80889	1.55280
645	2026.3	326745	416025	268336125	25.3969	8.6401	2.80956	1.55039
646	2029.5	327759	417316	269586136	25.4165	8.6446	2.81023	1.54799
647	2032.6	328775	418609	270840023	25.4362	8.6490	2.81090	1.54560
648	2035.8	329792	419904	272097792	25.4558	8.6535	2.81158	1.54321
649	2038.9	330810	421201	273359449	25.4755	8.6579	2.81224	1.54083
650	2042.0	331831	422500	274625000	25.4951	8.6624	2.81291	1.53846
651	2045.2	332853	423801	275894451	25.5147	8.6668	2.81358	1.53610
652	2048.3	333876	425104	277167808	25.5343	8.6713	2.81425	1.53374
653	2051.5	334901	426409	278445077	25.5539	8.6757	2.81491	1.53139
654	2054.6	335927	427716	279726264	25.5734	8.6801	2.81558	1.52905
655	2057.7	336955	429025	281011375	25.5930	8.6845	2.81624	1.52672
656	2060.9	337985	430336	282300416	25.6125	8.6890	2.81690	1.52439
657	2064.0	339016	431649	283593393	25.6320	8.6934	2.81757	1.52207
658	2067.2	340049	432964	284890312	25.6515	8.6978	2.81823	1.51976
659	2070.3	341084	434281	286191179	25.6710	8.7022	2.81889	1.51745
660	2073.5	342119	435600	287496000	25.6905	8.7066	2.81954	1.51515
661	2076.6	343157	436921	288804781	25.7099	8.7110	2.82020	1.51286
662	2079.7	344196	438244	290117528	25.7294	8.7154	2.82086	1.51057
663	2082.9	345237	439569	291434274	25.7488	8.7198	2.82151	1.50830
664	2086.0	346279	440896	292754944	25.7682	8.7241	2.82217	1.50602
665	2089.2	347323	442225	294079625	25.7876	8.7285	2.82282	1.50376
666	2092.3	348368	443556	295408296	25.8070	8.7329	2.82347	1.50150
667	2095.4	349415	444889	296740963	25.8263	8.7373	2.82413	1.49925
668	2098.6	350464	446224	298077632	25.8457	8.7416	2.82478	1.49701
669	2101.7	351514	447561	299418309	25.8650	8.7460	2.82543	1.49477

CIRCUMFERENCES AND AREAS, SQUARES, etc. (*Continued*).

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
670	2104.9	352535	448900	300763000	25.8844	8.7503	2.82607	1.49254
671	2108.0	353818	450241	302111711	25.9037	8.7547	2.82672	1.49031
672	2111.2	354673	451584	303464448	25.9230	8.7590	2.82737	1.48810
673	2114.3	355730	452929	304821217	25.9422	8.7634	2.82802	1.48588
674	2117.4	356788	454276	306182024	25.9615	8.7677	2.82866	1.48368
675	2120.6	357847	455625	307546875	25.9808	8.7721	2.82930	1.48148
676	2123.7	358908	456976	308915776	26.0000	8.7764	2.82995	1.47929
677	2126.9	359971	458329	310288733	26.0192	8.7807	2.83059	1.47711
678	2130.0	361035	459684	311665752	26.0384	8.7850	2.83123	1.47493
679	2133.1	362101	461041	313046839	26.0576	8.7893	2.83187	1.47275
680	2136.3	363168	462400	314432000	26.0768	8.7937	2.83251	1.47059
681	2139.4	364237	463761	315821241	26.0960	8.7980	2.83315	1.46843
682	2142.6	365308	465124	317214568	26.1151	8.8023	2.83378	1.46628
683	2145.7	366380	466489	318611987	26.1343	8.8066	2.83442	1.46413
684	2148.9	367453	467856	320013504	26.1534	8.8109	2.83506	1.46199
685	2152.0	368528	469225	321419125	26.1725	8.8152	2.83569	1.45985
686	2155.1	369605	470596	322828856	26.1916	8.8194	2.83632	1.45773
687	2158.3	370684	471969	324242703	26.2107	8.8237	2.83696	1.45560
688	2161.4	371764	473344	325660672	26.2298	8.8280	2.83759	1.45349
689	2164.6	372845	474721	327082769	26.2488	8.8323	2.83822	1.45138
690	2167.7	373928	476100	328509000	26.2679	8.8366	2.83885	1.44928
691	2170.8	375013	477481	329939371	26.2869	8.8408	2.83948	1.44718
692	2174.0	376099	478864	331373888	26.3059	8.8451	2.84011	1.44509
693	2177.1	377187	480249	332812557	26.3249	8.8493	2.84073	1.44300
694	2180.3	378276	481636	334255384	26.3439	8.8536	2.84136	1.44092
695	2183.4	379367	483025	335702375	26.3629	8.8578	2.84198	1.43885
696	2186.6	380459	484416	337153536	26.3818	8.8621	2.84261	1.43678
697	2189.7	381554	485809	338608873	26.4008	8.8663	2.84323	1.43472
698	2192.8	382649	487204	340068392	26.4197	8.8706	2.84386	1.43267
699	2196.0	383746	488601	341532099	26.4386	8.8748	2.84448	1.43062
700	2199.1	384845	490000	343000000	26.4575	8.8790	2.84510	1.42857
701	2202.3	385945	491401	344472101	26.4764	8.8833	2.84572	1.42653
702	2205.4	387047	492804	345948408	26.4953	8.8875	2.84634	1.42450
703	2208.5	388151	494209	347428927	26.5141	8.8917	2.84696	1.42248
704	2211.7	389256	495616	348913664	26.5330	8.8959	2.84757	1.42046
705	2214.8	390363	497025	350402625	26.5518	8.9001	2.84819	1.41844
706	2218.0	391471	498436	351895816	26.5707	8.9043	2.84880	1.41643
707	2221.1	392580	499849	353393243	26.5895	8.9085	2.84942	1.41443
708	2224.3	393692	501264	354894912	26.6083	8.9127	2.85003	1.41243
709	2227.4	394805	502681	356400829	26.6271	8.9169	2.85065	1.41044
710	2230.5	395919	504100	357911000	26.6458	8.9211	2.85126	1.40845
711	2233.7	397035	505521	359425431	26.6646	8.9253	2.85187	1.40647
712	2236.8	398153	506944	360944128	26.6833	8.9295	2.85248	1.40449
713	2240.0	399272	508369	362467097	26.7021	8.9337	2.85309	1.40253
714	2243.1	400393	509796	363994344	26.7208	8.9378	2.85370	1.40056
715	2246.2	401515	511225	365525875	26.7395	8.9420	2.85431	1.39860
716	2249.4	402639	512656	367061696	26.7582	8.9462	2.85491	1.39665
717	2252.5	403765	514089	368801813	26.7769	8.9503	2.85552	1.39470
718	2255.7	404892	515524	370146232	26.7955	8.9545	2.85612	1.39276
719	2258.8	406020	516961	371694959	26.8142	8.9587	2.85673	1.39082
720	2261.9	407150	518400	373248000	26.8328	8.9628	2.85733	1.38889
721	2265.1	408282	519841	374805361	26.8514	8.9670	2.85794	1.38696
722	2268.2	409416	521284	376367048	26.8701	8.9711	2.85854	1.38504
723	2271.4	410550	522729	377933067	26.8887	8.9752	2.85914	1.38313
724	2274.5	411687	524176	379503424	26.9072	8.9794	2.85974	1.38122
725	2277.7	412825	525625	381078125	26.9258	8.9835	2.86034	1.37931
726	2280.8	413965	527076	382657176	26.9444	8.9876	2.86094	1.37741
727	2283.9	415106	528529	384240583	26.9629	8.9918	2.86153	1.37552
728	2287.1	416248	529984	385828352	26.9815	8.9959	2.86213	1.37363
729	2290.2	417393	531441	387420489	27.0000	9.0000	2.86273	1.37174
730	2293.4	418539	532900	389017000	27.0185	9.0041	2.86332	1.36986
731	2296.5	419686	534361	390617891	27.0370	9.0082	2.86392	1.36799
732	2299.7	420835	535824	392223168	27.0555	9.0123	2.86451	1.36612
733	2302.8	421986	537289	393832837	27.0740	9.0164	2.86510	1.36426
734	2305.9	423138	538756	395446904	27.0924	9.0205	2.86570	1.36240
735	2309.1	424293	540225	397065375	27.1109	9.0246	2.86629	1.36054
736	2312.2	425448	541696	398688256	27.1293	9.0287	2.86688	1.35870
737	2315.4	426604	543169	400315553	27.1477	9.0328	2.86747	1.35685
738	2318.5	427762	544644	401947272	27.1662	9.0369	2.86806	1.35501
739	2321.6	428922	546121	403583419	27.1846	9.0410	2.86864	1.35318

CIRCUMFERENCES AND AREAS, SQUARES, etc. (*Continued*).

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
740	2324.8	430084	547600	405224000	27.2029	9.0450	2.86923	1.35135
741	2327.9	431247	549081	406869021	27.2213	9.0491	2.86982	1.34953
742	2331.1	432412	550564	408518488	27.2397	9.0532	2.87040	1.34771
743	2334.2	433578	552049	410172407	27.2580	9.0572	2.87099	1.34590
744	2337.3	434746	553536	411830784	27.2764	9.0613	2.87157	1.34409
745	2340.5	435916	555025	413493625	27.2947	9.0654	2.87216	1.34228
746	2343.6	437087	556516	415160936	27.3130	9.0694	2.87274	1.34048
747	2346.8	438259	558009	416832723	27.3313	9.0735	2.87332	1.33869
748	2349.9	439433	559504	418508992	27.3496	9.0775	2.87390	1.33690
749	2353.1	440609	561001	420189749	27.3679	9.0816	2.87448	1.33511
750	2356.2	441786	562500	421875000	27.3861	9.0856	2.87506	1.33333
751	2359.3	442965	564001	423564751	27.4044	9.0896	2.87564	1.33156
752	2362.5	444146	565504	425259008	27.4226	9.0937	2.87622	1.32979
753	2365.6	445328	567009	426957777	27.4408	9.0977	2.87679	1.32802
754	2368.8	446511	568516	428661064	27.4591	9.1017	2.87737	1.32626
755	2371.9	447697	570025	430368875	27.4773	9.1057	2.87795	1.32450
756	2375.0	448883	571536	432081216	27.4955	9.1098	2.87852	1.32275
757	2378.2	450072	573049	433798093	27.5136	9.1138	2.87910	1.32100
758	2381.3	451262	574564	435519512	27.5318	9.1178	2.87967	1.31926
759	2384.5	452453	576081	437245479	27.5500	9.1218	2.88024	1.31752
760	2387.6	453646	577600	438976000	27.5681	9.1258	2.88081	1.31579
761	2390.8	454841	579121	440711081	27.5862	9.1298	2.88138	1.31406
762	2393.9	456037	580644	442450728	27.6043	9.1338	2.88195	1.31234
763	2397.0	457234	582169	444194947	27.6225	9.1378	2.88252	1.31062
764	2400.2	458434	583696	445943744	27.6405	9.1418	2.88309	1.30890
765	2403.3	459635	585225	447697125	27.6586	9.1458	2.88366	1.30719
766	2406.5	460837	586756	449455096	27.6767	9.1498	2.88423	1.30548
767	2409.6	462042	588289	451217663	27.6948	9.1537	2.88480	1.30378
768	2412.7	463247	589824	452984832	27.7128	9.1577	2.88536	1.30208
769	2415.9	464454	591361	454756609	27.7308	9.1617	2.88593	1.30039
770	2419.0	465663	592900	456533000	27.7489	9.1657	2.88649	1.29870
771	2422.2	466873	594441	458314011	27.7669	9.1696	2.88705	1.29702
772	2425.3	468085	595984	460099648	27.7849	9.1736	2.88762	1.29534
773	2428.5	469298	597529	461889917	27.8029	9.1775	2.88818	1.29366
774	2431.6	470513	599076	463684824	27.8209	9.1815	2.88874	1.29199
775	2434.7	471730	600625	465484375	27.8388	9.1855	2.88930	1.29032
776	2437.9	472948	602176	467288576	27.8568	9.1894	2.88986	1.28866
777	2441.0	474168	603729	469097433	27.8747	9.1933	2.89042	1.28700
778	2444.2	475389	605284	470910952	27.8927	9.1973	2.89098	1.28535
779	2447.3	476612	606841	472729139	27.9106	9.2012	2.89154	1.28370
780	2450.4	477836	608400	474552000	27.9285	9.2052	2.89209	1.28205
781	2453.6	479062	609961	476379541	27.9464	9.2091	2.89265	1.28041
782	2456.7	480290	611524	478211768	27.9643	9.2130	2.89321	1.27877
783	2459.9	481519	613089	480048687	27.9821	9.2170	2.89376	1.27714
784	2463.0	482750	614656	481890304	28.0000	9.2209	2.89432	1.27551
785	2466.2	483982	616225	483736625	28.0179	9.2248	2.89487	1.27389
786	2469.3	485216	617796	485587656	28.0357	9.2287	2.89542	1.27226
787	2472.4	486451	619369	487443403	28.0535	9.2326	2.89597	1.27065
788	2475.6	487688	620944	489303872	28.0713	9.2365	2.89653	1.26904
789	2478.7	488927	622521	491169069	28.0891	9.2404	2.89708	1.26743
790	2481.9	490167	624100	493039000	28.1069	9.2443	2.89763	1.26582
791	2485.0	491409	625681	494913671	28.1247	9.2482	2.89818	1.26422
792	2488.1	492652	627264	496793088	28.1425	9.2521	2.89873	1.26263
793	2491.3	493897	628849	498677257	28.1603	9.2560	2.89927	1.26103
794	2494.4	495143	630436	500566184	28.1780	9.2599	2.89982	1.25945
795	2497.6	496391	632025	502459875	28.1957	9.2638	2.90037	1.25786
796	2500.7	497641	633616	504358336	28.2135	9.2677	2.90091	1.25628
797	2503.8	498892	635209	506261573	28.2312	9.2716	2.90146	1.25471
798	2507.0	500145	636804	508169592	28.2489	9.2754	2.90200	1.25313
799	2510.1	501399	638401	510082399	28.2666	9.2793	2.90255	1.25156
800	2513.3	502655	640000	512000000	28.2843	9.2832	2.90309	1.25000
801	2516.4	503912	641601	513922401	28.3019	9.2870	2.90363	1.24844
802	2519.6	505171	643204	515849608	28.3196	9.2909	2.90417	1.24688
803	2522.7	506432	644809	517781627	28.3373	9.2948	2.90472	1.24533
804	2525.8	507694	646416	519718464	28.3549	9.2896	2.90526	1.24378
805	2529.0	508958	648025	521660125	28.3725	9.3025	2.90580	1.24224
806	2532.1	510223	649636	523606616	28.3901	9.3063	2.90634	1.24069
807	2535.3	511490	651249	525557943	28.4077	9.3102	2.90687	1.23916
808	2538.4	512758	652864	527514112	28.4253	9.3140	2.90741	1.23762
809	2541.5	514028	654481	529475129	28.4429	9.3179	2.90795	1.23609

CIRCUMFERENCES AND AREAS, SQUARES, etc. (*Continued.*)

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
810	2544.7	515300	656100	531441000	28.4605	9.3217	2.90849	1.23457
811	2547.8	516573	657721	533411731	28.4781	9.3255	2.90902	1.23305
812	2551.0	517848	659344	535387328	28.4956	9.3294	2.90956	1.23153
813	2554.1	519124	660969	537367797	28.5132	9.3332	2.91009	1.23001
814	2557.3	520402	662596	539353144	28.5307	9.3370	2.91062	1.22850
815	2560.4	521681	664225	541343375	28.5482	9.3408	2.91116	1.22699
816	2563.5	522962	665856	543338496	28.5657	9.3447	2.91169	1.22549
817	2566.7	524245	667489	545338513	28.5832	9.3485	2.91222	1.22399
818	2569.8	525529	669124	547343432	28.6007	9.3523	2.91275	1.22249
819	2573.0	526814	670761	549353259	28.6182	9.3561	2.91328	1.22100
820	2576.1	528102	672400	551368000	28.6356	9.3599	2.91381	1.21951
821	2579.2	529391	674041	553387661	28.6531	9.3637	2.91434	1.21803
822	2582.4	530681	675684	555412248	28.6705	9.3675	2.91487	1.21655
823	2585.5	531973	677329	557441767	28.6880	9.3713	2.91540	1.21507
824	2588.7	533267	678976	559476224	28.7054	9.3751	2.91593	1.21359
825	2591.8	534562	680625	561515625	28.7228	9.3789	2.91645	1.21212
826	2595.0	535858	682276	563559976	28.7402	9.3827	2.91698	1.21065
827	2598.1	537157	683929	565609283	28.7576	9.3865	2.91751	1.20919
828	2601.2	538456	685584	567663552	28.7750	9.3902	2.91803	1.20773
829	2604.4	539758	687241	569722789	28.7924	9.3940	2.91855	1.20627
830	2607.5	541061	688900	571787000	28.8097	9.3978	2.91908	1.20482
831	2610.7	542365	690561	573856191	28.8271	9.4016	2.91960	1.20337
832	2613.8	543671	692224	575930368	28.8444	9.4053	2.92012	1.20192
833	2616.9	544979	693889	578009537	28.8617	9.4091	2.92065	1.20048
834	2620.1	546288	695556	580093704	28.8791	9.4129	2.92117	1.19904
835	2623.2	547599	697225	582182875	28.8964	9.4166	2.92169	1.19760
836	2626.4	548912	698896	584277056	28.9137	9.4204	2.92221	1.19617
837	2629.5	550226	700569	586376253	28.9310	9.4241	2.92273	1.19474
838	2632.7	551541	702244	588480472	28.9482	9.4279	2.92324	1.19332
839	2635.8	552858	703921	590589719	28.9655	9.4316	2.92376	1.19189
840	2638.9	554177	705600	592704000	28.9828	9.4354	2.92428	1.19048
841	2642.1	555497	707281	594823321	29.0000	9.4391	2.92480	1.18906
842	2645.2	556819	708964	596947688	29.0172	9.4429	2.92531	1.18765
843	2648.4	558142	710649	599077107	29.0345	9.4466	2.92583	1.18624
844	2651.5	559467	712336	601211584	29.0517	9.4503	2.92634	1.18483
845	2654.6	560794	714025	603351125	29.0689	9.4541	2.92686	1.18343
846	2657.8	562122	715716	605495736	29.0861	9.4578	2.92737	1.18203
847	2660.9	563452	717409	607645423	29.1033	9.4615	2.92788	1.18064
848	2664.1	564783	719104	609800192	29.1204	9.4652	2.92840	1.17925
849	2667.2	566116	720801	611960049	29.1376	9.4690	2.92891	1.17786
850	2670.4	567450	722500	614125000	29.1548	9.4727	2.92942	1.17647
851	2673.5	568786	724201	616295051	29.1719	9.4764	2.92993	1.17509
852	2676.6	570124	725904	618470208	29.1890	9.4801	2.93044	1.17371
853	2679.8	571463	727609	620650477	29.2062	9.4838	2.93095	1.17233
854	2682.9	572803	729316	622835864	29.2233	9.4875	2.93146	1.17096
855	2686.1	574146	731025	625026375	29.2404	9.4912	2.93197	1.16959
856	2689.2	575490	732736	627222016	29.2575	9.4949	2.93247	1.16822
857	2692.3	576835	734449	629422793	29.2746	9.4986	2.93298	1.16686
858	2695.5	578182	736164	631628712	29.2916	9.5023	2.93349	1.16550
859	2698.6	579530	737881	633839779	29.3087	9.5060	2.93399	1.16414
860	2701.8	580880	739600	636056000	29.3258	9.5097	2.93450	1.16279
861	2704.9	582232	741321	638277381	29.3428	9.5134	2.93500	1.16144
862	2708.1	583585	743044	640503928	29.3598	9.5171	2.93551	1.16009
863	2711.2	584940	744769	642735647	29.3769	9.5207	2.93601	1.15875
864	2714.3	586297	746496	644972544	29.3939	9.5244	2.93651	1.15741
865	2717.5	587655	748225	647214625	29.4109	9.5281	2.93702	1.15607
866	2720.6	589014	749956	649461896	29.4279	9.5317	2.93752	1.15473
867	2723.8	590375	751689	651714363	29.4449	9.5354	2.93802	1.15340
868	2726.9	591738	753424	653972032	29.4618	9.5391	2.93852	1.15207
869	2730.0	593102	755161	656234909	29.4788	9.5427	2.93902	1.15075
870	2733.2	594468	756900	658503000	29.4958	9.5464	2.93952	1.14943
871	2736.3	595835	758641	660776311	29.5127	9.5501	2.94002	1.14811
872	2739.5	597204	760384	663054848	29.5296	9.5537	2.94052	1.14679
873	2742.6	598575	762129	665338617	29.5466	9.5574	2.94101	1.14548
874	2745.8	599947	763876	667627624	29.5635	9.5610	2.94151	1.14416
875	2748.9	601320	765625	669921875	29.5804	9.5647	2.94201	1.14286
876	2752.0	602696	767376	672221376	29.5973	9.5683	2.94250	1.14155
877	2755.2	604073	769129	674526133	29.6142	9.5719	2.94300	1.14025
878	2758.3	605451	770884	676836152	29.6311	9.5756	2.94349	1.13895
879	2761.5	606831	772641	679151439	29.6479	9.5792	2.94399	1.13766

CIRCUMFERENCES AND AREAS, SQUARES, etc. (*Continued*).

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
880	2764.6	608212	774400	681472000	29.6648	9.5828	2.94448	1.13636
881	2767.7	609595	776161	683797841	29.6816	9.5865	2.94498	1.13507
882	2770.9	610980	777924	686128968	29.6985	9.5901	2.94547	1.13379
883	2774.0	612366	779689	688465387	29.7153	9.5937	2.94596	1.13250
884	2777.2	613754	781456	690807104	29.7321	9.5973	2.94645	1.13122
885	2780.3	615143	783225	693154125	29.7489	9.6010	2.94694	1.12994
886	2783.5	616534	784996	695506456	29.7658	9.6046	2.94743	1.12867
887	2786.6	617927	786769	697864103	29.7825	9.6082	2.94792	1.12740
888	2789.7	619321	788544	700227072	29.7993	9.6118	2.94841	1.12613
889	2792.9	620717	790321	702595369	29.8161	9.6154	2.94890	1.12486
890	2796.0	622114	792100	704969000	29.8329	9.6190	2.94939	1.12360
891	2799.2	623513	793881	707347971	29.8496	9.6226	2.94988	1.12233
892	2802.3	624913	795664	709732288	29.8664	9.6262	2.95036	1.12108
893	2805.4	626315	797449	712121957	29.8831	9.6298	2.95085	1.11982
894	2808.6	627718	799236	714516984	29.8998	9.6334	2.95134	1.11857
895	2811.7	629124	801025	716917375	29.9166	9.6370	2.95182	1.11732
896	2814.9	630530	802816	719323136	29.9333	9.6406	2.95231	1.11607
897	2818.0	631938	804609	721734273	29.9500	9.6442	2.95279	1.11483
898	2821.2	633348	806404	724150792	29.9666	9.6477	2.95328	1.11359
899	2824.3	634760	808201	726572699	29.9833	9.6513	2.95376	1.11235
900	2827.4	636173	810000	729000000	30.0000	9.6549	2.95424	1.11111
901	2830.6	637587	811801	731432701	30.0167	9.6585	2.95472	1.10988
902	2833.7	639003	813604	733870808	30.0333	9.6620	2.95521	1.10865
903	2836.9	640421	815409	736314327	30.0500	9.6656	2.95569	1.10742
904	2840.0	641840	817216	738763264	30.0666	9.6692	2.95617	1.10619
905	2843.1	643261	819025	741217625	30.0832	9.6727	2.95665	1.10497
906	2846.3	644683	820836	743677416	30.0998	9.6763	2.95713	1.10375
907	2849.4	646107	822649	746142643	30.1164	9.6799	2.95761	1.10254
908	2852.6	647533	824464	748613312	30.1330	9.6834	2.95809	1.10132
909	2855.7	648960	826281	751089429	30.1496	9.6870	2.95856	1.10011
910	2858.8	650388	828100	753571000	30.1662	9.6905	2.95904	1.09890
911	2862.0	651818	829921	756058031	30.1828	9.6941	2.95952	1.09769
912	2865.1	653250	831744	758550528	30.1993	9.6976	2.95999	1.09649
913	2868.3	654684	833569	761048497	30.2159	9.7012	2.96047	1.09529
914	2871.4	656118	835396	763551944	30.2324	9.7047	2.96095	1.09409
915	2874.6	657555	837225	766060875	30.2490	9.7082	2.96142	1.09290
916	2877.7	658993	839056	768575296	30.2655	9.7118	2.96190	1.09170
917	2880.8	660433	840889	771095213	30.2820	9.7153	2.96237	1.09051
918	2884.0	661874	842724	773620632	30.2985	9.7188	2.96284	1.08932
919	2887.1	663317	844561	776151559	30.3150	9.7224	2.96332	1.08814
920	2890.3	664761	846400	778688000	30.3315	9.7259	2.96379	1.08696
921	2893.4	666207	848241	781229961	30.3480	9.7294	2.96426	1.08578
922	2896.5	667654	850084	783777448	30.3645	9.7329	2.96473	1.08460
923	2899.7	669103	851929	786330467	30.3809	9.7364	2.96520	1.08342
924	2902.8	670554	853776	788889024	30.3974	9.7400	2.96567	1.08225
925	2906.0	672006	855625	791453125	30.4138	9.7435	2.96614	1.08108
926	2909.1	673460	857476	794022776	30.4302	9.7470	2.96661	1.07991
927	2912.3	674915	859329	796597983	30.4467	9.7505	2.96708	1.07875
928	2915.4	676372	861184	799178752	30.4631	9.7540	2.96755	1.07759
929	2918.5	677831	863041	801765089	30.4795	9.7575	2.96802	1.07643
930	2921.7	679291	864900	804357000	30.4959	9.7610	2.96848	1.07527
931	2924.8	680752	866761	806954491	30.5123	9.7645	2.96895	1.07411
932	2928.0	682216	868624	809557568	30.5287	9.7680	2.96942	1.07296
933	2931.1	683680	870489	812166237	30.5450	9.7715	2.96988	1.07181
934	2934.2	685147	872356	814780504	30.5614	9.7750	2.97035	1.07066
935	2937.4	686615	874225	817400375	30.5778	9.7785	2.97081	1.06952
936	2940.5	688084	876096	820025856	30.5941	9.7819	2.97128	1.06838
937	2943.7	689555	877969	822656953	30.6105	9.7854	2.97174	1.06724
938	2946.8	691028	879844	825293672	30.6268	9.7889	2.97220	1.06610
939	2950.0	692502	881721	827936019	30.6431	9.7924	2.97267	1.06496
940	2953.1	693978	883600	830584000	30.6594	9.7959	2.97313	1.06383
941	2956.2	695455	885481	833237621	30.6757	9.7993	2.97359	1.06270
942	2959.4	696934	887364	835896888	30.6920	9.8028	2.97405	1.06157
943	2962.5	698415	889249	838561807	30.7083	9.8063	2.97451	1.06045
944	2965.7	699897	891136	841232384	30.7246	9.8097	2.97497	1.05932
945	2968.8	701380	893025	843908625	30.7409	9.8132	2.97543	1.05820
946	2971.9	702865	894916	846590536	30.7571	9.8167	2.97589	1.05708
947	2975.1	704352	896809	849278123	30.7734	9.8201	2.97635	1.05597
948	2978.2	705840	898704	851971392	30.7896	9.8236	2.97681	1.05485
949	2981.4	707330	900601	854670349	30.8058	9.8270	2.97727	1.05374

CIRCUMFERENCES AND AREAS, SQUARES, etc. (*Continued*).

No.	No. = Diam.		Square.	Cube.	Square Root.	Cube Root.	Log.	1000 × Recip.
	Circum.	Area.						
950	2984.5	708822	902500	857375000	30.8221	9.8305	2.97772	1.05263
951	2987.7	710315	904401	860085351	30.8383	9.8339	2.97818	1.05152
952	2990.8	711809	906304	862801408	30.8545	9.8374	2.97864	1.05042
953	2993.9	713306	908209	865523177	30.8707	9.8408	2.97909	1.04932
954	2997.1	714803	910116	868250664	30.8869	9.8443	2.97995	1.04822
955	3000.2	716303	912025	870983875	30.9031	9.8477	2.98000	1.04712
956	3003.4	717804	913936	873722816	30.9192	9.8511	2.98046	1.04603
957	3006.5	719306	915849	876467493	30.9354	9.8546	2.98091	1.04493
958	3009.6	720810	917764	879217912	30.9516	9.8580	2.98137	1.04384
959	3012.8	722316	919681	881974079	30.9677	9.8614	2.98182	1.04275
960	3015.9	723823	921600	884736000	30.9839	9.8648	2.98227	1.04167
961	3019.1	725332	923521	887503681	31.0000	9.8683	2.98272	1.04058
962	3022.2	726842	925444	890277128	31.0161	9.8717	2.98318	1.03950
963	3025.4	728354	927369	893056347	31.0322	9.8751	2.98363	1.03842
964	3028.5	729867	929296	895841344	31.0483	9.8785	2.98408	1.03734
965	3031.6	731382	931225	898632125	31.0644	9.8819	2.98453	1.03627
966	3034.8	732899	933156	901428696	31.0805	9.8854	2.98498	1.03520
967	3037.9	734417	935089	904231063	31.0966	9.8888	2.98543	1.03413
968	3041.1	735937	937024	907039232	31.1127	9.8922	2.98588	1.03306
969	3044.2	737458	938961	909853209	31.1288	9.8956	2.98632	1.03199
970	3047.3	738981	940900	912673000	31.1448	9.8990	2.98677	1.03093
971	3050.5	740506	942841	915498611	31.1609	9.9024	2.98722	1.02987
972	3053.6	742032	944784	918330048	31.1769	9.9058	2.98767	1.02881
973	3056.8	743559	946729	921167317	31.1929	9.9092	2.98811	1.02775
974	3059.9	745088	948676	924010424	31.2090	9.9126	2.98856	1.02669
975	3063.1	746619	950625	926859375	31.2250	9.9160	2.98900	1.02564
976	3066.2	748151	952576	929714176	31.2410	9.9194	2.98945	1.02459
977	3069.3	749685	954529	932574833	31.2570	9.9227	2.98989	1.02354
978	3072.5	751221	956484	935441352	31.2730	9.9261	2.99034	1.02249
979	3075.6	752758	958441	938313739	31.2890	9.9295	2.99078	1.02145
980	3078.8	754296	960400	941192000	31.3050	9.9329	2.99123	1.02041
981	3081.9	755837	962361	944076141	31.3209	9.9363	2.99167	1.01937
982	3085.0	757378	964324	946966168	31.3369	9.9396	2.99211	1.01833
983	3088.2	758922	966289	949862087	31.3528	9.9430	2.99255	1.01729
984	3091.3	760466	968256	952763904	31.3688	9.9464	2.99300	1.01626
985	3094.5	762013	970225	955671625	31.3847	9.9497	2.99344	1.01523
986	3097.6	763561	972196	958585256	31.4006	9.9531	2.99388	1.01420
987	3100.8	765111	974169	961504803	31.4166	9.9565	2.99432	1.01317
988	3103.9	766662	976144	964430272	31.4325	9.9598	2.99476	1.01215
989	3107.0	768214	978121	967361669	31.4484	9.9632	2.99520	1.01112
990	3110.2	769769	980100	970299000	31.4643	9.9666	2.99564	1.01010
991	3113.3	771325	982081	973242271	31.4802	9.9699	2.99607	1.00908
992	3116.5	772882	984064	976191488	31.4960	9.9733	2.99651	1.00806
993	3119.6	774441	986049	979146657	31.5119	9.9766	2.99695	1.00705
994	3122.7	776002	988036	982107784	31.5278	9.9800	2.99739	1.00604
995	3125.9	777564	990025	985074875	31.5436	9.9833	2.99782	1.00503
996	3129.0	779128	992016	988047936	31.5595	9.9866	2.99826	1.00402
997	3132.2	780693	994009	991026973	31.5753	9.9900	2.99870	1.00301
998	3135.3	782260	996004	994011992	31.5911	9.9933	2.99913	1.00200
999	3138.5	783828	998001	997002999	31.6070	9.9967	2.99957	1.00100

SQUARES AND CUBES (Fractional).

No.	Square.	Cube.	No.	Square.	Cube.	No.	Square.	Cube.
1/8	0.0156	0.0019	8 1/8	76.5625	669.9218	17 1/8	301.8906	5245.3496
1/4	0.0625	0.0156	8 1/4	78.7656	699.0449	17 1/4	306.2500	5359.3750
3/8	0.1406	0.0527	9	81.0000	729.0000	17 3/8	310.6406	5475.0410
1/2	0.2500	0.1250	9 1/8	83.2656	759.7988	17 1/2	315.0625	5592.3593
5/8	0.3906	0.2441	9 1/4	85.5625	791.4531	17 5/8	319.5156	5711.3417
3/4	0.5625	0.4218	9 3/8	87.8906	823.9743	18	324.0000	5832.0000
7/8	0.7656	0.6699	9 1/2	90.2500	857.3750	18 1/8	328.5156	5954.3457
1	1.0000	1.0000	9 5/8	92.6406	891.6660	18 1/4	333.0625	6078.3906
1 1/8	1.2656	1.4238	9 3/4	95.0625	926.8593	18 3/8	337.6406	6204.1464
1 1/4	1.5625	1.9531	9 7/8	97.5156	962.9668	18 1/2	342.2500	6331.6250
1 3/8	1.8906	2.5996	10	100.0000	1000.0000	18 5/8	346.8906	6460.8378
1 1/2	2.2500	3.3750	10 1/8	102.5156	1037.9707	18 3/4	351.5625	6591.7968
1 5/8	2.6406	4.2910	10 1/4	105.0625	1076.8906	18 7/8	356.2656	6724.5136
1 3/4	3.0625	5.3593	10 3/8	107.6406	1116.7714	19	361.0000	6859.0000
1 7/8	3.5156	6.5917	10 1/2	110.2500	1157.6250	19 1/8	365.7656	6995.2675
2	4.0000	8.0000	10 5/8	112.8906	1199.4628	19 1/4	370.5625	7133.3281
2 1/8	4.5156	9.5957	10 3/4	115.5626	1242.2968	19 3/8	375.3906	7273.1933
2 1/4	5.0625	11.3906	10 7/8	118.2656	1286.1386	19 1/2	380.2500	7414.8750
2 3/8	5.6406	13.3964	11	121.0000	1331.0000	19 5/8	385.1406	7558.3847
2 1/2	6.2500	15.6250	11 1/8	123.7656	1376.8925	19 3/4	390.0625	7703.7343
2 5/8	6.8906	18.0879	11 1/4	126.5626	1423.8281	19 7/8	395.0156	7850.9355
2 3/4	7.5625	20.7968	11 3/8	129.3906	1471.8183	20	400.0000	8000.0000
2 7/8	8.2656	23.7536	11 1/2	132.2500	1520.8750	20 1/8	405.0156	8150.9395
3	9.0000	27.0000	11 5/8	135.1406	1571.0097	20 1/4	410.0625	8303.7656
3 1/8	9.7656	30.5175	11 3/4	138.0625	1622.2343	20 3/8	415.1406	8458.4902
3 1/4	10.5625	34.3281	11 7/8	141.0156	1674.5605	20 1/2	420.2500	8615.1259
3 3/8	11.3906	38.4432	12	144.0000	1728.0000	20 5/8	425.3906	8773.6816
3 1/2	12.2500	42.8750	12 1/8	147.0156	1782.5644	20 3/4	430.5625	8934.1719
3 5/8	13.1406	47.6346	12 1/4	150.0625	1838.2656	20 7/8	435.7656	9096.6074
3 3/4	14.0625	52.7343	12 3/8	153.1406	1895.1152	21	441.0000	9261.0000
3 7/8	15.0156	58.1854	12 1/2	156.2500	1953.1250	21 1/8	446.2656	9427.3613
4	16.0000	64.0000	12 5/8	159.3906	2012.3066	21 1/4	451.5625	9595.7031
4 1/8	17.0156	70.1893	12 3/4	162.5625	2072.6718	21 3/8	456.8906	9766.0371
4 1/4	18.0625	76.7656	12 7/8	165.7656	2134.2324	21 1/2	462.2500	9938.3750
4 3/8	19.1406	83.7401	13	169.0000	2197.0000	21 5/8	467.6406	10112.7285
4 1/2	20.2500	91.1250	13 1/8	172.2656	2260.9863	21 3/4	473.0625	10289.1094
4 5/8	21.3906	98.9315	13 1/4	175.5625	2326.2031	21 7/8	478.5156	10467.5293
4 3/4	22.5625	107.1718	13 3/8	178.8906	2392.6621	22	484.0000	10648.0000
4 7/8	23.7656	115.8573	13 1/2	182.2500	2460.3750	22 1/8	489.5156	10830.5332
5	25.0000	125.0000	13 5/8	185.6406	2529.3535	22 1/4	495.0625	11015.1406
5 1/8	26.2656	134.6112	13 3/4	189.0625	2599.6093	22 3/8	500.6406	11201.8340
5 1/4	27.5625	144.7031	13 7/8	192.5156	2671.1542	22 1/2	506.2500	11390.6250
5 3/8	28.8906	155.2869	14	196.0000	2744.0000	22 5/8	511.8906	11581.5254
5 1/2	30.2500	166.3750	14 1/8	199.5156	2818.1582	22 3/4	517.5625	11774.5469
5 5/8	31.6406	177.9783	14 1/4	203.0625	2893.6406	22 7/8	523.2656	11969.7012
5 3/4	33.0625	190.1093	14 3/8	206.6406	2970.4589	23	529.0000	12167.0000
5 7/8	34.5156	202.7791	14 1/2	210.2500	3048.6250	23 1/8	534.7656	12366.4551
6	36.0000	216.0000	14 5/8	213.8906	3128.1503	23 1/4	540.5625	12568.0781
6 1/8	37.5156	229.7832	14 3/4	217.5625	3209.0468	23 3/8	546.3906	12771.8809
6 1/4	39.0625	244.1406	14 7/8	221.2656	3291.3261	23 1/2	552.2500	12977.8750
6 3/8	40.6406	259.0839	15	225.0000	3375.0000	23 5/8	558.1046	13186.0723
6 1/2	42.2500	274.6250	15 1/8	228.7656	3460.0800	23 3/4	564.0625	13396.4844
6 5/8	43.8906	290.7754	15 1/4	232.5625	3546.5781	23 7/8	570.0156	13609.1230
6 3/4	45.5625	307.5468	15 3/8	236.3906	3634.5058	24	576.0000	13824.0000
6 7/8	47.2656	324.9511	15 1/2	240.2500	3723.8750	24 1/8	582.0156	14041.1270
7	49.0000	343.0000	15 5/8	244.1406	3814.6972	24 1/4	588.0625	14260.5156
7 1/8	50.7656	361.7050	15 3/4	248.0625	3906.9843	24 3/8	594.1406	14482.1777
7 1/4	52.5625	381.0781	15 7/8	252.0156	4000.7480	24 1/2	600.2500	14706.1250
7 3/8	54.3906	401.1308	16	256.0000	4096.0000	24 5/8	606.3906	14932.3691
7 1/2	56.2500	421.8750	16 1/8	260.0156	4192.7519	24 3/4	612.5625	15160.9219
7 5/8	58.1406	443.3222	16 1/4	264.0625	4291.0156	24 7/8	618.7656	15391.7949
7 3/4	60.0625	465.4843	16 3/8	268.1406	4390.8027	25	625.0000	15625.0000
7 7/8	62.0156	488.3730	16 1/2	272.2500	4492.1250	25 1/8	631.2656	15860.5488
8	64.0000	512.0000	16 5/8	276.3906	4594.9941	25 1/4	637.5625	16098.4531
8 1/8	66.0156	536.3769	16 3/4	280.5625	4699.4218	25 3/8	643.8906	16338.7246
8 1/4	68.0625	561.5156	16 7/8	284.7656	4705.4199	25 1/2	650.2500	16581.3750
8 3/8	70.1406	587.4277	17	289.0000	4913.0000	25 5/8	656.6406	16826.4160
8 1/2	72.2500	614.1250	17 1/8	293.2656	5022.1738	25 3/4	663.0625	17073.8594
8 5/8	74.3906	641.6191	17 1/4	297.5625	5132.9531			

TABLE OF THE FOURTH AND FIFTH POWERS OF NUMBERS.

No.	4th Power.	5th Power.	No.	4th Power.	5th Power.	No.	4th Power.	5th Power.
1	1	1	51	6,765,201	345,025,251	101	104,060,401	10,510,100,501
2	16	32	52	7,311,616	380,204,032	102	108,243,216	11,040,808,032
3	81	243	53	7,890,481	418,195,493	103	112,550,881	11,592,740,743
4	256	1,024	54	8,503,056	459,165,024	104	116,985,856	12,166,529,024
5	625	3,125	55	9,150,625	503,284,375	105	121,550,625	12,762,815,625
6	1,296	7,776	56	9,843,496	550,731,776	106	126,247,696	13,382,255,776
7	2,401	16,807	57	10,556,001	601,692,057	107	131,079,601	14,025,517,307
8	4,096	32,768	58	11,316,496	656,356,768	108	136,048,896	14,693,280,768
9	6,561	59,049	59	12,117,361	714,924,299	109	141,158,161	15,386,239,549
10	10,000	100,000	60	12,960,000	777,600,000	110	146,410,000	16,105,100,000
11	14,641	161,051	61	13,845,841	844,596.301	111	151,807,041	16,850,581,551
12	20,736	248,832	62	14,776,336	916,132,832	112	157,351,936	17,623,416,832
13	28,561	371,293	63	15,752,961	992,436,543	113	163,047,361	18,424,351,793
14	38,416	537,824	64	16,777,216	1,073,741,824	114	168,896,016	19,254,145,824
15	50,625	759,375	65	17,850,625	1,160,290,625	115	174,900,625	20,113,571,875
16	65,536	1,048,576	66	18,974,736	1,252,332,576	116	181,063,936	21,003,416,576
17	83,521	1,419,857	67	20,151,121	1,350,125,107	117	187,388,721	21,924,480,357
18	104,976	1,889,568	68	21,381,376	1,453,933,568	118	193,877,776	22,877,577,568
19	130,321	2,476,099	69	22,667,121	1,564,031,349	119	200,533,921	23,863,536,599
20	160,000	3,200,000	70	24,010,000	1,680,700,000	120	207,360,000	24,883,200,000
21	194,481	4,084,101	71	25,411,681	1,804,229,351	121	214,358,881	25,937,424,601
22	234,256	5,153,632	72	26,873,856	1,934,917,632	122	221,533,456	27,027,081,632
23	279,841	6,436,343	73	28,398,241	2,073,071,593	123	228,886,641	28,153,056,843
24	331,776	7,962,624	74	29,986,576	2,219,006,624	124	236,421,376	29,316,250,624
25	390,625	9,765,625	75	31,640,625	2,373,046,875	125	244,140,625	30,517,578,125
26	456,976	11,881,376	76	33,362,176	2,535,525,376	126	252,047,376	31,757,969,376
27	531,441	14,348,907	77	35,153,041	2,706,784,157	127	260,144,641	33,038,369,407
28	614,656	17,210,368	78	37,015,056	2,887,174,368	128	268,435,456	34,359,738,368
29	707,281	20,511,149	79	38,950,081	3,077,056,399	129	276,922,881	35,723,051,649
30	810,000	24,300,000	80	40,960,000	3,276,800,000	130	285,610,000	37,129,300,000
31	923,521	28,629,151	81	43,046,721	3,486,784,401	131	294,499,921	38,579,489,651
32	1,048,576	33,554,432	82	45,212,176	3,707,398,432	132	303,595,776	40,074,642,432
33	1,185,921	39,135,393	83	47,458,321	3,939,040,643	133	312,900,721	41,615,795,893
34	1,336,336	45,435,424	84	49,787,136	4,182,119,424	134	322,417,936	43,204,003,424
35	1,500,625	52,521,875	85	52,200,625	4,437,053,125	135	332,150,625	44,840,334,375
36	1,679,616	60,466,176	86	54,708,016	4,704,270,176	136	342,102,016	46,525,874,176
37	1,874,161	69,343,957	87	57,289,761	4,984,209,207	137	352,275,361	48,261,724,457
38	2,085,136	79,235,168	88	59,969,536	5,277,319,168	138	362,673,936	50,049,003,168
39	2,313,441	90,224,199	89	62,742,241	5,584,059,449	139	373,301,641	51,888,844,699
40	2,560,000	102,400,000	90	65,610,000	5,904,900,000	140	384,160,000	53,782,400,000
41	2,825,761	115,856,201	91	68,574,961	6,240,321,451	141	395,254,161	55,730,836,701
42	3,111,696	130,691,232	92	71,639,296	6,590,815,232	142	406,586,896	57,735,339,232
43	3,418,801	147,008,443	93	74,805,201	6,596,883,693	143	418,161,601	59,797,108,943
44	3,748,096	164,916,224	94	78,074,896	7,339,040,224	144	429,981,696	61,917,364,224
45	4,100,625	184,528,125	95	81,450,625	7,737,809,375	145	442,050,625	64,097,340,625
46	4,477,456	205,962,976	96	84,934,656	8,153,726,976	146	454,371,856	66,338,290,976
47	4,879,681	229,345,007	97	88,529,281	8,587,340,257	147	466,948,881	68,641,485,507
48	5,308,416	254,803,968	98	92,236,816	9,039,207,968	148	479,785,216	71,008,211,968
49	5,764,801	282,475,249	99	96,059,601	9,509,900,499	149	492,884,401	73,439,775,749
50	6,250,000	312,500,000	100	100,000,000	10,000,000,000	150	506,250,000	75,937,500,000

SQUARES, CUBES, AND FOURTH POWERS OF FRACTIONS.

No.	Square.	Cube.	Fourth Power.	No.	Square.	Cube.	Fourth Power.
1/64	0.0002441	0.000003815	0.00000005961	13/64	0.04126	0.008381	0.001702
1/32	0.0009766	0.00003052	0.0000009537	7/32	0.04785	0.01047	0.002290
3/64	0.002197	0.0001030	0.000001922	15/64	0.05493	0.01287	0.003018
1/16	0.003906	0.0002441	0.00001526	1/4	0.06250	0.01563	0.003906
5/64	0.006104	0.0004768	0.00003725	17/64	0.07056	0.01874	0.004978
9/128	0.008789	0.0008240	0.00007725	9/32	0.07910	0.02225	0.006257
7/64	0.01196	0.001308	0.0001431	19/64	0.08813	0.02617	0.007768
1/8	0.01563	0.001953	0.0002441	5/16	0.09766	0.03052	0.009537
9/64	0.01978	0.002781	0.0003911	21/64	0.1077	0.03533	0.01159
11/128	0.02441	0.003815	0.0005961	11/32	0.1182	0.04062	0.01396
5/32	0.02954	0.005077	0.0008727	23/64	0.1292	0.04641	0.01668
13/64	0.03516	0.006592	0.001236	3/8	0.1406	0.05273	0.01978

SQUARES, CUBES, AND FOURTH POWERS OF FRACTIONS (*Continued*).

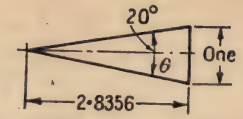
No.	Square.	Cube.	Fourth Power.	No.	Square.	Cube.	Fourth Power.	No.	Square.	Cube.	Fourth Power.
33/64	0.1526	0.05960	0.02328	55/64	0.8499	0.7835	0.7223	1 29/64	2.112	3.068	4.459
17/32	0.1650	0.06705	0.02724	7/8	0.8789	0.8240	0.7725	1 15/32	2.157	3.168	4.654
35/64	0.1780	0.07508	0.03168					1 31/64	2.203	3.271	4.855
9/16	0.1914	0.08374	0.03664	57/64	0.9084	0.8659	0.8253	1 1/2	2.250	3.375	5.063
				29/32	0.9385	0.9091	0.8807				
37/64	0.2053	0.09304	0.04216	59/64	0.9690	0.9539	0.9390	1 33/64	2.297	3.482	5.277
19/32	0.2197	0.1030	0.04828	1	1.000	1.000	1.000	1 17/32	2.345	3.590	5.498
39/64	0.2346	0.1136	0.05505					1 35/64	2.393	3.701	5.726
5/8	0.2500	0.1250	0.06250	1 1/64	1.031	1.048	1.064	1 9/16	2.441	3.815	5.961
				1 1/32	1.063	1.097	1.131				
41/64	0.2659	0.1371	0.07069	1 3/64	1.096	1.147	1.201	1 37/64	2.490	3.930	6.203
21/32	0.2822	0.1499	0.07965	1 1/16	1.129	1.199	1.274	1 19/32	2.540	4.048	6.452
43/64	0.2991	0.1636	0.08944					1 39/64	2.590	4.168	6.709
11/16	0.3164	0.1780	0.1001	1 5/64	1.162	1.253	1.351	1 5/8	2.641	4.291	6.973
				1 3/32	1.196	1.308	1.431				
45/64	0.3342	0.1932	0.1117	1 7/64	1.231	1.365	1.515	1 41/64	2.692	4.416	7.245
23/32	0.3526	0.2093	0.1243	1 1/8	1.266	1.424	1.602	1 21/32	2.743	4.543	7.525
47/64	0.3713	0.2263	0.1379					1 43/64	2.795	4.673	7.813
3/8	0.3906	0.2441	0.1526	1 9/64	1.301	1.484	1.693	1 11/16	2.848	4.805	8.109
				1 5/32	1.337	1.546	1.787				
49/64	0.4104	0.2629	0.1684	1 11/64	1.373	1.609	1.996	1 45/64	2.901	4.940	8.414
25/32	0.4307	0.2826	0.1855	1 3/16	1.410	1.675	1.989	1 23/32	2.954	5.077	8.727
51/64	0.4514	0.3033	0.2038					1 47/64	3.008	5.217	9.048
13/16	0.4727	0.3250	0.2234	1 13/64	1.448	1.742	2.095	1 3/4	3.063	5.359	9.379
				1 7/32	1.485	1.810	2.206				
53/64	0.4944	0.3476	0.2444	1 15/64	1.524	1.881	2.322	1 49/64	3.117	5.504	9.718
27/32	0.5166	0.3713	0.2669	1 1/4	1.563	1.953	2.441	1 25/32	3.173	5.652	10.07
55/64	0.5393	0.3961	0.2909					1 51/64	3.229	5.802	10.43
7/8	0.5625	0.4219	0.3164	1 17/64	1.602	2.027	2.566	1 13/16	3.285	5.954	10.79
				1 9/32	1.642	2.103	2.695	1 53/64	3.342	6.110	11.17
57/64	0.5862	0.4488	0.3436	1 19/64	1.682	2.181	2.829	1 27/32	3.399	6.268	11.56
29/32	0.6104	0.4768	0.3725	1 5/16	1.723	2.261	2.968	1 55/64	3.457	6.428	11.95
59/64	0.6350	0.5060	0.4032					1 7/8	3.516	6.592	12.36
15/16	0.6602	0.5364	0.4358	1 21/64	1.764	2.343	3.111				
				1 11/32	1.806	2.426	3.260	1 57/64	3.574	6.758	12.78
61/64	0.6858	0.5679	0.4703	1 23/64	1.848	2.512	3.415	1 29/32	3.634	6.927	13.20
31/32	0.7119	0.6007	0.5068	1 3/8	1.891	2.600	3.575	1 59/64	3.694	7.099	13.64
63/64	0.7385	0.6347	0.5454					1 15/16	3.754	7.273	14.09
1	0.7656	0.6699	0.5862	1 25/64	1.934	2.689	3.740	1 61/64	3.815	7.451	14.55
				1 13/32	1.978	2.781	3.911	1 31/32	3.876	7.631	15.02
1 1/32	0.7932	0.7065	0.6290	1 27/64	2.022	2.875	4.087	1 63/64	3.938	7.814	15.51
1 1/16	0.8213	0.7443	0.6745	1 7/16	2.066	2.970	4.270	2	4.000	8.000	16.00

POWERS AND ROOTS OF USEFUL FACTORS.

n	$\frac{1}{n}$	n^2	n^3	$\sqrt{n}$	$\frac{1}{\sqrt{n}}$	$\sqrt[3]{n}$	$\frac{1}{\sqrt[3]{n}}$
$\pi = 3.141593$	0.318	9.870	31.006	1.772	0.564	1.465	0.683
$2\pi = 6.283$	0.159	39.478	248.050	2.507	0.399	1.845	0.542
$\frac{\pi}{2} = 1.571$	0.637	2.467	3.878	1.253	0.798	1.162	0.860
$\frac{\pi}{3} = 1.047$	0.955	1.097	1.148	1.023	0.977	1.016	0.985
$\frac{4}{3\pi} = 4.189$	0.239	17.546	73.496	2.047	0.489	1.612	0.622
$\frac{\pi}{4} = 0.7854$	1.274	0.617	0.484	0.886	1.128	0.923	1.084
$\frac{\pi}{6} = 0.524$	1.910	0.274	0.144	0.724	1.382	0.806	1.241
$\pi^2 = 9.870$	0.101	97.409	961.390	3.142	0.318	2.145	0.466
$\pi^3 = 31.006$	0.032	961.390	29809.910	5.568	1.796	3.142	0.318
$\frac{\pi}{32} = 0.098$	10.186	0.0095	0.001	0.313	3.192	0.461	2.168
$g = 32.2$	0.031	1036.84	33386.24	5.674	0.176	3.181	0.314
$2g = 64.4$	0.015	4147.36	267090	8.025	0.125	4.007	0.249

Log $\pi = 0.49714987$

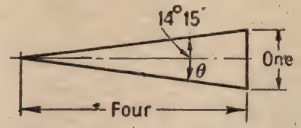
ANGLES AND TAPERS.



Deg. θ	Taper per Inch.	Taper Ratio, One In	Deg. θ	Taper per Inch.	Taper Ratio, One In	Deg. θ	Taper per Inch.	Taper Ratio, One In
1	.01746	57.2945	16	.28108	3.55768	31	.55464	1.80294
2	.03492	28.6450	17	.29890	3.34558	32	.57350	1.74370
3	.05238	19.0943	18	.31676	3.15687	33	.59242	1.68797
4	.06984	14.3181	19	.33468	2.98788	34	.61146	1.63542
5	.08732	11.4519	20	.35266	2.83564	35	.63060	1.58579
6	.10482	9.5405	21	.37068	2.69776	36	.64984	1.53884
7	.12232	8.1749	22	.38876	2.57227	37	.66920	1.49434
8	.13986	7.1503	23	.40690	2.45758	38	.68866	1.45210
9	.15740	6.3531	24	.42512	2.35231	39	.70824	1.41195
10	.17498	5.7150	25	.44338	2.25535	40	.72794	1.37374
11	.19258	5.1927	26	.46174	2.16574	41	.74776	1.33731
12	.21020	4.75718	27	.48016	2.08265	42	.76772	1.30254
13	.22788	4.38844	28	.49866	2.00539	43	.78782	1.26932
14	.24556	4.07217	29	.51724	1.93335	44	.80806	1.23754
15	.26330	3.79787	30	.53590	1.86602	45	.82842	1.20710

Taper per inch $= 2 \tan \frac{\theta}{2}$ Taper ratio $= \frac{1}{2} \cot \frac{\theta}{2}$

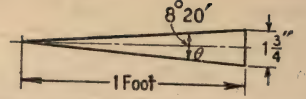
TAPERS AND ANGLES.



Taper One In.	Degrees θ	Taper One In	Degrees θ	Taper One In	Degrees θ	Taper One In	Degrees θ	Taper One In	Degrees θ
2	28° 5′	7	8° 10′	12	4° 46′	17	3° 22′	30	1° 54′
3	18° 55′	8	7° 9′	13	4° 24′	18	3° 10′	36	1° 35′
4	14° 15′	9	6° 21′	14	4° 6′	19	3° 0′	40	1° 26′
5	11° 26′	10	5° 44′	15	3° 49′	20	2° 52′		
6	9° 32′	11	5° 12′	16	3° 35′	24	2° 23′		

Taper ratio $= \frac{1}{2} \cot \frac{\theta}{2}$

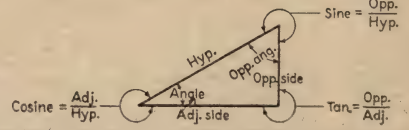
TAPERS PER FOOT.



Taper per Ft.	Degrees θ	Taper per Inch.	Taper per Ft.	Degrees. θ	Taper per Inch.	Taper per Ft.	Degrees θ	Taper per Inch.
1/16″	18′	.0052	9/16″	2° 41′	.046875	1 1/16″	5° 22′	.09375
1/8″	36′	.010416	5/8″	2° 59′	.052084	1 1/8″	5° 58′	.10416
3/16″	54′	.015625	11/16″	3° 17′	.057292	1 3/16″	6° 33′	.11460
1/4″	1° 12′	.02083	3/4″	3° 35′	.0625	1 1/4″	7° 9′	.125
5/16″	1° 30′	.02604	13/16″	3° 52′	.067708	1 5/16″	7° 43′	.1354
3/8″	1° 47′	.03125	7/8″	4° 11′	.072917	1 3/8″	8° 20′	.145833
7/16″	2° 5′	.036458	15/16″	4° 28′	.078125	1 7/16″	8° 56′	.15625
1/2″	2° 23′	.041667	1″	4° 46′	.083333			

Taper per inch $= 2 \tan \frac{\theta}{2}$ $\frac{\text{Taper per foot}}{24} = \tan \frac{\theta}{2}$

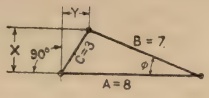
RIGHT ANGLE TRIANGLES.



Parts Given.	Parts to be Found.				
	Angle.	Adj. Side.	Opp. Side.	Hyp.	Opp. Ang.
Opp. and Hyp.	$\text{Sin} = \frac{\text{Opp.}}{\text{Hyp.}}$	$\sqrt{\text{Hyp.}^2 - \text{Opp.}^2}$	Opp. Side	Hyp.	$\text{Cos} = \frac{\text{Opp.}}{\text{Hyp.}}$
Opp. and Adj.	$\text{Tan} = \frac{\text{Opp.}}{\text{Adj.}}$	Adj. Side	Opp. Side	$\sqrt{\text{Opp.}^2 + \text{Adj.}^2}$	$\text{Tan} = \frac{\text{Adj.}}{\text{Opp.}}$
Adj. and Hyp.	$\text{Cos} = \frac{\text{Adj.}}{\text{Hyp.}}$	Adj. Side	$\sqrt{\text{Hyp.}^2 - \text{Adj.}^2}$	Hyp.	$\text{Sin} = \frac{\text{Adj.}}{\text{Hyp.}}$
Ang. and Opp.	Angle	Opp. ÷ Tan	Opp. Side	Opp. ÷ Sin	90° — Ang.
Ang. and Adj.	Angle	Adj. Side	Adj. × Tan	Adj. ÷ Cos	90° — Ang.
Ang. and Hyp.	Angle	Hyp. × Cos	Hyp. × Sin	Hyp.	90° — Ang.

Solution of triangles by natural sines.

GEAR-CENTRE TRIANGLES.



S = Half sum of sides (9 in example).

$$X = \frac{\sqrt{4S\ (S-A)\ (S-B)\ (S-C)}}{A} = \frac{\sqrt{36 \times 1 \times 2 \times 6}}{8} = 2.598$$

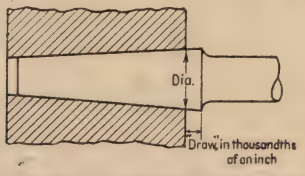
$$Y = \frac{2S\ (S-B)}{A} - C = \frac{18 \times 2}{8} - 3 = 1.5$$

Note.—When Y falls to the left of the vertical line, $Y = C - \frac{2S\ (S-B)}{A}$

$$\text{Cos } \phi = \frac{A^2 + B^2 - C^2}{2B \times A}$$

TAPER SHAFT FITS.

Table of "Draw" Allowances.



Taper ½ per Foot.		Average "Morse" .620 per Ft.		Taper ¾ per Foot.		Taper 1 per Foot.		Taper 1½ per Foot.		Taper 3½ per Foot.	
Draw	Grind off Dia.	Draw	Grind off Dia.	Draw	Grind off Dia.	Draw	Grind off Dia.	Draw	Grind off Dia.	Draw	Grind off Dia.
.001	.00004	.001	.00005	.001	.00006	.001	.00008	.001	.00013	.001	.00029
.010	.00041	.010	.00052	.010	.00063	.010	.00083	.010	.00125	.101	.00291
1/64	.00065	1/64	.00081	1/64	.00098	1/64	.00130	1/64	.00195	1/64	.00456
1/32	.00130	1/32	.00161	1/32	.00195	1/32	.00260	1/32	.00391	1/32	.00911
3/64	.00195	3/64	.00242	3/64	.00293	3/64	.00391	3/64	.00586	3/64	.01367
1/16	.00260	1/16	.00323	1/16	.00391	1/16	.00521	1/16	.00781	1/16	.01823
5/64	.00325	5/64	.00404	5/64	.00488	5/64	.00651	5/64	.00977	5/64	.02279
3/32	.00391	3/32	.00484	3/32	.00586	3/32	.00781	3/32	.01172	3/32	.02734
.100	.00417	.100	.00517	.100	.00625	.100	.00833	.100	.01250	.100	.02917
7/64	.00456	7/64	.00565	7/64	.00683	7/64	.00911	7/64	.01367	7/64	.03190
1/8	.00521	1/8	.00646	1/8	.00781	1/8	.01042	1/8	.01563	1/8	.03646
9/64	.00586	9/64	.00727	9/64	.00879	9/64	.01172	9/64	.01757	9/64	.14102
5/32	.00651	5/32	.00807	5/32	.00977	5/32	.01302	5/32	.01953	5/32	.04557
11/64	.00716	11/64	.00888	11/64	.01074	11/64	.01432	11/64	.02148	11/64	.05013
3/16	.00781	3/16	.00969	3/16	.01172	3/16	.01562	3/16	.02344	3/16	.05469
13/64	.00846	13/64	.01049	13/64	.01269	13/64	.01693	13/64	.02539	13/64	.05924
7/32	.00911	7/32	.01130	7/32	.01367	7/32	.01823	7/32	.02734	7/32	.06380
15/64	.00977	15/64	.01211	15/64	.01465	15/64	.01953	15/64	.02930	15/64	.06836
1/4	.01042	1/4	.01292	1/4	.01563	1/4	.02083	1/4	.03125	1/4	.07292

TRIGONOMETRICAL DATA.

	Sine.	Cosine.	Tangent.	Cotangent.	Secant.	Cosecant.	Versed Sine.
Sin θ =	$\sin\theta$	$\sqrt{(1-\cos^2\theta)}$	$\frac{\tan\theta}{\sqrt{(1+\tan^2\theta)}}$	$\frac{1}{\sqrt{(1+\cot^2\theta)}}$	$\frac{\sqrt{(\sec^2\theta-1)}}{\sec\theta}$	$\frac{1}{\operatorname{cosec}\theta}$	$\sqrt{(2\ \mathrm{vers}\ \theta-\mathrm{vers}^2\theta)}$
Cos θ =	$\sqrt{(1-\sin^2\theta)}$	$\cos\theta$	$\frac{1}{\sqrt{(1+\tan^2\theta)}}$	$\frac{\cot\theta}{\sqrt{(1+\cot^2\theta)}}$	$\frac{1}{\sec\theta}$	$\frac{\sqrt{(\operatorname{cosec}^2\theta-1)}}{\operatorname{cosec}\theta}$	$1-\mathrm{vers}\ \theta$
Tan θ =	$\frac{\sin\theta}{\sqrt{(1-\sin^2\theta)}}$	$\frac{\sqrt{(1-\cos^2\theta)}}{\cos\theta}$	$\tan\theta$	$\frac{1}{\cot\theta}$	$\sqrt{(\sec^2\theta-1)}$	$\frac{1}{\sqrt{(\operatorname{cosec}^2\theta-1)}}$	$\frac{\sqrt{(2\ \mathrm{vers}\ \theta-\mathrm{vers}^2\theta)}}{1-\mathrm{vers}\ \theta}$
Cot θ =	$\frac{\sqrt{(1-\sin^2\theta)}}{\sin\theta}$	$\frac{\cos\theta}{\sqrt{(1-\cos^2\theta)}}$	$\frac{1}{\tan\theta}$	$\cot\theta$	$\frac{1}{\sqrt{(\sec^2\theta-1)}}$	$\sqrt{(\operatorname{cosec}^2\theta-1)}$	$\frac{1-\mathrm{vers}\ \theta}{\sqrt{(2\ \mathrm{vers}\ \theta-\mathrm{vers}^2\theta)}}$
Sec θ =	$\frac{1}{\sqrt{(1-\sin^2\theta)}}$	$\frac{1}{\cos\theta}$	$\sqrt{(1+\tan^2\theta)}$	$\frac{\sqrt{(1+\cot^2\theta)}}{\cot\theta}$	$\sec\theta$	$\frac{\operatorname{cosec}\theta}{\sqrt{(\operatorname{cosec}^2\theta-1)}}$	$\frac{1}{1-\mathrm{vers}\ \theta}$
Cosec θ =	$\frac{1}{\sin\theta}$	$\frac{1}{\sqrt{(1-\cos^2\theta)}}$	$\frac{\sqrt{(1+\tan^2\theta)}}{\tan\theta}$	$\sqrt{(1+\cot^2\theta)}$	$\frac{\sec\theta}{\sqrt{(\sec^2\theta-1)}}$	$\operatorname{cosec}\theta$	$\frac{1}{\sqrt{(2\ \mathrm{vers}\ \theta-\mathrm{vers}^2\theta)}}$
Vers θ =	$1-\sqrt{(1-\sin^2\theta)}$	$1-\cos\theta$	$\frac{1}{1-\sqrt{(1+\tan^2\theta)}}$	$\frac{\cot\theta}{1-\sqrt{(1+\cot^2\theta)}}$	$\frac{1}{1-\sec\theta}$	$\frac{1-\sqrt{(\operatorname{cosec}^2\theta-1)}}{\operatorname{cosec}\theta}$	$\mathrm{vers}\ \theta$

CONVERSION FACTORS.

LENGTH.

Inch	=25.400 millimetres
Foot	=0.30480 metre
Yard	=0.914399 metre
Mile	=1.6093 kilometres
Do.	=5280 feet
Do.	=1760 yards
Nautical mile	=1.1516 miles
Millimetre	=0.03937 inch
Centimetre	=10 millimetres
Do.	=0.3937 inch
Decimetre	=10 centimetres
Metre	=10 decimetres
Do.	=39.3701 inch
Do.	=3.2808 feet
Kilometre	=1000 metres
Do.	=0.62137 mile

AREA.

Square inch	=645.16 sq. millimetres
Do. do.	=6.4516 sq. centimetres
Square foot	=144 sq. inches
Do. do.	=0.0929 sq. centimetres
Square yard	=9 sq. feet
Do. do.	=0.83612 sq. metre
Square centimetre	=100 sq. millimetres
Do. do.	=0.15500 sq. inch
Square decimetre	=100 sq. centimetres
Do. do.	=15.500 sq. inches
Square metre	=100 sq. decimetres
Do. do.	=10.764 sq. feet

VOLUME.

Cubic inch	=16.387 cubic centimetres
Do. do.	=0.016387 litre
Do. do.	=0.029 pint
Do. do.	=0.0036 gallon
Cubic foot	=1728 cubic inches
Do. do.	=28317 cubic cm.
Do. do	=28.317 litres
Do. do.	=49.832 pints
Do. do.	=6.229 gallons
Pint	=34.676 cubic in.
Do.	=0.020 cubic ft.
Do.	=568.245 cubic cm.
Do.	=0.568 litre
Do.	=0.125 gallon
Do.	=20.000 fluid ounces
Gallon	=277.419 cubic in.
Do.	=0.1606 cubic ft.
Do.	=4545.963 cubic cm.
Do.	=4.545963 litres
Do.	=1,2003 U.S. gallons
U.S. gallon	=0.8331 gallon
Cubic centimetre	=0.06103 cubic in.
Do. do.	=0.001758 pint
Do. do.	=1000 cubic mm.
Cubic decimetre	=1000 cubic cm.
Cubic metre	=35.3148 cubic ft.
Do. do.	=1000 cubic decimetres
Litre	=61.023 cubic in.
Do.	=0.0353 cubic ft.
Do.	=1.75980 pints
Do.	=0.220 gallon
Do.	=0.2642 U.S. gallon

WEIGHT.

Ounce	=28.350 grammes
Pound	=0.453592 kilogrammes
Ton	=2240 pounds
Do.	=1.0160 tonnes
Do.	=1016 kilogrammes
Do. (water)	=35.9 cubic feet
Milligram	=0.015 grain
Centigram	=10 milligram
Decigram	=10 centigram
Gram	=10 decigram
Decagram	=10 grams
Hectogram	=10 decagrams
Kilogram	=10 hectograms
Do.	=2.204622 pounds
Do.	=0.000984 tons
Tonne	=1000 kilograms
Do.	=0.9842 tons
Liquid pint	=1.25 × S.G. lb.

VELOCITY.

Foot per second	=60 feet per min.
Do. do.	=0.68182 miles per hour
Do. do.	=0.592105 knots
Do. do.	=30.4801 cms. per sec.
Do. do.	=0.304801 metres per sec.
Do. do.	=1.0973 kilom. per hour
Foot per minute	=0.016667 feet per sec.
Do. do.	=0.011364 miles per hour
Do. do.	=0.0098684 knots
Do. do.	=0.50800 cms. per sec.
Do. do.	=0.00508 metres per sec.
Do. do.	=0.018288 kilom. per hour
Miles per hour	=14667 feet per sec.
Do. do.	=88 feet per min.
Do. do.	=0.86842 knots
Do. do.	=44.704 cms. per sec.
Do. do.	=0.44704 metres per sec.
Do. do.	=1.60935 kilom. per hour
Knot	=1.1515 miles per hour
Do.	=1.8532 kilom. per hour

CONVERSION FACTORS (*Continued*).

VELOCITY—*continued.*

Centimetre per sec.	=0.032808 ft. per sec.
Do. do.	=1.9685 ft. per min.
Do. do.	=0.022369 miles per hour
Do. do.	=0.01 metres per sec.
Do. do.	=0.036 kilom. per hour
Metre per sec.	=3.2808 feet per sec.
Do. do.	=196.85 feet per min.
Do. do.	=2.2369 miles per hour
Do. do.	=3.60 kilom. per hour
Kilometre per hour	=54.68 ft. per min.
Do. do.	=0.62137 miles per hour

PRESSURE.

Pound per sq. inch	=144 lb. per sq. foot
Do. do.	$=4.4643\times10^{-4}$ tons per sq. in.
Do. do.	=0.070306 kgm. per sq. cm.
Do. do.	=703.06 kgm. per sq. metre
Do. do.	=2.3067 ft. of water
Do. do.	=0.06803 atmosphere
Pound per sq. foot	$=6.9443\times10^{-3}$ lb. per sq. in.
Do. do.	$=3.1002\times10^{-6}$ tons per sq. in.
Do. do.	=4.883 kgm. per sq. metre
Do. do.	=0.01602 ft. of water
Ton per sq. in.	=2240 lb. per sq. in.
Do. do.	=322560 lb. per sq. ft.
Do. do.	=157.5 kgm. per sq. cm.
Do. do.	$=1.575\times10^{6}$ kgm. per sq. metre
Do. do.	=5167.0 feet of water
Kilogm. per sq. cm.	=14.224 lb. per sq. in.
Do. do.	=2048.2 lb. per sq. ft.
Do. do.	=0.006350 ton per sq. in.
Do. do.	=10000 kgm. per sq. metre
Do. do.	=32.808 feet of water
Kilogm. per sq. metre	=0.0014224 lb. per sq. in.
Do. do.	=0.20482 lb. per sq. ft.
Do. do.	$=6.350\times10^{-7}$ tons per sq. in.
Do. do.	=0.0001 kgm. per sq. cm.
Foot of water	=0.43352 lb. per sq. in.
Do. do.	=62.43 lb. per sq. ft.
Do. do.	=304.8 kgm. per sq. metre
Atmosphere	=14.696 lb. per sq. in.
Do.	=1.033 kgm. per sq. cm.
Do.	=33.900 ft. water

POWER.

Horse power	=550 ft.-lb. per sec.
Do. do.	=33000 ft.-lb. per min.
Do. do.	=1.0139 French horse power
Do. do.	=745.95 watts
Do. do.	=0.74595 kilowatts
Horse power (French)	=0.9863 horse power
Do. do.	=735.80 watts
Do. do.	=542.48 ft.-lb. per sec.
Watt	=7373 ft.-lb. per sec.
Do.	=0.0013406 horse power
Do.	=0.0013592 French horse power
Kilowatt	=1000 watts
Do.	=737.80 ft.-lb. per sec.
Do.	=1.3406 horse power
Foot-pound per sec.	=0.13825 kilogrammetres per sec.
Do. do.	=0.0018182 horse power
Do. do.	=0.0018434 French horse power
Do. do.	=1.3563 watts
Kilogrammetres per sec.	=7.233 ft.-lb. per sec.

ENERGY.

Foot-pound	=0.13825 kilogrammetres
Do.	=0.000324 kilog. calories
Do.	=0.001285 B.Th.U.
Do.	$=0.505\times10^{-6}$ h.p. hours
Kilogrammetre	=7.233 ft.-lb.
Do.	=0.00234 kilog. calories
Do.	=0.00929 B.Th.U.
Do.	$=3.65\times10^{-6}$ h.p. hours
Kilogm. calories	=3086 ft.-lb.
Do. do.	=426.1 kilogrammetres
Do. do.	=3.968 B.Th.U.
Do. do.	=0.00156 h.p. hours
B.Th.U.	=778.3 ft.-lbs.
Do.	=107.6 kilogrammetres
Do.	=0.252 kilogm. calories
Do.	=0.000393 h.p. hours
Kilowatt hour	$=2.655\times10^{6}$ ft.-lb.
Do. do.	=367100 kilogrammetres
Do. do.	=860.3 kilogm. calories
Do. do.	=3411 B.Th.U.
Do. do.	=1.341 h.p. hours
Horse power hour	$=1.981\times10^{6}$ ft.-lb.
Do. do.	=273700 kilogrammetres
Do. do.	=642.0 kilogm. calories
Do. do.	=2545 B.Th.U.
Do. do.	=0.746 kilowatt hours

TIME AND ANGLES.

Second	=0.01667 minutes
Do.	$=2.7778\times10^{-4}$ hours or degrees
Do.	$=4.848\times10^{-6}$ radians
Do.	$=3.0864\times10^{-4}$ right angles
Minute	=60 seconds
Do.	=0.016667 hours or degrees
Do.	$=2.9089\times10^{-4}$ radians
Do.	$=1.851\times10^{-4}$ right angles
Hour or degree	=3600 seconds
Do. do.	=0.017453 radians
Do. do.	=0.01 right angles
Radian	=20626 seconds
Do.	=3437.7 minutes
Do.	=57.296 degrees
Do.	=63662 right angles
Right angle	=324000 seconds
Do. do.	=5400 minutes
Do. do.	=90 degrees
Do. do.	=1.5708 radians

FRACTIONS OF AN INCH IN DECIMALS AND MILLIMETRES.

¼ and over.	8ths	16ths	32nds	64ths	Decimals.	mm.
—	—	—	—	1	.015625	0.397
—	—	—	1	2	.031250	0.794
—	—	—	—	3	.046875	1.191
—	—	1	2	4	.062500	1.588
—	—	—	—	5	.078125	1.984
—	—	—	3	6	.093750	2.381
—	—	—	—	7	.109375	2.778
—	1	2	4	8	.125000	3.175
—	—	—	—	9	.140625	3.572
—	—	—	5	10	.156250	3.969
—	—	—	—	11	.171875	4.366
—	—	3	6	12	.187500	4.762
—	—	—	—	13	.203125	5.159
—	—	—	7	14	.218750	5.556
—	—	—	—	15	.234375	5.943
¼	2	4	8	16	.250000	6.350
—	—	—	—	17	.265625	6.747
—	—	—	9	18	.281250	7.144
—	—	—	—	19	.296875	7.541
—	—	5	10	20	.312500	7.938
—	—	—	—	21	.328125	8.335
—	—	—	11	22	.343750	8.732
—	—	—	—	23	.359375	9.129
—	3	6	12	24	.375000	9.524
—	—	—	—	25	.390625	9.921
—	—	—	13	26	.406250	10.318
—	—	—	—	27	.421875	10.715
—	—	7	14	28	.437500	11.112
—	—	—	—	29	.453125	11.509
—	—	—	15	30	.468750	11.906
—	—	—	—	31	.484375	12.303
½	4	8	16	32	.500000	12.700
—	—	—	—	33	.515625	13.097
—	—	—	17	34	.531250	13.494
—	—	—	—	35	.546875	13.891
—	—	9	18	36	.562500	14.288
—	—	—	—	37	.578125	14.685
—	—	—	19	38	.593750	15.082
—	—	—	—	39	.609375	15.479
—	5	10	20	40	.625000	15.876
—	—	—	—	41	.640625	16.273
—	—	—	21	42	.656250	16.670
—	—	—	—	43	.671875	17.067
—	—	11	22	44	.687500	17.464
—	—	—	—	45	.703125	17.861
—	—	—	23	46	.718750	18.238
—	—	—	—	47	.734375	18.635
¾	6	12	24	48	.750000	19.048
—	—	—	—	49	.765625	19.445
—	—	—	25	50	.781250	19.842
—	—	—	—	51	.796875	20.239
—	—	13	26	52	.812500	20.636
—	—	—	—	53	.828125	21.033
—	—	—	27	54	.843750	21.430
—	—	—	—	55	.859375	21.827
—	7	14	28	56	.875000	22.224
—	—	—	—	57	.890625	22.621
—	—	—	29	58	.906250	23.018
—	—	—	—	59	.921875	23.415
—	—	15	30	60	.937500	23.812
—	—	—	—	61	.953125	24.209
—	—	—	31	62	.968750	24.606
—	—	—	—	63	.984375	25.003
1	8	16	32	64	1.000000	25.400

INCHES EQUIVALENT TO MILLIMETRES.

NOTE.—$\frac{1}{64}$ in. approximately equals 0.4 mm., so to obtain values intermediate between those given below add or subtract this amount.

Thus: $1\frac{1}{32}$ in. $= 25.4 + 2 \times 0.4$ mm. $= 26.2$ mm. Or
$1\frac{3}{64}$ in. $= \frac{1}{16}$ in. $- \frac{1}{64}$ in. $= 27.0 - 0.4$ mm. $= 26.6$ mm.

in.	mm.	in.	mm.	in.	mm.	in.	mm.
$\frac{1}{16}$	1.6	$3\frac{1}{16}$	77.8	$6\frac{1}{16}$	154.0	$9\frac{1}{16}$	230.2
$\frac{1}{8}$	3.2	$3\frac{1}{8}$	79.4	$6\frac{1}{8}$	155.6	$9\frac{1}{8}$	231.8
$\frac{3}{16}$	4.8	$3\frac{3}{16}$	81.0	$6\frac{3}{16}$	157.2	$9\frac{3}{16}$	233.4
$\frac{1}{4}$	6.4	$3\frac{1}{4}$	82.5	$6\frac{1}{4}$	158.8	$9\frac{1}{4}$	235.0
$\frac{5}{16}$	7.9	$3\frac{5}{16}$	84.1	$6\frac{5}{16}$	160.3	$9\frac{5}{16}$	236.5
$\frac{3}{8}$	9.5	$3\frac{3}{8}$	85.7	$6\frac{3}{8}$	161.9	$9\frac{3}{8}$	238.1
$\frac{7}{16}$	11.1	$3\frac{7}{16}$	87.3	$6\frac{7}{16}$	163.5	$9\frac{7}{16}$	239.7
$\frac{1}{2}$	12.7	$3\frac{1}{2}$	88.9	$6\frac{1}{2}$	165.1	$9\frac{1}{2}$	241.3
$\frac{9}{16}$	14.3	$3\frac{9}{16}$	90.5	$6\frac{9}{16}$	166.7	$9\frac{9}{16}$	242.9
$\frac{5}{8}$	15.9	$3\frac{5}{8}$	92.1	$6\frac{5}{8}$	168.3	$9\frac{5}{8}$	244.5
$\frac{11}{16}$	17.5	$3\frac{11}{16}$	93.7	$6\frac{11}{16}$	169.9	$9\frac{11}{16}$	246.1
$\frac{3}{4}$	19.1	$3\frac{3}{4}$	95.2	$6\frac{3}{4}$	171.5	$9\frac{3}{4}$	247.7
$\frac{13}{16}$	20.6	$3\frac{13}{16}$	96.8	$6\frac{13}{16}$	173.0	$9\frac{13}{16}$	249.2
$\frac{7}{8}$	22.2	$3\frac{7}{8}$	98.4	$6\frac{7}{8}$	174.6	$9\frac{7}{8}$	250.8
$\frac{15}{16}$	23.8	$3\frac{15}{16}$	100.0	$6\frac{15}{16}$	176.2	$9\frac{15}{16}$	252.4
1	25.4	4	101.6	7	177.8	10	254.0
$1\frac{1}{16}$	27.0	$4\frac{1}{16}$	103.2	$7\frac{1}{16}$	179.4	$10\frac{1}{16}$	255.6
$1\frac{1}{8}$	28.6	$4\frac{1}{8}$	104.8	$7\frac{1}{8}$	181.0	$10\frac{1}{8}$	257.2
$1\frac{3}{16}$	30.2	$4\frac{3}{16}$	106.4	$7\frac{3}{16}$	182.6	$10\frac{3}{16}$	258.8
$1\frac{1}{4}$	31.7	$4\frac{1}{4}$	108.0	$7\frac{1}{4}$	184.2	$10\frac{1}{4}$	260.4
$1\frac{5}{16}$	33.3	$4\frac{5}{16}$	109.5	$7\frac{5}{16}$	185.7	$10\frac{5}{16}$	261.9
$1\frac{3}{8}$	34.9	$4\frac{3}{8}$	111.1	$7\frac{3}{8}$	187.3	$10\frac{3}{8}$	263.5
$1\frac{7}{16}$	36.5	$4\frac{7}{16}$	112.7	$7\frac{7}{16}$	188.9	$10\frac{7}{16}$	265.1
$1\frac{1}{2}$	38.1	$4\frac{1}{2}$	114.3	$7\frac{1}{2}$	190.5	$10\frac{1}{2}$	266.7
$1\frac{9}{16}$	39.7	$4\frac{9}{16}$	115.9	$7\frac{9}{16}$	192.1	$10\frac{9}{16}$	268.3
$1\frac{5}{8}$	41.3	$4\frac{5}{8}$	117.5	$7\frac{5}{8}$	193.7	$10\frac{5}{8}$	269.9
$1\frac{11}{16}$	42.9	$4\frac{11}{16}$	119.1	$7\frac{11}{16}$	195.3	$10\frac{11}{16}$	271.5
$1\frac{3}{4}$	44.4	$4\frac{3}{4}$	120.7	$7\frac{3}{4}$	196.9	$10\frac{3}{4}$	273.1
$1\frac{13}{16}$	46.0	$4\frac{13}{16}$	122.2	$7\frac{13}{16}$	198.4	$10\frac{13}{16}$	274.6
$1\frac{7}{8}$	47.6	$4\frac{7}{8}$	123.8	$7\frac{7}{8}$	200.0	$10\frac{7}{8}$	276.2
$1\frac{15}{16}$	49.2	$4\frac{15}{16}$	125.4	$7\frac{15}{16}$	201.6	$10\frac{15}{16}$	277.8
2	50.8	5	127.0	8	203.2	11	279.4
$2\frac{1}{16}$	52.4	$5\frac{1}{16}$	128.6	$8\frac{1}{16}$	204.8	$11\frac{1}{16}$	281.0
$2\frac{1}{8}$	54.0	$5\frac{1}{8}$	130.2	$8\frac{1}{8}$	206.4	$11\frac{1}{8}$	282.6
$2\frac{3}{16}$	55.6	$5\frac{3}{16}$	131.8	$8\frac{3}{16}$	208.0	$11\frac{3}{16}$	284.2
$2\frac{1}{4}$	57.1	$5\frac{1}{4}$	133.4	$8\frac{1}{4}$	209.6	$11\frac{1}{4}$	285.7
$2\frac{5}{16}$	58.7	$5\frac{5}{16}$	134.9	$8\frac{5}{16}$	211.1	$11\frac{5}{16}$	287.3
$2\frac{3}{8}$	60.3	$5\frac{3}{8}$	136.5	$8\frac{3}{8}$	212.7	$11\frac{3}{8}$	288.9
$2\frac{7}{16}$	61.9	$5\frac{7}{16}$	138.1	$8\frac{7}{16}$	214.3	$11\frac{7}{16}$	290.5
$2\frac{1}{2}$	63.5	$5\frac{1}{2}$	139.7	$8\frac{1}{2}$	215.9	$11\frac{1}{2}$	292.1
$2\frac{9}{16}$	65.1	$5\frac{9}{16}$	141.3	$8\frac{9}{16}$	217.5	$11\frac{9}{16}$	293.7
$2\frac{5}{8}$	66.7	$5\frac{5}{8}$	142.9	$8\frac{5}{8}$	219.1	$11\frac{5}{8}$	295.3
$2\frac{11}{16}$	68.3	$5\frac{11}{16}$	144.5	$8\frac{11}{16}$	220.7	$11\frac{11}{16}$	296.9
$2\frac{3}{4}$	69.8	$5\frac{3}{4}$	146.1	$8\frac{3}{4}$	222.3	$11\frac{3}{4}$	298.4
$2\frac{13}{16}$	71.4	$5\frac{13}{16}$	147.6	$8\frac{13}{16}$	223.8	$11\frac{13}{16}$	300.0
$2\frac{7}{8}$	73.0	$5\frac{7}{8}$	149.2	$8\frac{7}{8}$	225.4	$11\frac{7}{8}$	301.6
$2\frac{15}{16}$	74.6	$5\frac{15}{16}$	150.8	$8\frac{15}{16}$	227.0	$11\frac{15}{16}$	303.2
3	76 2	6	152.4	9	228.6	12	304.8

$\frac{1}{1000}$ INCH TO MILLIMETRES.

$\frac{1}{1000}$ Inch.	Millimetres.	$\frac{1}{1000}$ Inch.	Millimetres.	$\frac{1}{1000}$ Inch.	Millimetres.	$\frac{1}{1000}$ Inch.	Millimetres.	$\frac{1}{1000}$ Inch.	Millimetres.	$\frac{1}{1000}$ Inch.	Millimetres.
1	.0254	18	.4571	35	.8888	52	1.321	69	1.752	85	2.159
2	.0508	19	.4825	36	.9142	53	1.346	70	1.778	86	2.184
3	.0762	20	.5079	37	.9396	54	1.372	71	1.803	87	2.209
4	.1016	21	.5333	38	.9650	55	1.397	72	1.829	88	2.235
5	.1270	22	.5587	39	.9904	56	1.422	73	1.854	89	2.260
6	.1524	23	.5841	40	1.016	57	1.448	74	1.879	90	2.286
7	.1778	24	.6095	41	1.041	58	1.473	75	1.905	91	2.311
8	.2032	25	.6348	42	1.067	59	1.499	76	1.930	92	2.336
9	.2286	26	.6602	43	1.092	60	1.524	77	1.956	93	2.362
10	.2540	27	.6856	44	1.118	61	1.549	78	1.981	94	2.387
11	.2793	28	.7110	45	1.143	62	1.575	79	2.006	95	2.413
12	.3047	29	.7364	46	1.168	63	1.600	80	2.032	96	2.438
13	.3301	30	.7618	47	1.194	64	1.626	81	2.057	97	2.465
14	.3555	31	.7872	48	1.219	65	1.651	82	2.083	98	2.489
15	.3809	32	.8126	49	1.245	66	1.676	83	2.108	99	2.514
16	.4063	33	.8380	50	1.270	67	1.702	84	2.133	100	2.540
17	.4317	34	.8634	51	1.295	68	1.727	—	—	—	—

NOTE.—0.00010 inch = 0.00254 millimetre. 0.00050 inch = 0.01270 millimetre.
0.00025 ,, = 0.00635 ,, 0.00075 ,, = 0.01905 ,,

$\frac{1}{100}$ MILLIMETRES TO INCHES.

Mm.	Inch.	Mm.	Inch.	Mm.	Inch.	Mm.	Inch.	Mm.	Inch.	Mm.	Inch.
$\frac{1}{100}$	= .00039	$\frac{22}{100}$	= .00866	$\frac{43}{100}$	= .01693	$\frac{64}{100}$	= .02520	$\frac{85}{100}$	= .03346	7	= .27559
$\frac{2}{100}$	= .00079	$\frac{23}{100}$	= .00906	$\frac{44}{100}$	= .01732	$\frac{65}{100}$	= .02559	$\frac{86}{100}$	= .03386	8	= .31496
$\frac{3}{100}$	= .00118	$\frac{24}{100}$	= .00945	$\frac{45}{100}$	= .01772	$\frac{66}{100}$	= .02598	$\frac{87}{100}$	= .03425	9	= .35433
$\frac{4}{100}$	= .00157	$\frac{25}{100}$	= .00984	$\frac{46}{100}$	= .01811	$\frac{67}{100}$	= .02638	$\frac{88}{100}$	= .03465	10	= .39370
$\frac{5}{100}$	= .00197	$\frac{26}{100}$	= .01024	$\frac{47}{100}$	= .01850	$\frac{68}{100}$	= .02677	$\frac{89}{100}$	= .03504	11	= .43307
$\frac{6}{100}$	= .00236	$\frac{27}{100}$	= .01063	$\frac{48}{100}$	= .01890	$\frac{69}{100}$	= .02717	$\frac{90}{100}$	= .03543	12	= .47244
$\frac{7}{100}$	= .00276	$\frac{28}{100}$	= .01102	$\frac{49}{100}$	= .01929	$\frac{70}{100}$	= .02756	$\frac{91}{100}$	= .03583	13	= .51181
$\frac{8}{100}$	= .00315	$\frac{29}{100}$	= .01142	$\frac{50}{100}$	= .01969	$\frac{71}{100}$	= .02795	$\frac{92}{100}$	= .03622	14	= .55118
$\frac{9}{100}$	= .00354	$\frac{30}{100}$	= .01181	$\frac{51}{100}$	= .02008	$\frac{72}{100}$	= .02835	$\frac{93}{100}$	= .03661	15	= .59055
$\frac{10}{100}$	= .00394	$\frac{31}{100}$	= .01220	$\frac{52}{100}$	= .02047	$\frac{73}{100}$	= .02874	$\frac{94}{100}$	= .03701	16	= .62992
$\frac{11}{100}$	= .00433	$\frac{32}{100}$	= .01260	$\frac{53}{100}$	= .02087	$\frac{74}{100}$	= .02913	$\frac{95}{100}$	= .03740	17	= .66929
$\frac{12}{100}$	= .00472	$\frac{33}{100}$	= .01299	$\frac{54}{100}$	= .02126	$\frac{75}{100}$	= .02953	$\frac{96}{100}$	= .03780	18	= .70866
$\frac{13}{100}$	= .00512	$\frac{34}{100}$	= .01339	$\frac{55}{100}$	= .02165	$\frac{76}{100}$	= .02992	$\frac{97}{100}$	= .03819	19	= .74803
$\frac{14}{100}$	= .00551	$\frac{35}{100}$	= .01378	$\frac{56}{100}$	= .02205	$\frac{77}{100}$	= .03032	$\frac{98}{100}$	= .03858	20	= .78740
$\frac{15}{100}$	= .00591	$\frac{36}{100}$	= .01477	$\frac{57}{100}$	= .02244	$\frac{78}{100}$	= .03071	$\frac{99}{100}$	= .03898	21	= .82677
$\frac{16}{100}$	= .00630	$\frac{37}{100}$	= .01457	$\frac{58}{100}$	= .02283	$\frac{79}{100}$	= .03110	1	= .03937	22	= .86614
$\frac{17}{100}$	= .00669	$\frac{38}{100}$	= .01496	$\frac{59}{100}$	= .02323	$\frac{80}{100}$	= .03150	2	= .07874	23	= .90551
$\frac{18}{100}$	= .00709	$\frac{39}{100}$	= .01535	$\frac{60}{100}$	= .02362	$\frac{81}{100}$	= .03189	3	= .11811	24	= .94488
$\frac{19}{100}$	= .00748	$\frac{40}{100}$	= .01575	$\frac{61}{100}$	= .02402	$\frac{82}{100}$	= .03228	4	= .15748	25	= .98425
$\frac{20}{100}$	= .00787	$\frac{41}{100}$	= .01614	$\frac{62}{100}$	= .02441	$\frac{83}{100}$	= .03268	5	= .19685	26	= 1.02362
$\frac{21}{100}$	= .00827	$\frac{42}{100}$	= .01654	$\frac{63}{100}$	= .02480	$\frac{84}{100}$	= .03307	6	= .23622	27	= 1.06299

MILLIMETRES TO INCHES. 1 METRE = 39.37027 in.

mm.	inches.	mm.	inches.	mm.	inches.	mm.	inches.	mm.	inches.	mm.	inches.	mm.	inches.
1	.03937027	31	1.22047837	61	2.40158647	91	3.58269457	121	4.76380267	151	5.94491077	181	7.12601887
2	.07874054	32	1.25984864	62	2.44095674	92	3.62206484	122	4.80317294	152	5.98428104	182	7.16538914
3	.11811081	33	1.29921891	63	2.48032701	93	3.66143511	123	4.84254321	153	6.02365131	183	7.20475941
4	.15748108	34	1.33858918	64	2.51969728	94	3.70080538	124	4.88191348	154	6.06302158	184	7.24412968
5	.19685135	35	1.37795945	65	2.55906755	95	3.74017565	125	4.92128375	155	6.10239185	185	7.28349995
6	.23622162	36	1.41732972	66	2.59843782	96	3.77954592	126	4.96065402	156	6.14176212	186	7.32287022
7	.27559189	37	1.45669999	67	2.63780809	97	3.81841619	127	5.00002429	157	6.18113239	187	7.36224049
8	.31496216	38	1.49607026	68	2.67717836	98	3.85828646	128	5.03939456	158	6.22050266	188	7.40161076
9	.35433243	39	1.53544053	69	2.71654863	99	3.89765673	129	5.07876483	159	6.25987293	189	7.44098103
10	.39370270	40	1.57481080	70	2.75591890	100	3.93702700	130	5.11813510	160	6.29924320	190	7.48035130
11	.43307297	41	1.61418107	71	2.79528917	101	3.97639727	131	5.15750537	161	6.33861347	191	7.51972157
12	.47244324	42	1.65355134	72	2.83465944	102	4.01576754	132	5.19687564	162	6.37798374	192	7.55909184
13	.51181351	43	1.69292161	73	2.87402971	103	4.05513781	133	5.23624591	163	6.41735401	193	7.59846211
14	.55118378	44	1.73229188	74	2.91339998	104	4.09450808	134	5.27561618	164	6.45672428	194	7.63783238
15	.59055405	45	1.77166215	75	2.95277025	105	4.13387835	135	5.31498645	165	6.49609455	195	7.67720265
16	.62992432	46	1.81103242	76	2.99214052	106	4.17324862	136	5.35435672	166	6.53546482	196	7.71657292
17	.66929459	47	1.85040269	77	3.03151079	107	4.21261889	137	5.39372699	167	6.57483509	197	7.75594319
18	.70866486	48	1.88977296	78	3.07088106	108	4.25198916	138	5.43309726	168	6.61420536	198	7.79531346
19	.74803513	49	1.92914323	79	3.11025133	109	4.29135943	139	5.47246753	169	6.65357563	199	7.83468373
20	.78740540	50	1.96851350	80	3.14962160	110	4.33072970	140	5.51183780	170	6.69294590	200	7.87405400
21	.82677567	51	2.00788377	81	3.18899187	111	4.37009997	141	5.55120807	171	6.73231617	201	7.91342427
22	.86614594	52	2.04725404	82	3.22836214	112	4.40947024	142	5.59057834	172	6.77168644	202	7.95279454
23	.90551621	53	2.08662431	83	3.26773241	113	4.44884051	143	5.62994861	173	6.81105671	203	7.99216481
24	.94488648	54	2.12599458	84	3.30710268	114	4.48821078	144	5.66931888	174	6.85042698	204	8.03153508
25	.98425675	55	2.16536485	85	3.34647295	115	4.52758105	145	5.70868915	175	6.88979725	205	8.07090535
26	1.02362702	56	2.20473512	86	3.38584322	116	4.56695132	146	5.74805942	176	6.92916752	206	8.11027562
27	1.06299729	57	2.24410539	87	3.42521349	117	4.60632159	147	5.78742969	177	6.96853779	207	8.14964589
28	1.10236756	58	2.28347566	88	3.46458376	118	4.64569186	148	5.82679996	178	7.00790806	208	8.18901616
29	1.14173783	59	2.32284593	89	3.50395403	119	4.68506213	149	5.86617023	179	7.04727833	209	8.22838643
30	1.18110810	60	2.36221620	90	3.54332430	120	4.72443240	150	5.90554050	180	7.08664860	210	8.26775670

SQUARE INCHES to SQUARE CENTIMETRES.

Square Inches.	0	1	2	3	4	5	6	7	8	9
0		6.45137	12.9027	19.3541	25.8055	32.2568	38.7082	45.1596	51.6109	58.0623
10	64.51367	70.9650	77.4164	83.8678	90.3191	96.7705	103.222	109.673	116.125	122.576
20	129.0273	135.479	141.930	148.381	154.833	161.284	167.736	174.187	180.638	187.090
30	193.5410	199.992	206.444	212.895	219.346	225.798	323.249	238.701	245.152	251.603
40	258.0547	264.506	270.957	277.409	283.860	290.311	296.763	303.214	309.666	316.117
50	322.5683	329.020	335.471	341.922	348.374	354.825	361.277	367.728	374.179	380.631
60	387.0820	393.533	399.985	406.436	412.887	419.339	425.790	232.242	438.693	445.144
70	451.5957	458.047	464.498	470.950	477.401	483.852	490.304	496.755	503.207	509.658
80	516.1093	522.561	529.012	535.463	541.915	548.366	554.818	561.269	567.720	574.172
90	580.6230	587.074	593.526	599.977	606.428	612.880	619.331	625.783	632.234	638.685

SQUARE CENTIMETRES.

Alter *two* decimal points for each division of the metre.

SQUARE CENTIMETRES to SQUARE INCHES.

Sq. Centimetres.	0	1	2	3	4	5	6	7	8	9
0		.155006	.310012	.465018	.620024	.775030	.930036	1.08504	1.24005	1.39505
10	1.550059	1.70507	1.86007	2.01508	2.17008	2.32509	2.48009	2.63510	2.79011	2.94511
20	3.100118	3.25512	3.41013	3.56514	3.72014	3.87515	4.03015	4.18516	4.34017	4.49517
30	4.650178	4.80518	4.96019	5.11520	5.27020	5.42521	5.58021	5.73522	5.89022	6.04523
40	6.200237	6.35524	6.51025	6.66525	6.82026	6.97527	7.13027	7.28528	7.44028	7.59529
50	7.750296	7.90530	8.06031	8.21531	8.37032	8.52533	8.68033	8.83534	8.99034	9.14535
60	9.300355	9.45536	9.61037	9.76537	9.92038	10.0754	10.2304	10.3854	10.5404	10.6954
70	10.85041	11.0054	11.1604	11.3154	11.4704	11.6254	11.7804	11.9355	12.0905	12.2455
80	12.40047	12.5555	12.7105	12.8655	13.0205	13.1755	13.3305	13.4855	13.6405	13.7955
90	13.95053	14.1055	14.2605	14.4156	14.5706	14.7256	14.8806	15.0356	15.1906	15.3456

SQUARE INCHES.

Alter *two* decimal points for each division of the metre.

POUNDS AVOIRDUPOIS to KILOGRAMMES.

Lbs. Avoir.	0	1	2	3	4	5	6	7	8	9
0		.453593	.907185	1.36078	1.81431	2.26796	2.72156	3.17515	3.62874	4.08233
10	4.535927	4.98953	5.44312	5.89671	6.35030	6.80390	7.25749	7.71108	8.16467	8.61827
20	9.071853	9.52545	9.97904	10.4326	10.8862	11.3398	11.7934	12.2470	12.7000	13.1542
30	13.60780	14.0614	14.5150	14.9686	15.4222	15.8757	16.3293	16.7829	17.2365	17.6901
40	18.14371	18.5973	19.0509	19.5045	19.9581	20.4117	20.8653	21.3189	21.7725	22.2260
50	22.67963	23.1332	23.5868	24.0404	24.4940	24.9476	25.4012	25.8548	26.3084	26.7620
60	27.21556	27.6691	28.1227	28.5763	29.0299	29.4835	29.9371	30.3907	30.8443	31.2978
70	31.75149	32.2051	32.6587	33.1122	33.5658	34.0194	34.4730	34.9266	35.3802	35.8338
80	36.28741	36.7410	37.1946	37.6482	38.1018	38.5554	39.0090	39.4626	39.9162	40.3697
90	40.82334	41.2769	41.7305	42.1841	42.6377	43.0913	43.5449	43.9985	44.4521	44.9057

KILOGRAMMES.

Alter *one* decimal place for each division or multiple of the kilogramme, and *three* for the millier.

KILOGRAMMES to POUNDS AVOIRDUPOIS.

Kilogs.	0	1	2	3	4	5	6	7	8	9
0		2.2046	4.4092	6.6139	8.8185	11.0231	13.2277	15.4323	17.6370	19.8416
10	22.0462	24.2508	26.4554	28.6601	30.8647	33.0693	35.2739	37.4785	39.6832	41.8878
20	44.0924	46.297	48.502	50.706	52.911	55.116	57.320	59.525	61.729	63.934
30	66.1386	68.343	70.548	72.753	74.957	77.162	79.366	81.571	83.776	85.980
40	88.1848	90.389	92.594	94.799	97.003	99.208	101.413	103.617	105.822	108.026
50	110.231	112.436	114.640	116.845	119.050	121.254	123.459	125.663	127.868	130.073
60	132.277	134.482	136.686	138.891	141.096	143.300	145.505	147.710	149.914	152.119
70	154.323	156.258	158.733	160.937	163.142	165.347	167.551	169.756	171.960	174.165
80	176.370	178.574	180.779	182.984	185.188	187.393	189.597	191.802	194.007	196.211
90	198.416	200.620	202.825	205.030	207.234	209.439	211.644	213.848	216.053	218.258

POUNDS AVOIRDUPOIS.

POUNDS PER SQUARE INCH to KILOGRAMMES PER SQUARE CENTIMETRE.

Lbs. per Sq. Inch.	0	1	2	3	4	5	6	7	8	9
0		.070310	.140619	.210929	.281238	.351548	.421857	.492167	.562476	.632786
10	.7030955	.773405	.843715	.914024	.984334	1.05464	1.12495	1.19526	1.26557	1.33588
20	1.406191	1.47650	1.54681	1.61712	1.68743	1.75774	1.82805	1.89836	1.96867	2.03898
30	2.109286	2.17960	2.24991	2.32022	2.39052	2.46083	2.53114	2.60145	2.67176	2.74207
40	2.812382	2.88269	2.95300	3.02331	3.09362	3.16393	3.23424	3.30455	3.37486	3.44517
50	3.515477	3.58579	3.65610	3.72641	3.79672	3.86703	3.93733	4.00764	4.07795	4.14826
60	4.218573	4.28888	4.35919	4.42950	4.49981	4.57012	4.64043	4.71074	4.78105	4.85136
70	4.921668	4.99198	5.06229	5.13260	5.20291	5.27322	5.34353	5.41384	5.48414	5.55446
80	5.624764	5.69507	5.76538	5.83569	5.90600	5.97631	6.04662	6.11693	6.18724	6.25755
90	6.327859	6.39817	6.46848	6.53879	6.60910	6.67941	6.74972	6.82003	6.89034	6.96065

KILOGRAMMES PER SQUARE CENTIMETRE.

Alter *two* places of decimals for each division of the metre.

KILOGRAMMES PER SQUARE CENTIMETRE to POUNDS PER SQUARE INCH.

Kilogrammes per Sq. Cm.	0	1	2	3	4	5	6	7	8	9
0		14.2228	28.4456	42.6685	56.8913	71.1141	85.3369	99.5597	113.783	128.005
10	142.2282	156.451	170.674	184.897	199.119	213.342	227.565	241.788	256.011	270.234
20	284.4564	298.679	312.902	327.125	341.348	355.571	369.793	384.016	398.239	412.462
30	426.6846	440.907	455.130	469.353	483.576	497.799	512.022	526.244	540.467	554.690
40	568.9128	583.136	597.358	611.581	625.804	640.027	654.250	668.473	682.695	696.918
50	711.1410	725.364	739.587	753.809	768.032	782.255	796.478	810.701	824.924	839.146
60	853.3692	867.592	881.815	896.038	910.260	924.483	938.706	952.929	967.152	981.375
70	995.5974	1009.82	1024.04	1038.27	1052.49	1066.71	1080.93	1095.16	1109.38	1123.60
80	1137.826	1152.05	1166.27	1180.49	1194.72	1208.94	1232.16	1237.39	1251.61	1265.83
90	1280.054	1294.28	1308.50	1322.72	1336.95	1351.17	1365.39	1379.61	1393.84	1408.06

POUNDS PER SQUARE INCH.

Alter *two* places of decimals for each division of the metre.

FOOT-POUNDS to KILOGRAMMETRES.

Foot-lbs.	0	1	2	3	4	5	6	7	8	9
0		.138253	.276505	.414758	.553010	.691263	.829515	.967768	1.10602	1.24427
10	1.382525	1.52078	1.65903	1.79728	1.93554	2.07379	2.21204	2.35029	2.48855	2.62680
20	2.765051	2.90330	3.04156	3.17981	3.31806	3.45631	3.59457	3.73282	3.87107	4.00932
30	4.147576	4.28583	4.42408	4.56233	4.70059	4.83884	4.97709	5.11534	5.25360	5.39185
40	5.530102	5.66835	5.80661	5.94486	6.08311	6.22136	6.35962	6.49787	6.63612	6.77437
50	6.912627	7.05088	7.18913	7.32738	7.46564	7.60389	7.74214	7.88039	8.01865	8.15690
60	8.295152	8.43340	8.57166	8.70991	8.84816	8.98642	9.12467	9.26292	9.40117	9.53943
70	9.677678	9.81593	9.95418	10.0924	10.2307	10.3689	10.5072	10.6454	10.7837	10.9220
80	11.06020	11.1985	11.3367	11.4750	11.6132	11.7515	11.8897	12.0280	12.1662	12.3045
90	12.44273	12.5810	12.7192	12.8575	12.9957	13.1349	13.2722	13.4105	13.5487	13.6870

KILOGRAMMETRES.

KILOGRAMMETRES to FOOT-POUNDS.

Kilogram-metres.	0	1	2	3	4	5	6	7	8	9
0		7.23314	14.4663	21.6994	28.9326	36.1657	43.3988	50.6320	57.8651	65.0983
10	72.33140	79.5645	86.7977	94.0308	101.264	108.497	115.730	122.963	130.197	137.430
20	144.6628	151.896	159.129	166.362	173.595	180.829	188.062	195.295	202.529	209.761
30	216.9942	224.227	231.460	238.694	245.927	253.160	260.393	267.626	274.859	282.092
40	289.3256	296.559	303.792	311.025	318.258	325.491	332.724	339.958	347.191	354.424
50	361.6570	368.890	376.123	383.356	390.590	397.823	405.056	412.289	419.522	426.755
60	433.9884	441.222	448.455	455.688	462.921	470.154	477.387	484.620	491.854	499.087
70	506.3198	513.553	520.786	528.019	535.252	542.486	549.719	556.952	564.185	571.418
80	578.6512	585.884	593.117	600.351	607.584	614.817	622.050	629.283	636.516	643.749
90	650.9826	658.216	665.449	672.682	679.915	687.148	694.381	701.615	708.848	716.081

FOOT-POUNDS.

CUBIC INCHES TO CUBIC CENTIMETRES.

Cu. Ins.	0	1	2	3	4	5	6	7	8	9
0		16.3862	32.7723	49.1585	65.5447	81.9309	98.3171	114.703	131.089	147.476
10	163.8618	180.248	196.634	213.020	229.406	245.793	262.179	278.565	294.951	311.337
20	327.7235	344.110	360.496	376.882	393.268	409.654	426.041	442.427	458.813	475.199
30	491.5853	507.971	524.358	540.744	557.130	573.516	589.902	606.288	622.675	639.061
40	655.4470	671.833	688.219	704.606	720.992	737.378	753.764	770.150	786.536	802.923
50	819.3088	835.695	852.081	868.467	884.853	901.240	917.626	934.012	950.398	966.784
60	983.1705	999.557	1015.94	1032.33	1048.72	1065.10	1081.49	1097.87	1114.26	1130.65
70	1147.032	1163.42	1179.80	1196.19	1212.58	1228.96	1245.35	1261.74	1278.12	1294.51
80	1310.894	1327.28	1343.67	1360.05	1376.44	1392.82	1409.21	1425.60	1441.98	1458.37
90	1474.756	1491.14	1507.53	1523.91	1540.30	1556.69	1573.07	1589.46	1605.85	1622.23
100	1638.62	1655.00	1671.39	1687.78	1704.16	1720.55	1736.94	1753.32	1769.71	1786.09
110	1802.48	1818.87	1835.26	1851.64	1868.02	1884.41	1900.80	1917.18	1933.57	1949.96
120	1966.34	1982.73	1999.11	2015.50	2031.88	2048.27	2064.66	2081.04	2097.43	2113.82
130	2130.20	2146.59	2162.97	2179.36	2195.74	2212.13	2228.52	2244.90	2261.29	2277.68
140	2294.06	2310.45	2326.83	2343.22	2359.60	2375.99	2392.38	2408.76	2425.15	2441.54
150	2457.93	2474.32	2490.70	2507.09	2523.47	2539.86	2556.25	2572.63	2589.02	2605.41
160	2621.79	2638.18	2654.56	2670.95	2687.33	2703.72	2720.11	2736.49	2752.88	2769.27
170	2785.65	2802.04	2818.42	2834.81	2851.19	2867.58	2883.97	2900.35	2916.74	2953.13
180	2949.51	2965.90	2982.28	2998.67	3015.05	3031.44	3047.83	3064.21	3080.60	3096.99
190	3113.37	3128.76	3146.14	3162.53	3178.91	3195.31	3211.69	3228.07	3244.46	3260.85
200	3277.23	3293.62	3310.00	3326.39	3342.77	3359.16	3375.55	3391.93	3408.32	3424.71
210	3441.10	3457.49	3473.87	3490.26	3506.64	3533.03	3539.42	3555.80	3572.19	3588.58
220	3604.96	3621.35	3637.73	3654.12	3670.50	3686.89	3703.28	3719.66	3736.05	2752.44
230	3768.82	3785.21	3801.59	3817.98	3834.36	3850.75	3867.14	3883.52	3899.91	3916.30
240	3932.68	3949.07	3965.45	3981.84	3998.22	4014.61	4031.00	4047.38	4063.77	4080.16
250	4096.54	4112.93	4129.31	4145.70	4162.08	4178.47	4194.86	4211.24	4227.63	4244.02
260	4260.41	4276.80	4293.18	4309.57	4325.95	4342.24	4358.73	4375.11	4391.50	4407.89
270	4424.27	4440.66	4457.04	4473.43	4489.81	4506.20	4522.59	4538.97	4555.36	4571.75
280	4588.13	4604.52	4620.90	4637.29	4653.67	4670.06	4686.45	4702.83	4719.22	4735.61
290	4751.99	4768.38	4784.76	4801.15	4817.53	4833.92	4850.31	4866.69	4883.08	4899.47
300	4915.85	4932.24	4948.62	4965.01	4981.39	4997.78	5014.17	5030.55	5046.94	5063.33
310	5079.71	5096.10	5112.48	5128.87	5145.25	5161.64	5178.03	5194.41	5210.80	5227.19
320	5243.58	5259.97	5276.35	5292.74	5309.12	5325.51	5341.90	5358.28	5374.67	5391.06
330	5407.44	5423.83	5440.21	5456.60	5472.98	5489.37	5505.76	5522.14	5538.53	5554.92
340	5571.30	5587.69	5604.07	5620.46	5636.84	5653.23	5669.62	5686.00	5702.39	5718.78
350	5735.16	5751.55	5767.93	5784.32	5800.70	5817.09	5833.48	5849.86	5866.25	5882.64
360	5899.02	5915.41	5931.79	5948.18	5964.56	5980.95	5997.34	6012.72	6030.11	6046.50
370	6062.88	6079.27	6095.65	6112.04	6128.42	6144.81	6161.20	6177.58	6193.97	6210.36
380	6226.75	6243.14	6259.52	6275.91	6292.29	6308.68	6325.07	6341.45	6357.84	6374.23
390	6390.61	6407.00	6423.38	6439.77	6456.15	6472.54	6488.93	6505.31	6521.70	6538.39
400	6554.47	6570.86	6587.24	6603.63	6620.01	6636.40	6652.79	6669.17	6685.56	6701.95
410	6718.33	6734.72	6751.10	6767.49	6783.87	6800.26	6816.65	6833.03	6849.42	6865.81
420	6882.19	6898.58	6914.96	6931.35	6947.73	6964.12	6980.51	6996.89	7013.28	7029.67
430	7046.06	7062.45	7078.83	7095.22	7111.60	7127.99	7144.38	7160.76	7177.15	7193.54
440	7209.92	7226.31	7242.69	7259.08	7275.46	7291.85	7308.24	7324.62	7341.01	7357.40
450	7373.78	7390.17	7406.55	7422.94	7439.32	7455.71	7472.10	7488.48	7504.87	7521.26
460	7537.64	7554.03	7570.41	7586.80	7603.18	7619.57	7635.96	7652.34	7668.73	7685.12
470	7701.50	7717.89	7734.27	7750.66	7767.04	7783.43	7799.82	7816.20	7832.59	7848.98
480	7865.36	7881.75	7898.13	7914.52	7930.90	7947.29	7963.68	7980.06	7996.45	8012.84
490	8029.23	8045.62	8062.00	8078.39	8094.77	8111.16	8127.55	8143.93	8160.32	8176.71
500	8193.09	8209.48	8225.86	8242.25	8258.63	8275.02	8291.41	8307.79	8324.18	8340.57
510	8556.95	8373.34	8389.72	8406.11	8422.49	8438.88	8455.27	8471.65	8488.04	8504.43
520	8520.81	8537.20	8553.58	8569.97	8586.35	8602.74	8619.13	8635.51	8651.90	8668.29
530	8684.67	8701.06	8717.44	8733.83	8750.21	8766.60	8782.99	8799.37	8815.76	8832.15
540	8848.53	8864.92	8881.30	8897.69	8914.07	8930.46	8946.85	8963.23	8979.62	8996.01
550	9012.40	9028.74	9045.17	9061.56	9077.94	9094.33	9110.72	9127.10	9143.49	9159.88
560	9176.26	9192.65	9209.03	9225.42	9241.80	9258.19	9274.58	9290.96	9507.35	9323.74
570	9340.12	9356.51	9372.89	9389.28	9405.66	9422.05	9438.44	9454.92	9471.21	9487.60
580	9503.98	9520.37	9536.75	9553.14	9569.52	9585.91	9602.30	9618.68	9635.07	9651.46
590	9667.84	9684.23	9701.61	9717.00	9733.38	9749.77	9766.16	9782.54	9798.93	9815.32
600	9831.70	9848.09	9864.47	9880.76	9897.24	9913.63	9930.02	9946.40	9962.79	9979.18
610	9995.57	10011.9	10028.3	10044.7	10061.1	10077.5	10093.9	10110.3	10126.6	10143.0
620	10159.4	10175.8	10192.2	10208.6	10225.9	10241.3	10257.7	10274.1	10290.5	10306.9
630	10323.3	10339.7	10356.1	10372.5	10388.8	10405.2	10431.6	10438.0	10454.4	10470.8
640	10487.2	10503.6	10520.0	10536.4	10552.7	10569.1	10585.5	10601.9	10618.3	10634.7
650	10651.0	10667.4	10683.8	10700.2	10716.5	10732.9	10749.3	10765.7	10782.1	10798.5
660	10814.9	10831.3	10847.7	10864.1	10880.4	10896.8	10913.2	10929.6	10946.0	10962.4
670	10978.7	10995.1	11011.5	11027.9	11044.2	11060.6	11077.0	11093.4	11109.8	11126.2
680	11142.6	11159.0	11175.4	11191.8	11208.1	11224.5	11240.9	11257.3	11273.7	11290.1
690	11306.5	11322.9	11339.3	11355.7	11372.0	11388.4	11404.8	11421.2	11437.6	11454.0

CUBIC INCHES to CUBIC CENTIMETRES (*Continued*).

Cubic Inches.	0	1	2	3	4	5	6	7	8	9
700	11470.3	11486.7	11503.1	11519.5	11535.8	11552.2	11568.5	11585.0	11601.4	11617.8
710	11634.2	11650.6	11667.0	11683.4	11699.7	11716.1	11732.5	11748.9	11765.3	11781.7
720	11798.0	11814.4	11830.8	11847.2	11863.5	11879.9	11896.3	11912.7	11929.1	11945.5
730	11961.9	11978.3	11994.7	12011.1	12027.4	12043.8	12060.2	12076.6	12093.0	12109.4
740	12125.8	12142.2	12158.6	12175.0	12191.3	12207.7	12224.1	12240.5	12256.9	12273.3
750	12289.6	12306.0	12322.4	12338.8	12355.1	12371.5	12387.9	12404.3	12420.7	12437.1
760	12453.5	12469.9	12486.3	12502.7	12519.0	12535.4	12551.8	12568.2	12584.6	12601.0
770	12617.4	12633.8	12650.2	12666.6	12682.9	12699.3	12715.7	12732.1	12748.5	12764.9
780	12781.2	12797.6	12814.0	12830.4	12846.7	12863.1	12879.5	12895.9	12912.3	12928.7
790	12945.1	12961.5	12977.9	12994.3	13010.6	13027.0	13043.4	13059.8	13076.2	13092.6
800	13108.9	13125.3	13141.7	13158.1	13174.4	13190.8	13207.2	13223.6	13240.0	13256.4
810	13272.8	13289.2	13305.6	13322.0	13338.3	13354.7	13371.1	13387.5	13403.9	13420.3
820	13436.7	13453.1	13469.5	13485.9	13502.2	13518.6	13535.0	13551.4	13567.8	13584.2
830	13600.5	13616.9	13633.3	13649.7	13666.0	13682.4	13698.8	13715.2	13731.6	13748.0
840	13764.4	13780.8	13797.2	13813.6	13829.9	13846.3	13862.7	13879.1	13895.5	13911.9
850	13928.2	13944.6	13961.0	13977.4	13993.7	14010.1	14026.5	14042.9	14059.3	14075.7
860	14092.1	14108.5	14124.9	14141.3	14157.6	14174.0	14190.4	14206.8	14223.2	14239.6
870	14256.0	14272.4	14288.8	14305.2	14321.5	14337.9	14354.3	14370.7	14387.1	14403.5
880	14419.8	14436.2	14452.6	14469.0	14485.3	14501.7	14518.1	14534.5	14550.9	14567.3
890	14583.7	14600.1	14616.5	14632.9	14649.2	14665.6	14682.0	14698.4	14714.8	14731.2
900	14747.6	14764.0	14780.4	14796.8	14813.1	14829.5	14845.9	14862.3	14878.7	14895.1
910	14911.4	14927.8	14944.2	14960.6	14976.9	14993.3	15009.7	15026.1	15042.5	15058.9
920	15075.3	15091.7	15108.1	15124.5	15140.8	15157.2	15173.6	15190.0	15206.4	15222.8
930	15239.1	15255.5	15271.9	15288.3	15304.6	15321.0	15337.4	15353.8	15370.2	15386.6
940	15403.0	15419.4	15435.8	15452.2	15468.5	15484.9	15501.3	15517.7	15534.1	15550.5
950	15566.9	15583.3	15599.7	15616.1	15632.4	15648.8	15665.2	15681.6	15698.0	15714.4
960	15730.7	15747.1	15763.5	15779.9	15796.2	15812.6	15829.0	15845.4	15861.8	15878.2
970	15894.6	15911.0	15927.4	15943.8	15960.1	15976.5	15992.9	16009.3	16025.7	16042.1
980	16058.5	16074.9	16091.3	16107.7	16124.0	16140.4	16156.8	16173.2	16189.6	16206.0
990	16222.3	16238.7	16255.1	16271.5	16287.8	16304.2	16320.6	16337.0	16353.4	16369.8

CUBIC CENTIMETRES to CUBIC INCHES.

Cubic Cm.	0	1	2	3	4	5	6	7	8	9
0		.061027	.122054	.183081	.244108	.305135	.366162	.427189	.488216	.549243
10	.6102706	.671298	.732325	.793352	.854379	.915406	.976433	1.03746	1.09849	1.15951
20	1.220541	1.28157	1.34260	1.40362	1.46465	1.52568	1.58670	1.64773	1.70876	1.76978
30	1.830812	1.89184	1.95287	2.01389	2.07492	2.13595	2.19697	2.25800	2.31903	2.38006
40	2.441082	2.50211	2.56314	2.62416	2.68519	2.74622	2.80724	2.86827	2.92930	2.99033
50	3.051353	3.11238	3.17341	3.23443	3.29546	3.35649	3.41752	3.47854	3.53957	3.60060
60	3.661623	3.72265	3.78368	3.84470	3.90573	3.96676	4.02779	4.08881	4.14984	4.21087
70	4.271894	4.33292	4.39395	4.45498	4.51600	4.57703	4.63806	4.69908	4.76011	4.82114
80	4.882164	4.94319	5.00422	5.06525	5.12627	5.18730	5.24833	5.30935	5.37038	5.43141
90	5.492435	5.55346	5.61449	5.67552	5.73654	5.79757	5.85860	5.91962	5.98065	6.04168

GALLONS to LITRES.

Gallons.	0	1	2	3	4	5	6	7	8	9
0		4.54348	9.08696	13.6304	18.1739	22.7174	27.2609	31.8044	36.3478	40.8913
10	45.4348	49.9783	54.5218	59.0652	63.6087	68.1522	72.6957	77.2392	81.7826	86.3261
20	90.8696	95.4131	99.9566	104.500	109.044	113.587	118.130	122.674	127.217	131.761
30	136.3044	140.848	145.391	149.935	154.478	159.022	163.565	168.109	172.652	177.196
40	181.7392	186.283	190.826	195.370	199.913	204.457	209.000	213.544	218.087	222.631
50	227.1740	231.717	236.261	240.804	245.348	249.891	254.435	258.978	263.522	268.065
60	272.6088	277.152	281.696	286.239	290.783	295.326	299.870	304.413	308.957	313.500
70	318.0436	322.587	327.131	331.674	336.218	340.761	345.304	349.848	354.391	358.935
80	363.4784	368.022	372.565	377.109	381.652	386.196	390.739	395.283	399.826	404.370
90	408.9132	413.457	418.000	422.544	427.087	431.631	436.174	440.718	445.261	449.805

LITRES (OR CUBIC DECIMETRES).

Alter *one* decimal point for each division or multiple of the litre, and *three* places for cubic metres.

LITRES to GALLONS.

Litres.	0	1	2	3	4	5	6	7	8	9
0		.220097	.440193	.660290	.880387	1.10048	1.32058	1.54068	1.76077	1.98087
10	2.200967	2.42106	2.64116	2.86126	3.08135	3.30145	3.52155	3.74164	3.96174	4.18184
20	4.401934	4.62203	4.84213	5.06222	5.28232	5.50242	5.72251	5.94261	6.16271	6.38281
30	6.602900	6.82300	7.04309	7.26319	7.48329	7.70338	7.92348	8.14358	8.36367	8.58377
40	8.803867	9.02396	9.24406	9.46416	9.68425	9.90435	10.1244	10.3445	10.5646	10.7847
50	11.00483	11.2249	11.4450	11.6651	11.8852	12.1053	12.3254	12.5455	12.7656	12.9857
60	13.20580	13.4259	13.6460	13.8661	14.0862	14.3063	14.5264	14.7465	14.9666	15.1867
70	15.40677	15.6269	15.8470	16.0671	16.2872	16.5073	16.7273	16.9474	17.1675	17.3876
80	17.60773	17.8278	18.0479	18.2680	18.4881	18.7082	18.9283	19.1484	19.3685	19.5886
90	19.8087	20.0288	20.2489	20.4690	20.6891	20.9092	21.1293	21.3494	21.5695	21.7896

GALLONS.

Alter *one* place of decimals for each division of the litre, and *three* places for cubic metres.

TONS PER SQUARE INCH to KILOGRAMMES PER SQUARE MILLIMETRE.

Tons per Square Inch.	0	1	2	3	4	5	6	7	8	9
0		1.57	3.15	4.72	6.30	7.87	9.45	11.02	12.60	14.17
10	15.75	17.32	18.90	20.47	22.05	23.62	25.20	26.77	28.35	29.92
20	31.50	33.07	34.65	36.23	37.80	39.38	40.95	42.52	44.10	45.67
30	47.25	48.82	50.40	51.97	53.55	55.12	56.70	58.27	59.84	61.42
40	63.00	64.57	66.15	67.72	69.30	70.87	72.45	74.02	75.60	77.17
50	78.75	80.32	81.90	83.47	85.05	86.62	88.20	89.77	91.35	92.92
60	94.50	96.07	97.65	99.22	100.80	102.37	103.95	105.52	107.10	108.67
70	110.25	111.82	113.40	114.97	116.55	118.12	119.70	121.27	122.85	124.42
80	126.00	127.57	129.14	130.72	132.30	133.87	135.45	137.02	138.59	140.15
90	141.75	143.32	144.90	146.47	148.05	149.62	151.20	152.77	154.35	155.92

KILOGRAMMES PER SQUARE MILLIMETRE.

KILOGRAMMES PER SQUARE MILLIMETRE to TONS PER SQUARE INCH.

Kilogrammes per Square Millimetre.	0	1	2	3	4	5	6	7	8	9
0		0.64	1.27	1.90	2.54	3.17	3.81	4.44	5.08	5.71
10	6.35	6.98	7.62	8.25	8.89	9.52	10.16	10.79	11.43	12.06
20	12.70	13.33	13.97	14.60	15.24	15.87	16.51	17.14	17.78	18.41
30	19.05	19.68	20.32	20.95	21.59	22.22	22.86	23.49	24.13	24.76
40	25.40	26.03	26.67	27.30	27.94	28.57	29.21	29.84	30.48	31.11
50	31.75	32.38	33.02	33.65	34.29	34.92	35.56	36.19	36.83	37.46
60	38.10	38.73	39.37	40.00	40.64	41.27	41.91	42.54	43.18	43.81
70	44.45	45.08	45.72	46.35	46.99	47.62	48.26	48.89	49.53	50.16
80	50.80	51.43	52.07	52.70	53.34	53.97	54.60	55.24	55.88	56.51
90	57.15	57.78	58.42	59.05	59.69	60.33	60.96	61.59	62.23	62.86

TONS PER SQUARE INCH.

TONS INTO POUNDS.

Tons.	Pounds.	Tons.	Pounds.	Tons.	Pounds.	Tons.	Pounds.	Tons.	Pounds.
1	2,240	11	24,640	21	47,040	31	69,440	41	91,840
¼	2,800	¼	25,200	¼	47,600	¼	70,000	¼	92,400
½	3,360	½	25,760	½	48,160	½	70,560	½	92,960
¾	3,920	¾	26,320	¾	48,720	¾	71,120	¾	93,520
2	4,480	12	26,880	22	49,280	32	71,680	42	94,080
¼	5,040	¼	27,440	¼	49,840	¼	72,240	¼	94,640
½	5,600	½	28,000	½	50,400	½	72,800	½	95,200
¾	6,160	¾	28,560	¾	50,960	¾	73,360	¾	95,760
3	6,720	13	29,120	23	51,520	33	73,920	43	96,320
¼	7,280	¼	29,680	¼	52,080	¼	74,480	¼	96,880
½	7,840	½	30,240	½	52,640	½	75,040	½	97,440
¾	8,400	¾	30,800	¾	53,200	¾	75,600	¾	98,000
4	8,960	14	31,360	24	53,760	34	76,160	44	98,560
¼	9,520	¼	31,920	¼	54,320	¼	76,720	¼	99,120
½	10,080	½	32,480	½	54,880	½	77,280	½	99,680
¾	10,640	¾	33,040	¾	55,440	¾	77,840	¾	100,240
5	11,200	15	33,600	25	56,000	35	78,400	45	100,800
¼	11,760	¼	34,160	¼	56,5660	¼	78,960	¼	101,360
½	12,320	½	34,720	½	57,120	½	79,520	½	101,920
¾	12,880	¾	35,280	¾	57,680	¾	80,080	¾	102,480
6	13,440	16	35,840	26	58,240	36	80,640	46	103,040
¼	14,000	¼	36,400	¼	58,800	¼	81,200	¼	103,600
½	14,560	½	36,960	½	59,360	½	81,760	½	104,160
¾	15,120	¾	37,520	¾	59,920	¾	82,320	¾	014,720
7	15,680	17	38,080	27	60,480	37	82,880	47	105,280
¼	16,240	¼	38,640	¼	61,040	¼	83,440	¼	105,840
½	16,800	½	39,200	½	61,600	½	84,000	½	106,400
¾	17,360	¾	39,760	¾	62,160	¾	84,560	¾	106,960
8	17,920	18	40,320	28	62,720	38	85,120	48	107,520
¼	18,480	¼	40,880	¼	63,280	¼	85,680	¼	108,080
½	19,040	½	41,440	½	63,840	½	86,240	½	108,640
¾	19,600	¾	42,000	¾	64,400	¾	86,800	¾	109,200
9	20,160	19	42,560	29	64,960	39	87,360	49	109,760
¼	20,720	¼	43,120	¼	65,520	¼	87,920	¼	110,320
½	21,280	½	43,680	½	66,080	½	88,480	½	110,880
¾	21,840	¾	44,240	¾	66,640	¾	89,040	¾	111,440
10	22,400	20	44,800	30	67,200	40	89,600	50	112,000
¼	22,960	¼	45,360	¼	67,760	¼	90,160		
½	23,520	½	45,920	½	68,320	½	90,720		
¾	24,080	¾	46,480	¾	68,880	¾	91,280		

TEMPERATURE—CENTIGRADE AND FAHRENHEIT.

°C.	0	10	20	30	40	50	60	70	80	90
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
—200	—328	—346	—364	—382	—400	—418	—436	—454		
—100	—148	—166	—184	—202	—220	—238	—256	—274	—292	—310
— 0	+ 32	+ 14	— 4	— 22	— 40	— 58	— 76	— 94	—112	—130
0	32	50	68	86	104	122	140	158	176	194
100	212	230	248	266	284	302	320	338	356	374
200	392	410	428	446	464	482	500	518	536	554
300	572	590	608	626	644	662	680	698	716	734
400	752	770	788	806	824	842	860	878	896	914
500	932	950	968	986	1004	1022	1040	1058	1076	1094
600	1112	1130	1148	1166	1184	1202	1220	1238	1256	1274
700	1292	1310	1328	1346	1364	1382	1400	1418	1436	1454
800	1472	1490	1508	1526	1544	1562	1580	1598	1616	1634
900	1652	1670	1688	1706	1724	1742	1760	1778	1796	1814
1000	1832	1850	1868	1886	1904	1922	1940	1958	1976	1994
1100	2012	2030	2048	2066	2084	2102	2120	2138	2156	2174
1200	2192	2210	2228	2246	2264	2282	2300	2318	2336	2354
1300	2372	2390	2408	2426	2444	2462	2480	2498	2516	2534
1400	2552	2570	2588	2606	2624	2642	2660	2678	2696	2714
1500	2732	2750	2768	2786	2804	2822	2840	2858	2876	2894
1600	2912	2930	2948	2966	2984	3002	3020	3038	3056	3074
1700	3092	3110	3128	3146	3164	3182	3200	3218	3236	3254
1800	3272	3290	3308	3326	3344	3362	3380	3398	3416	3434
1900	3452	3470	3488	3506	3524	3542	3560	3578	3596	3614
2000	3632	3650	3668	3686	3704	3722	3740	3758	3776	3794
2100	3812	3830	3848	3866	3884	3902	3920	3938	3956	3974
2200	3992	4010	4028	4046	4064	4082	4100	4118	4136	4154
2300	4172	4190	4208	4226	4244	4262	4280	4298	4316	4334
2400	4352	4370	4388	4406	4424	4442	4460	4478	4496	4514
2500	4532	4550	4568	4586	4604	4622	4640	4658	4676	4694
2600	4712	4730	4748	4766	4784	4802	4820	4838	4856	4874
2700	4892	4910	4928	4946	4964	4982	5000	5018	5036	5054
2800	5072	5090	5108	5126	5144	5162	5180	5198	5216	5234
2900	5252	5270	5288	5306	5324	5342	5360	5378	5396	5414
3000	5432	5450	5468	5486	5504	5522	5540	5558	5576	5594
3100	5612	5630	5648	5666	5684	5702	5720	5738	5756	5774
3200	5792	5810	5828	5846	5864	5882	5900	5918	5936	5954
3300	5972	5990	6008	6026	6044	6062	6080	6098	6116	6134
3400	6152	6170	6188	6206	6224	6242	6260	6278	6296	6314
3500	6332	6350	6368	6386	6404	6422	6440	6458	6476	6494
3600	6512	6530	6548	6566	6584	6602	6620	6638	6656	6674
3700	6692	6710	6728	6746	6764	6782	6800	6818	6836	6854
3800	6872	6890	6908	6926	6944	6962	6980	6998	7016	7034
3900	7052	7070	7088	7106	7124	7142	7160	7178	7196	7214

°C. °F.	°F. °C.
1= 1.8	1= 0.56
2= 3.6	2= 1.11
3= 5.4	3= 1.67
4= 7.2	4= 2.22
5= 9.0	5= 2.78
6=10.8	6= 3.33
7=12.6	7= 3.89
8=14.4	8= 4.44
9=16.2	9= 5.00
10=18.0	10= 5.56
	11= 6.11
	12= 6.67
	13= 7.22
	14= 7.78
	15= 8.33
	16= 8.89
	17= 9.44
	18=10.00

EXAMPLES: 1347° C. = 2444° F. + 12.6° F. = 2456.6° F. 3367° F. = 1850° C. + 2.78° C. = 1852.78° C.

This table is for converting Centigrade to Fahrenheit and *vice versa*. It is based upon the well-known logarithmic tables, and covers the whole range of temperatures from that of liquid air to that of the electric arc. DR. LEONARD WALDO in *Metallurgical and Chemical Engineering*.

SCREW THREADS.

WHITWORTH.

Full diameter.	Number of threads.	Diameter at bottom of threads.	Cross sectional area of bottom threads.
Inches.	Per inch.	Inches.	Sq. inches.
1/4	20	0.1860	0.0272
5/16	18	0.2414	0.0458
3/8	16	0.2950	0.0683
7/16	14	0.3460	0.0940
1/2	12	0.3933	0.1215
9/16	12	0.4558	0.1632
5/8	11	0.5086	0.2032
11/16	11	0.5711	0.2562
3/4	10	0.6219	0.3038
13/16	10	0.6844	0.3679
7/8	9	0.7327	0.4216
1	8	0.8399	0.5540
1 1/8	7	0.9420	0.6969
1 1/4	7	1.0670	0.8942
1 3/8	6	1.1616	1.0597
1 1/2	6	1.2866	1.3001
1 5/8	5	1.3689	1.4718
1 3/4	5	1.4939	1.7528
2	4.5	1.7154	2.3111
2 1/4	4	1.9298	2.9249
2 1/2	4	2.1798	3.7318
2 3/4	3.5	2.3841	4.4641
3	3.5	2.6341	6.4496

$$p = \text{pitch} = \frac{1}{\text{No. of threads per in.}}$$

depth $= p \times 0.64033$

radius $= p \times 0.1373$

Angle of vee $= 55$ degrees.

B.S.F.

Full diameter.	Number of threads.	Diameter at bottom of threads.	Cross sectional area at bottom thread.
Inches.	Per inch.	Inches.	Square inches.
1/4	26	0.2007	0.0316
5/16	26	0.2320	0.0423
3/8	22	0.2543	0.0508
7/16	20	0.3110	0.0760
1/2	18	0.3664	0.1054
9/16	16	0.4200	0.1385
5/8	16	0.4825	0.1828
11/16	14	0.5335	0.2235
3/4	14	0.5960	0.2790
13/16	12	0.6433	0.3250
7/8	12	0.7058	0.3913
15/16	11	0.7586	0.4520
1	11	0.8211	0.5295
1 1/8	10	0.8719	0.5971
1 1/4	9	0.9827	0.7585
1 3/8	9	1.1077	0.9637
1 1/2	8	1.2149	1.1593
1 5/8	8	1.3399	1.4100
1 3/4	8	1.4649	1.6854
1 7/8	7	1.5670	1.9285
2	7	1.6920	2.2485
2 1/8	7	1.8170	2.5930
2 1/4	7	1.9420	2.9620
2 3/8	6	2.0366	3.2576
2 1/2	6	2.1616	3.6698
2 5/8	6	2.2866	4.1065
2 3/4	6	2.4116	4.5677
2 7/8	6	2.5366	5.0535
2 1/4	6	2.6616	5.5639
3	5	2.7439	5.9133

The form and proportions are the same as Whitworth, but No. of threads per in. are greater for a given diameter.

B.A.

Number.	Diameter.		Pitch.		Core diameter. mm.	Cross sectional area at bottom of thread. sq. mm.
	Millimetres.	Inches.	Millimetres.	Inches.		
0	6.0	0.236	1.0	0.0394	4.8	18.10
1	5.3	0.209	0.90	0.0354	4.22	13.99
2	4.7	0.185	0.81	0.0319	3.73	10.93
3	4.1	0.161	0.73	0.0287	3.22	8.14
4	3.6	0.142	0.66	0.0260	2.81	6.20
5	3.2	0.126	0.59	0.0232	2.49	4.87
6	2.8	0.110	0.53	0.0209	2.16	3.66
7	2.5	0.098	0.48	0.0189	1.92	2.89
8	2.2	0.087	0.43	0.0169	1.68	2.22
9	1.9	0.075	0.39	0.0154	1.43	1.61
10	1.7	0.067	0.35	0.0138	1.28	1.29
11	1.5	0.059	0.31	0.0122	1.13	1.00
12	1.3	0.051	0.28	0.0110	0.96	0.72
13	1.2	0.047	0.25	0.0098	0.90	0.64
14	1.0	0.039	0.23	0.0091	0.72	0.41
15	0.90	0.035	0.21	0.0083	0.65	0.33
16	0.79	0.031	0.19	0.0075	0.56	0.25
17	0.70	0.028	0.17	0.0067	0.50	0.20
18	0.62	0.024	0.15	0.0059	0.44	0.15
19	0.54	0.021	0.14	0.0055	0.37	0.11
20	0.48	0.019	0.12	0.0047	0.34	0.091
21	0.42	0.017	0.11	0.0043	0.29	0.066
22	0.37	0.015	0.10	0.0039	0.25	0.049
23	0.33	0.013	0.09	0.0035	0.22	0.038
24	0.29	0.011	0.08	0.0031	0.19	0.028
25	0.25	0.010	0.07	0.0028	0.17	0.023

Depth of thread $= 0.6 \times$ pitch of thread

Radius at top and bottom of thread $= \frac{2 \times \text{pitch}}{11}$

Angle of vee of thread $= 47\frac{1}{2}$ degrees.

S.A.E.

Diameter, Inches.	Pitch.	
	Regular.	Fine.
1/4	28	36
5/16	24	32
3/8	24	32
7/16	20	28
1/2	20	28
9/16	18	24
5/8	18	24
11/16	16	24
3/4	16	20
7/8	14	20
1	14	20
1 1/8	12	18
1 1/4	12	18
1 3/8	12	18
1 1/2	12	18
1 5/8	12	16
1 3/4	12	16
1 7/8	12	16
2	12	16
2 1/8	12	16
2 1/4	12	16
2 3/8	12	16
2 1/2	12	16
2 5/8	12	16
2 3/4	12	16
2 7/8	12	16
3	10	16

All threads shall be U.S. Form.

The maximum screw size equals the nominal or basic screw size for all except wrench fits. In the minimum gauge for internal threads and the maximum gauge for external threads, the profile of the thread shall be such as not to encroach on that of the true U.S. Standard (or Franklin Institute) thread.

The fine pitches for the 1/4 in. to 1 1/2 in. diameters inclusive are for aeronautic practice.

BRITISH STANDARD PIPE THREADS.

(Dimensions in Inches.)

Nominal Bore of Pipe.	Diam. at Top of Thread.	Depth of Thread.	Diam. at Bottom of Thread.	No. of Threads per Inch.	Nominal Bore of Pipe.	Diam. at Top of Thread.	Depth of Thread.	Diam. at Bottom of Thread.	No. of Threads per Inch.
1/8	.383	.023	.337	28	2 1/4	2.587	.058	2.471	11
1/4	.518	.0335	.451	19	2 1/2	2.960	.058	2.844	11
3/8	.656	.0335	.589	19	2 3/4	3.210	.058	3.094	11
1/2	.825	.0455	.734	14	3	3.460	.058	3.344	11
5/8	.902	.0455	.811	14	3 1/4	3.700	.058	3.584	11
3/4	1.041	.0455	.950	14	3 1/2	3.950	.058	3.834	11
7/8	1.189	.0455	1.098	14	3 3/4	4.200	.058	4.084	11
1	1.309	.058	1.193	11	4	4.450	.058	4.334	11
1 1/4	1.650	.058	1.534	11	4 1/2	4.950	.058	4.834	11
1 1/2	1.882	.058	1.766	11	5	5.450	.058	5.334	11
1 3/4	2.116	.058	2.000	11	5 1/2	5.950	.058	5.834	11
2	2.347	.058	2.231	11	6	6.450	.058	6.334	11

METRIC INTERNATIONAL STANDARD THREAD.

Size in mm.	Pitch in mm.	Size of Hole for Tapping in Inches.	Size in mm.	Pitch in mm.	Size of Hole for Tapping in Inches.
6	1	5/16	12	1.75	25/64
7	1	17/64	14	2	29/64
8	1.25	1/4	16	2	17/32
9	1.25	19/64	18	2.5	5/8
10	1.5	21/64	20	2.5	21/32
11	1.5	3/8			

WIRE PLATE AND TUBE WALL GAUGES.

Standard Wire Gauge.	Equiv. Diam. in.	Equiv. Diam. mm.	B'ham Wire Gauge.	Standard Wire Gauge.	Equiv. Diam. in.	Equiv. Diam. mm.	B'ham Wire Gauge.	Standard Wire Gauge.	Equiv. Diam. in.	Equiv. Diam. mm.	B'ham Wire Gauge.
7/0	.500	12.699	—	9	.144	3.657	—	24	.022	.5585	24
6/0	.464	11.785	—	—	.134	3.403	10	25	.020	.5078	25
—	.454	11.531	0000	10	.128	3.251	—	26	.018	.4570	26
5/0	.432	10.972	—	—	.120	3.047	11	27	.0164	.4166	27
—	.425	10.794	000	11	.116	2.946	—	28	.0148	.3759	28
0000	.400	10.159	—	—	.109	2.768	12	29	.0136	.3454	29
—	.380	9.651	00	12	.104	2.641	—	30	.0124	.3150	30
000	.372	9.448	—	—	.095	2.412	13	31	.0116	.2946	—
00	.348	8.839	—	13	.092	2.336	—	32	.0108	.2743	—
—	.340	8.635	0	—	.083	2.108	14	33	.0105	.2539	31
0	.324	8.229	—	14	.080	2.032	—	34	.0092	.2337	32
1	.300	7.620	1	15	.072	1.828	15	35	.0084	.2134	33
—	.284	7.213	2	—	.065	1.650	16	36	.0076	.1930	34
2	.276	7.010	—	16	.064	1.625	—	37	.0068	.1727	—
—	.259	6.578	3	—	.058	1.472	17	38	.006	.1523	—
3	.252	6.400	—	17	.056	1.421	—	39	.0052	.1320	35
—	.238	6.045	4	—	.049	1.244	18	40	.0048	.1219	—
4	.232	5.892	—	18	.048	1.218	—	41	.0044	.1116	—
—	.220	5.588	5	—	.042	1.066	19	42	.004	.1015	36
5	.212	5.384	—	19	.040	1.016	—	43	.0036	.0914	—
—	.203	5.156	6	20	.036	.9140	—	44	.0032	.0813	—
6	.192	4.877	—	—	.035	.8886	20	45	.0028	.0713	—
—	.180	4.571	7	21	.032	.8124	21	46	.0024	.0610	—
7	.176	4.470	—	—	—	—	—	47	.002	.0507	—
—	.165	4.191	8	22	.028	.7109	22	48	.0016	.0406	—
8	.160	4.064	—	—	.025	.6347	23	49	.0012	.0305	—
—	.148	3.759	9	23	.024	.6093	—	50	.001	.0253	—

MILD STEEL TUBING.

Weight in Lb. per Lineal Foot (based on weight of 1 cubic inch of steel = 0.2833 lb.).

Outside Diam. in Inches.	Thickness in Gauge and Fractions of an Inch.																
	22 B.W.G.	20 B.W.G.	18 B.W.G.	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8	1/2	5/8	3/4	7/8	1
1/2	.141	.174	.236	.292	.407	.501	—	—	—	—	—	—	—	—	—	—	—
5/8	.179	.221	.301	.375	.532	.668	—	—	—	—	—	—	—	—	—	—	—
3/4	.216	.267	.367	.459	.657	.834	.991	1.13	—	—	—	—	—	—	—	—	—
7/8	.253	.314	.432	.542	.782	1.00	1.20	1.38	1.53	—	—	—	—	—	—	—	—
1	.291	.361	.498	.626	.907	1.17	1.41	1.63	1.83	2.00	—	—	—	—	—	—	—
1 1/8	.328	.407	.563	.709	1.03	1.34	1.62	1.88	2.12	2.34	—	—	—	—	—	—	—
1 1/4	.365	.454	.629	.793	1.16	1.50	1.83	2.13	2.41	2.67	3.13	3.50	—	—	—	—	—
1 3/8	—	.501	.694	.876	1.28	1.67	2.03	2.38	2.70	3.00	3.55	4.01	—	—	—	—	—
1 1/2	—	.548	.759	.960	1.41	1.84	2.24	2.63	2.99	3.34	3.96	4.51	5.34	—	—	—	—
1 3/4	—	—	—	1.13	1.66	2.17	2.66	3.13	3.58	4.01	4.80	5.51	6.68	—	—	—	—
2	—	—	—	1.29	1.91	2.50	3.08	3.63	4.16	4.67	5.63	6.51	8.01	9.18	—	—	—
2 1/4	—	—	—	1.46	2.16	2.84	3.49	4.13	4.75	5.34	6.47	7.51	9.35	10.85	—	—	—
2 1/2	—	—	—	1.63	2.41	3.17	3.91	4.63	5.33	6.01	7.30	8.51	10.68	12.52	—	—	—
2 3/4	—	—	—	1.79	2.66	3.50	4.33	5.13	5.91	6.68	8.14	9.51	12.02	14.18	—	—	—
3	—	—	—	—	2.91	3.84	4.75	5.63	6.50	7.34	8.97	10.51	13.35	15.85	18.02	19.86	21.36
3 1/4	—	—	—	—	3.16	4.17	5.16	6.13	7.08	8.01	9.80	11.51	14.69	17.52	20.03	22.19	24.03
3 1/2	—	—	—	—	3.41	4.51	5.58	6.63	7.67	8.68	10.64	12.52	16.02	19.19	22.03	24.53	26.70
3 3/4	—	—	—	—	—	4.84	6.00	7.13	8.25	9.35	11.47	13.52	17.36	20.86	24.03	26.87	29.37
4	—	—	—	—	—	5.17	6.41	7.63	8.83	10.01	12.31	14.52	18.69	22.53	26.03	29.20	32.04
4 1/4	—	—	—	—	—	—	6.83	8.14	9.42	10.68	13.14	15.22	20.03	24.20	28.04	31.54	34.71
4 1/2	—	—	—	—	—	—	7.25	8.64	10.00	11.35	13.98	16.52	21.36	25.87	30.04	33.88	37.38
4 3/4	—	—	—	—	—	—	7.67	9.14	10.59	12.02	14.81	17.52	22.70	27.53	32.04	36.21	40.05
5	—	—	—	—	—	—	8.08	9.64	11.17	12.68	15.64	18.52	24.03	29.20	34.04	38.55	42.72
5 1/4	—	—	—	—	—	—	8.50	10.14	11.75	13.35	16.48	19.52	25.37	30.87	36.05	40.88	45.39
5 1/2	—	—	—	—	—	—	8.92	10.64	12.34	14.02	17.31	20.53	26.70	32.54	38.05	43.22	48.06
5 3/4	—	—	—	—	—	—	9.33	11.14	12.92	14.69	18.15	21.53	28.04	34.21	40.05	45.56	50.73
6	—	—	—	—	—	—	9.75	11.64	13.51	15.35	18.98	22.53	29.37	35.88	42.05	47.89	53.40

MILD STEEL TUBING (*Continued*).

Moment of Inertia, "I," for Neutral Axis through Centre of Section.

Outside Diam. in Inches.	Thickness in Gauge and Fractions of an Inch.																
	22 B.W.G.	20 B.W.G.	18 B.W.G.	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8	1/2	5/8	3/4	7/8	1
1/2	.00116	.00139	.00179	.00210	.00260	.00288	—	—	—	—	—	—	—	—	—	—	—
5/8	.00234	.00283	.00370	.00442	.00569	.00652	—	—	—	—	—	—	—	—	—	—	—
3/4	.00414	.00504	.00666	.00804	.01062	.01246	.01373	.01456	—	—	—	—	—	—	—	—	—
7/8	.00669	.00816	.01088	.01324	.01781	.02128	.02386	.02571	.02698	—	—	—	—	—	—	—	—
1	.01011	.01237	.01659	.02031	.02769	.03356	.03812	.04160	.04417	.04602	—	—	—	—	—	—	—
1 1/8	.01453	.01782	.02402	.02954	.04071	.04985	.05724	.06310	.06766	.07114	—	—	—	—	—	—	—
1 1/4	.02008	.02467	.03339	.04121	.05728	.07075	.08192	.09107	.09845	.1043	.1124	.1168	—	—	—	—	—
1 3/8	—	.03309	.04493	.05562	.07785	.09683	.1129	.1264	.1375	.1467	.1599	.1680	—	—	—	—	—
1 1/2	—	.04324	.05885	.07304	.1028	.1287	.1509	.1699	.1859	.1994	.2197	.2330	.2454	—	—	—	—
1 3/4	—	—	—	.1181	.1678	.2119	.2508	.2849	.3147	.3405	.3818	.4113	.4449	—	—	—	—
2	—	—	—	.1787	.2556	.3250	.3873	.4431	.4928	.5369	.6099	.6656	.7363	.7699	—	—	—
2 1/4	—	—	—	.2571	.3698	.4727	.5663	.6514	.7283	.7978	.9158	1.010	1.138	1.209	—	—	—
2 1/2	—	—	—	.3557	.5137	.6594	.7935	.9165	1.029	1.132	1.311	1.457	1.669	1.798	—	—	—
2 3/4	—	—	—	.4767	.6909	.8899	1.075	1.246	1.404	1.549	1.806	2.022	2.347	2.559	—	—	—
3	—	—	—	—	.9047	1.169	1.415	1.645	1.860	2.059	2.414	2.718	3.191	3.516	3.728	3.856	3.927
3 1/4	—	—	—	—	1.159	1.500	1.822	2.123	2.405	2.669	3.146	3.559	4.218	4.691	5.016	5.228	5.357
3 1/2	—	—	—	—	1.456	1.890	2.299	2.685	3.048	3.390	4.013	4.559	5.449	6.108	6.581	6.906	7.118
3 3/4	—	—	—	—	—	2.341	2.853	3.338	3.797	4.231	5.026	5.731	6.900	7.790	8.449	8.922	9.247
4	—	—	—	—	—	2.859	3.490	4.092	4.660	5.202	6.197	7.090	8.590	9.759	10.65	11.31	11.78
4 1/4	—	—	—	—	—	—	4.216	4.947	5.644	6.308	7.539	8.649	10.54	12.04	13.21	14.10	14.76
4 1/2	—	—	—	—	—	—	5.035	5.917	6.759	7.563	9.061	10.42	12.76	14.65	16.15	17.32	18.21
4 3/4	—	—	—	—	—	—	5.955	7.005	8.011	8.974	10.78	12.42	15.28	17.62	19.51	21.01	22.18
5	—	—	—	—	—	—	6.980	8.219	9.409	10.55	12.70	14.66	18.11	20.97	23.31	25.20	26.70
5 1/4	—	—	—	—	—	—	8.117	9.566	10.96	12.30	14.83	17.16	21.27	24.72	27.58	29.92	31.81
5 1/2	—	—	—	—	—	—	9.371	11.05	12.68	14.24	17.19	19.93	24.79	28.90	32.35	35.21	37.55
5 3/4	—	—	—	—	—	—	10.75	12.69	14.56	16.37	19.79	22.98	28.67	33.53	37.64	41.09	43.95
6	—	—	—	—	—	—	12.26	14.48	16.63	18.70	22.65	26.33	32.94	38.63	43.49	47.60	51.05

MILD STEEL TUBING (*Continued*).

Section Modulus, "Z," for Neutral Axis through Centre of Section.

Outside Diam. in Inches.	Thickness in Gauge and Fractions of an Inch.																
	22 B.W.G.	20 B.W.G.	18 B.W.G.	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8	1/2	5/8	3/4	7/8	1
1/2	.00461	.00556	.00714	.00839	.01040	.0115	—	—	—	—	—	—	—	—	—	—	—
5/8	.00750	.00906	.0119	.0142	.0182	.0209	—	—	—	—	—	—	—	—	—	—	—
3/4	.0111	.0134	.0178	.0214	.0283	.0332	.0366	.0388	—	—	—	—	—	—	—	—	—
7/8	.0153	.0187	.0249	.0303	.0407	.0486	.0545	.0588	.0617	—	—	—	—	—	—	—	—
1	.0202	.0247	.0332	.0406	.0554	.0671	.0762	.0832	.0883	.0920	—	—	—	—	—	—	—
1 1/8	.0258	.0317	.0427	.0525	.0724	.0886	.1018	.1122	.1203	.1265	—	—	—	—	—	—	—
1 1/4	.0321	.0395	.0534	.0659	.0917	.1132	.1311	.1457	.1575	.1669	.1798	.1869	—	—	—	—	—
1 3/8	—	.0481	.0653	.0809	.1132	.1408	.1642	.1838	.2001	.2134	.2326	.2443	—	—	—	—	—
1 1/2	—	.0577	.0785	.0974	.1371	.1716	.2012	.2265	.2479	.2659	.2930	.3106	.3272	—	—	—	—
1 3/4	—	—	—	.1350	.1918	.2422	.2866	.3256	.3597	.3892	.4363	.4701	.5084	—	—	—	—
2	—	—	—	.1787	.2556	.3250	.3873	.4431	.4928	.5369	.6099	.6656	.7363	.7699	—	—	—
2 1/4	—	—	—	.2286	.3287	.4201	.5034	.5790	.6474	.7090	.8140	.8974	1.012	1.075	—	—	—
2 1/2	—	—	—	.2845	.4110	.5275	.6348	.7332	.8234	.9057	1.049	1.166	1.335	1.438	—	—	—
2 3/4	—	—	—	.3467	.5024	.6472	.7815	.9059	1.021	1.127	1.314	1.471	1.707	1.861	—	—	—
3	—	—	—	—	.6031	.7791	.9436	1.097	1.240	1.372	1.610	1.812	2.127	2.344	2.485	2.571	2.618
3 1/4	—	—	—	—	.7130	.9233	1.121	1.306	1.480	1.643	1.936	2.190	2.596	2.887	3.087	3.217	3.295
3 1/2	—	—	—	—	.8321	1.080	1.314	1.534	1.742	1.937	2.293	2.605	3.114	3.490	3.760	3.946	4.067
3 3/4	—	—	—	—	—	1.249	1.522	1.780	2.025	2.256	2.680	3.057	3.680	4.155	4.506	4.758	4.932
4	—	—	—	—	—	1.430	1.745	2.046	2.330	2.600	3.099	3.545	4.295	4.880	5.324	5.654	5.891
4 1/4	—	—	—	—	—	—	1.984	2.328	2.656	2.968	3.548	4.070	4.959	5.665	6.215	6.634	6.944
4 1/2	—	—	—	—	—	—	2.238	2.630	3.004	3.361	4.027	4.632	5.672	6.512	7.179	7.698	8.094
4 3/4	—	—	—	—	—	—	2.507	2.949	3.373	3.778	4.537	5.230	6.434	7.420	8.216	8.847	9.340
5	—	—	—	—	—	—	2.792	3.288	3.764	4.220	5.078	5.866	7.245	8.389	9.325	10.081	10.681
5 1/4	—	—	—	—	—	—	3.092	3.644	4.176	4.687	5.650	6.538	8.105	9.419	10.508	11.400	12.120
5 1/2	—	—	—	—	—	—	3.408	4.019	4.609	5.178	6.252	7.247	9.014	10.510	11.764	12.804	13.655
5 3/4	—	—	—	—	—	—	3.738	4.413	5.064	5.693	6.885	7.993	9.972	11.663	13.094	14.293	15.288
6	—	—	—	—	—	—	4.085	4.825	5.541	6.233	7.549	8.775	10.979	12.876	14.496	15.867	17.017

MILD STEEL TUBING (*Continued*).

Radius of Gyration, "R," for Neutral Axis through Centre of Section.

Outside Diam. in Inches.	Thickness in Gauge and Fractions of an Inch.																
	22 B.W.G.	20 B.W.G.	18 B.W.G.	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8	1/2	5/8	3/4	7/8	1
1/2	.1672	.1649	.1604	.1563	.1474	.1398	—	—	—	—	—	—	—	—	—	—	—
5/8	.2113	.2090	.2044	.2001	.1907	.1822	—	—	—	—	—	—	—	—	—	—	—
3/4	.2555	.2531	.2484	.2441	.2344	.2253	.2171	.2096	—	—	—	—	—	—	—	—	—
7/8	.2996	.2972	.2925	.2881	.2782	.2688	.2601	.2519	.2446	—	—	—	—	—	—	—	—
1	.3438	.3414	.3367	.3322	.3221	.3125	.3034	.2948	.2868	.2795	—	—	—	—	—	—	—
1 1/8	.3880	.3856	.3808	.3763	.3661	.3563	.3469	.3380	.3296	.3217	—	—	—	—	—	—	—
1 1/4	.4322	.4297	.4250	.4204	.4101	.4002	.3906	.3815	.3727	.3644	.3494	.3366	—	—	—	—	—
1 3/8	—	.4739	.4691	.4646	.4542	.4441	.4344	.4250	.4160	.4075	.3916	.3776	—	—	—	—	—
1 1/2	—	.5181	.5133	.5087	.4983	.4881	.4783	.4688	.4595	.4507	.4341	.4193	.3953	—	—	—	—
1 3/4	—	—	—	.5970	.5865	.5762	.5662	.5564	.5469	.5376	.5201	.5039	.4760	—	—	—	—
2	—	—	—	.6854	.6748	.6644	.6542	.6442	.6345	.6250	.6068	.5896	.5590	.5340	—	—	—
2 1/4	—	—	—	.7737	.7631	.7526	.7423	.7322	.7223	.7126	.6939	.6760	.6435	.6156	—	—	—
2 1/2	—	—	—	.8621	.8513	.8409	.8305	.8203	.8102	.8004	.7813	.7629	.7289	.6988	—	—	—
2 3/4	—	—	—	.9504	.9397	.9291	.9187	.9084	.8983	.8883	.8688	.8501	.8149	.7831	—	—	—
3	—	—	—	—	1.028	1.017	1.007	.9966	.9864	.9763	.9566	.9375	.9014	.8683	.8385	.8125	.7906
3 1/4	—	—	—	—	1.116	1.106	1.095	1.085	1.074	1.064	1.044	1.025	.9882	.9540	.9228	.8949	.8705
3 1/2	—	—	—	—	1.205	1.194	1.183	1.173	1.163	1.152	1.132	1.113	1.075	1.040	1.008	.9783	.9520
3 3/4	—	—	—	—	—	1.282	1.272	1.261	1.251	1.241	1.220	1.201	1.163	1.127	1.093	1.063	1.035
4	—	—	—	—	—	1.371	1.360	1.350	1.339	1.329	1.308	1.288	1.250	1.214	1.179	1.147	1.118
4 1/4	—	—	—	—	—	—	1.448	1.438	1.427	1.417	1.396	1.376	1.338	1.301	1.266	1.233	1.202
4 1/2	—	—	—	—	—	—	1.537	1.526	1.516	1.505	1.485	1.464	1.425	1.388	1.352	1.318	1.287
4 3/4	—	—	—	—	—	—	1.625	1.614	1.604	1.593	1.573	1.552	1.513	1.475	1.439	1.405	1.372
5	—	—	—	—	—	—	1.713	1.703	1.692	1.682	1.661	1.641	1.601	1.563	1.526	1.491	1.458
5 1/4	—	—	—	—	—	—	1.802	1.791	1.780	1.770	1.749	1.729	1.689	1.650	1.613	1.577	1.544
5 1/2	—	—	—	—	—	—	1.890	1.879	1.869	1.858	1.837	1.817	1.777	1.738	1.700	1.664	1.630
5 3/4	—	—	—	—	—	—	1.979	1.968	1.957	1.947	1.926	1.905	1.865	1.825	1.788	1.751	1.716
6	—	—	—	—	—	—	2.067	2.056	2.045	2.035	2.014	1.993	1.953	1.913	1.875	1.838	1.803

MILD STEEL TUBING (*Continued*).

Sectional Areas and Weights. Imperial Standard Wire Gauge.

External Diam. of Tube.	Gauge No. 6, 0.192in.		Gauge No. 7, 0.176in.		Gauge No. 8, 0.160in.		Gauge No. 9, 0.144in.		Gauge No. 10, 0.128in.		Gauge No. 11, 0.116in.		Gauge No. 12, 0.104in.		Gauge No. 13, 0.092in.	
	Weight, lb. per ft.	Area, sq. in.	Weight, lb. per ft.	Area, sq. in.	Weight. lb. per ft.	Area, sq. in.	Weight lb. per ft.	Area, sq. in.	Weight, lb. per ft.	Area, sq. in.	Weight, lb. per ft.	Area, sq. in.	Weight, lb. per ft.	Area, sq. in.	Weight, lb. per ft.	Area, sq. in.
1/4"	—	—	—	—	—	—	—	—	—	—	.166	.04882	.162	.04771	.155	.04567
9/32"	—	—	—	—	—	—	—	—	.210	.06162	.205	.06021	.197	.05792	.186	.05470
5/16"	—	—	—	—	—	—	.259	.07623	.252	.07419	.243	.07160	.232	.06813	.217	.06373
3/8"	—	—	.374	.1100	.368	.1081	.355	.1045	.338	.09932	.321	.09438	.301	.08855	.278	.08180
7/16"	.504	.1481	.492	.1446	.474	.1395	.452	.1328	.423	.1245	.398	.1172	.371	.1090	.340	.09986
1/2"	.632	.1858	.609	.1791	.581	.1709	.548	.1611	.509	.1496	.476	.1399	.440	.1294	.401	.1179
9/16"	.760	.2235	.727	.2137	.688	.2023	.644	.1893	.594	.1747	.553	.1627	.509	.1498	.462	.1360
5/8"	.888	.2612	.844	.2483	.795	.2337	.740	.2176	.680	.1999	.631	.1855	.579	.1702	.524	.1541
11/16"	1.016	.2989	.962	.2828	.902	.2652	.836	.2459	.765	.2250	.708	.2083	.648	.1906	.585	.1721
3/4"	1.144	.3366	1.079	.3174	1.008	.2966	.932	.2742	.850	.2501	.785	.2310	.718	.2111	.647	.1902
13/16"	1.273	.3743	1.196	.3519	1.115	.3280	1.028	.3024	.936	.2753	.863	.2538	.787	.2315	.708	.2082
7/8"	1.401	.4120	1.314	.3865	1.222	.3594	1.124	.3307	1.021	.3004	.940	.2766	.856	.2519	.769	.2263
15/16"	1.529	.4497	1.431	.4210	1.329	.3908	1.221	.3590	1.107	.3255	1.018	.2994	.926	.2723	.831	.2444
1"	1.657	.4874	1.549	.4556	1.435	.4222	1.316	.3872	1.192	.3507	1.095	.3221	.995	.2927	.892	.2624
1 1/16"	1.785	.5251	1.667	.4902	1.542	.4536	1.413	.4155	1.278	.3758	1.173	.3449	1.065	.3132	.954	.2805
1 1/8"	1.914	.5628	1.784	.5247	1.649	.4851	1.509	.4438	1.363	.4009	1.250	.3677	1.134	.3336	1.015	.2986
1 3/16"	2.042	.6005	1.902	.5593	1.756	.5165	1.605	.4721	1.448	.4260	1.328	.3905	1.204	.3540	1.076	.3166
1 1/4"	2.170	.6382	2.019	.5938	1.863	.5479	1.701	.5003	1.534	.4512	1.405	.4133	1.273	.3744	1.138	.3347
1 5/16"	2.298	.6759	2.137	.6284	1.970	.5793	1.797	.5286	1.619	.4763	1.482	.4360	1.342	.3948	1.200	.3528
1 3/8"	2.426	.7136	2.254	.6630	2.076	.6107	1.893	.5569	1.705	.5014	1.560	.4588	1.412	.4153	1.261	.3708
1 7/16"	2.554	.7513	2.372	.6975	2.183	.6421	1.990	.5852	1.790	.5266	1.637	.4816	1.481	.4357	1.322	.3889
1 1/2"	2.683	.7890	2.489	.7321	2.290	.6736	2.086	.6134	1.876	.5517	1.715	.5044	1.551	.4561	1.384	.4070
1 9/16"	2.811	.8267	2.606	.7666	2.397	.7050	2.182	.6417	1.961	.5768	1.792	.5271	1.620	.4765	1.445	.4250
1 5/8"	2.939	.8644	2.724	.8012	2.504	.7364	2.278	.6700	2.047	.6020	1.870	.5499	1.689	.4969	1.507	.4431
1 11/16"	3.067	.9021	2.841	.8357	2.611	.7678	2.374	.6983	2.132	.6271	1.947	.5727	1.759	.5174	1.568	.4611
1 3/4"	3.195	.9398	2.959	.8703	2.717	.7992	2.470	.7265	2.217	.6522	2.025	.5955	1.829	.5378	1.629	.4792
1 13/16"	3.324	.9775	3.077	.9049	2.824	.8306	2.566	.7548	2.303	.6774	2.102	.6182	1.898	.5582	1.691	.4973
1 7/8"	3.451	1.015	3.194	.9394	2.931	.8621	2.663	.7831	2.389	.7025	2.179	.6410	1.967	.5786	1.752	.5153
1 15/16"	3.580	1.053	3.312	.9740	3.038	.8935	2.759	.8114	2.474	.7276	2.257	.6638	2.037	.5990	1.814	.5334
2"	3.709	1.091	3.431	1.009	3.145	.9249	2.855	.8396	2.560	.7528	2.334	.6866	2.106	.6195	1.875	.5515
2 1/16"	3.835	1.128	3.546	1.043	3.251	.9563	2.951	.8679	2.645	.7779	2.412	.7094	2.176	.6399	1.936	.5695
2 1/8"	3.964	1.166	3.665	1.078	3.358	.9877	3.047	.8962	2.730	.8030	2.489	.7321	2.245	.6603	1.998	.5876
2 3/16"	4.094	1.204	3.781	1.112	3.465	1.019	3.143	.9245	2.816	.8282	2.567	.7549	2.314	.6807	2.059	.6057
2 1/4"	4.219	1.241	3.900	1.147	3.573	1.051	3.239	.9527	2.901	.8533	2.644	.7777	2.384	.7011	2.121	.6237
2 5/16"	4.349	1.279	4.015	1.181	3.679	1.082	3.335	.9810	2.987	.8784	2.722	.8005	3.453	.7216	2.182	.6418
2 3/8"	4.478	1.317	4.134	1.216	3.784	1.113	3.431	1.009	3.072	.9036	2.799	.8232	2.523	.7420	2.243	.6598
2 7/16"	4.604	1.354	4.250	1.250	3.893	1.145	3.529	1.038	3.158	.9287	2.876	.8460	2.592	.7624	2.305	.6779
2 1/2"	4.733	1.392	4.369	1.285	3.998	1.176	3.624	1.066	3.243	.9538	2.954	.8688	2.662	.7828	2.366	.6960

MILD STEEL TUBING (*Continued*).

Sectional Areas and Weights. Imperial Standard Wire Gauge.

External Diam. of Tube.	Gauge No. 14, 0.080in.		Gauge No. 15, 0.072in.		Gauge No. 16, 0.064in.		Gauge No. 17, 0.056in.		Gauge No. 18, 0.048in.		Gauge No. 19, 0.040in.		Gauge No. 20, 0.036in.		Gauge No. 21, 0.032in.	
	Weight, lb. per ft.	Area, sq. in.	Weight, lb. per ft.	Area, sq. in.	Weight, lb. per ft.	Area, sq. in.	Weight lb. per ft.	Area, sq. in.	Weight, lb. per ft.	Area, sq. in.	Weight, lb. per ft.	Area, sq. in.	Weight, lb. per ft.	Area, sq. in.	Weight, lb. per ft.	Area, sq. in.
1/4"	.145	.04272	.137	.04026	.127	.03740	.116	.03414	.104	.03046	.090	.02639	.082	.04240	.075	.02192
5/16"	.172	.05058	.161	.04733	.149	.04369	.135	.03964	.120	.03517	.103	.03032	.094	.02774	.085	.02506
3/8"	.199	.05843	.185	.05440	.170	.04997	.153	.04514	.136	.03988	.116	.03424	.106	.03127	.096	.02820
7/16"	.252	.07414	.233	.06854	.213	.06253	.191	.05613	.168	.04931	.143	.04210	.130	.03834	.117	.03449
1/2"	.305	.08985	.281	.08267	.255	.07510	.228	.06713	.200	.05873	.170	.04995	.154	.04541	.139	.04077
9/16"	.359	.1056	.329	.09681	.298	.08767	.266	.07812	.232	.06816	.197	.05781	.178	.05248	.160	.04705
5/8"	.412	.1213	.377	.1109	.341	.1002	.303	.08912	.264	.07758	.223	.06566	.202	.05955	.181	.05334
11/16"	.466	.1370	.425	.1251	.384	.1128	.340	.1001	.296	.08701	.250	.07351	.226	.06661	.203	.05962
3/4"	.519	.1527	.473	.1392	.426	.1254	.378	.1111	.328	.09643	.277	.08137	.251	.07368	.224	.06590
13/16"	.573	.1684	.522	.1534	.469	.1379	.415	.1221	.360	.1059	.303	.08922	.275	.08075	.245	.07218
7/8"	.626	.1841	.570	.1675	.512	.1505	.453	.1331	.392	.1153	.330	.09708	.299	.08782	.267	.07847
15/16"	.679	.1998	.617	.1816	.555	.1631	.490	.1441	.424	.1247	.357	.1049	.323	.09489	.288	.08475
1"	.733	.2155	.666	.1958	.597	.1756	.527	.1551	.456	.1341	.384	.1128	.347	.1020	.310	.09103
1 1/16"	.786	.2312	.714	.2099	.640	.1882	.565	.1661	.488	.1436	.410	.1206	.371	.1090	.331	.09732
1 1/8"	.839	.2469	.762	.2240	.683	.2008	.602	.1771	.520	.1530	.437	.1285	.395	.1161	.352	.1036
1 3/16"	.893	.2626	.810	.2382	.725	.2133	.640	.1881	.552	.1624	.463	.1363	.419	.1232	.374	.1099
1 1/4"	.946	.2783	.859	.2523	.768	.2259	.677	.1991	.584	.1718	.490	.1442	.443	.1302	.395	.1162
1 5/16"	1.000	.2941	.906	.2665	.811	.2385	.714	.2101	.616	.1813	.517	.1521	.467	.1373	.416	.1224
1 3/8"	1.053	.3098	.954	.2806	.853	.2510	.752	.2211	.648	.1907	.544	.1599	.491	.1444	.438	.1287
1 7/16"	1.107	.3255	1.002	.2947	.896	.2636	.789	.2321	.680	.2001	.571	.1678	.515	.1514	.459	.1350
1 1/2"	1.160	.3412	1.050	.3089	.939	.2762	.826	.2430	.712	.2095	.597	.1756	.539	.1585	.480	.1413
1 5/8"	1.213	.3569	1.098	.3230	.982	.2887	.864	.2540	.745	.2190	.624	.1835	.563	.1656	.502	.1476
1 9/16"	1.267	.3726	1.146	.3371	1.024	.3013	.901	.2650	.777	.2284	.650	.1913	.587	.1726	.523	.1539
1 5/8"	1.320	.3883	1.194	.3513	1.067	.3139	.938	.2760	.809	.2378	.677	.1992	.611	.1797	.544	.1601
1 11/16"	1.374	.4040	1.242	.3654	1.110	.3264	.976	.2870	.840	.2472	.704	.2070	.635	.1868	.566	.1664
1 3/4"	1.427	.4197	1.291	.3796	1.153	.3390	1.013	.2980	.873	.2567	.731	.2149	.659	.1938	.587	.1727
1 13/16"	1.480	.4354	1.339	.3937	1.195	.3516	1.051	.3090	.905	.2661	.757	.2227	.683	.2009	.609	.1790
1 7/8"	1.534	.4511	1.387	.4078	1.238	.3641	1.088	.3200	.937	.2755	.784	.2306	.707	.2080	.630	.1853
1 15/16"	1.587	.4668	1.435	.4220	1.281	.3767	1.125	.3310	.969	.2849	.811	.2384	.731	.2151	.651	.1916
2"	1.641	.4825	1.483	.4361	1.323	.3892	1.163	.3420	1.001	.2944	.837	.2463	.755	.2221	.673	.1978
2 1/16"	1.694	.4983	1.531	.4502	1.366	.4018	1.200	.3530	1.033	.3038	.864	.2542	.779	.2292	.694	.2041
2 1/8"	1.748	.5140	1.579	.4644	1.409	.4144	1.238	.3640	1.065	.3132	.891	.2620	.803	.2363	.715	.2104
2 3/16"	1.801	.5297	1.627	.4785	1.451	.4269	1.275	.3750	1.097	.3226	.918	.2699	.827	.2433	.737	.2167
2 1/4"	1.854	.5454	1.675	.4927	1.494	.4395	1.312	.3860	1.109	.3321	.944	.2777	.851	.2504	.758	.2230
2 5/16"	1.908	.5611	1.723	.5068	1.537	.4521	1.350	.3970	1.161	.3415	.971	.2856	.876	.2575	.780	.2293
2 3/8"	1.961	.5768	1.771	.5209	1.580	.4646	1.387	.4080	1.193	.3509	.998	.2934	.899	.2645	.801	.2355
2 7/16"	2.015	.5925	1.819	.5351	1.622	.4772	1.425	.4190	1.225	.3603	1.024	.3013	.923	.2716	.822	.2418
2 1/2"	2.068	.6082	1.867	.5492	1.665	.4898	1.462	.4300	1.257	.3698	1.051	.3091	.948	.2787	.844	.2481

MILD STEEL TUBING (*Continued*).

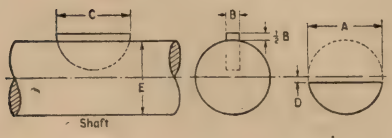
Sectional Areas and Weights. Imperial Standard and Wire Gauge.

External Diam. of Tube.	Gauge No. 22, 0.028in.		Gauge No. 23, 0.024in.		Gauge No. 24, 0.022in.		Gauge No. 25, 0.020in.	
	Weight, lb. per ft.	Area, sq. in.	Weight, lb. per ft.	Area, sq. in.	Weight, lb. per ft.	Area, sq. in.	Weight, lb. per ft.	Area, sq. in.
1/4"	.066	.01953	.058	.01705	.054	.01576	.049	.01445
9/32"	.076	.02228	.066	.01940	.061	.01792	.056	.01641
5/16"	.085	.02503	.074	.02176	.068	.02008	.062	.01838
3/8"	.104	.03052	.090	.02647	.083	.02440	.076	.02231
7/16"	.122	.03602	.106	.03118	.098	.02872	.089	.02623
1/2"	.141	.04152	.122	.03590	.112	.03304	.103	.03016
9/16"	.160	.04702	.138	.04061	.127	.03736	.116	.03409
5/8"	.179	.05252	.154	.04532	.142	.04168	.129	.03801
11/16"	.197	.05801	.170	.05003	.156	.04600	.143	.04194
3/4"	.216	.06351	.186	.05474	.171	.05032	.156	.04587
13/16"	.235	.06901	.202	.05946	.186	.05464	.169	.04979
7/8"	.253	.07451	.218	.06417	.200	.05896	.183	.53720
15/16"	.272	.08001	.234	.06888	.215	.06327	.196	.05765
1"	.291	.08550	.250	.07359	.230	.06759	.209	.06158
1 1/16"	.309	.09100	.266	.07830	.244	.07191	.223	.06550
1 1/8"	.328	.09650	.282	.08302	.259	.07623	.236	.06943
1 3/16"	.347	.1020	.298	.08773	.274	.08055	.249	.07336
1 1/4"	.366	.1075	.314	.09244	.289	.08487	.263	.07728
1 5/16"	.384	.1130	.330	.09715	.303	.08919	.276	.08121
1 3/8"	.403	.1185	.346	.1018	.318	.09351	.289	.08514
1 7/16"	.422	.1240	.362	.1066	.333	.09783	.303	.08906
1 1/2"	.440	.1295	.378	.1113	.347	.1022	.316	.09299
1 9/16"	.459	.1350	.394	.1160	.362	.1065	.330	.09692
1 5/8"	.478	.1405	.410	.1207	.377	.1108	.343	.1008
1 11/16"	.496	.1460	.426	.1254	.391	.1151	.356	.1048
1 3/4"	.515	.1515	.442	.1301	.406	.1194	.370	.1087
1 13/16"	.534	.1570	.458	.1348	.421	.1238	.383	.1126
1 7/8"	.553	.1625	.475	.1396	.436	.1281	.396	.1166
1 15/16"	.571	.1680	.491	.1443	.450	.1324	.410	.1205
2"	.590	.1735	.507	.1490	.465	.1367	.423	.1244
2 1/16"	.609	.1790	.523	.1537	.479	.1410	.436	.1283
2 1/8"	.627	.1845	.539	.1584	.494	.1453	.450	.1323
2 3/16"	.646	.1900	.555	.1631	.509	.1497	.463	.1362
2 1/4"	.665	.1955	.571	.1678	.524	.1540	.476	.1401
2 5/16"	.683	.2010	.587	.1725	.538	.1583	.490	.1440
2 3/8"	.702	.2065	.603	.1773	.553	.1626	.503	.1480
2 7/16"	.721	.2120	.619	.1820	.567	.1669	.516	.1519
2 1/2"	.740	.2175	.635	.1867	.582	.1713	.530	.1558

VALUES OF "I" AND "Z" FOR ROUND SECTIONS $\frac{1}{8}$in. to $3\frac{5}{8}$in.

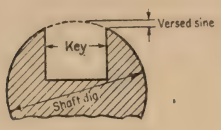
Diameter.	"I" = $\frac{\pi D^4}{64}$ Bending.	"Z" = $\frac{\pi D^3}{32}$ Bending.	"I" = $\frac{\pi D^4}{32}$ Twisting.	"Z" = $\frac{\pi D^3}{16}$ Twisting.
0.125	0.00001198	0.0001917	0.00002397	0.0003835
0.187	0.00006059	0.0006473	0.00012118	0.0012946
0.218	0.0001124	0.0010276	0.0002248	0.0020552
0.250	0.0001917	0.001534	0.0003835	0.003068
0.281	0.0003072	0.002184	0.0006144	0.004368
0.312	0.0004652	0.002994	0.0009304	0.005988
0.343	0.0006794	0.003964	0.0013588	0.007928
0.375	0.0009707	0.005177	0.001941	0.01035
0.406	0.001334	0.00657	0.002668	0.01314
0.437	0.001793	0.00819	0.003586	0.01638
0.468	0.002355	0.01067	0.004710	0.02134
0.500	0.003068	0.01227	0.006136	0.02454
0.515	0.003470	0.01342	0.006940	0.02684
0.562	0.004915	0.01744	0.009830	0.03488
0.593	0.006100	0.02048	0.012200	0.04096
0.625	0.007490	0.02397	0.014980	0.04794
0.656	0.007908	0.02775	0.015816	0.05550
0.687	0.010967	0.03190	0.021934	0.06380
0.718	0.01312	0.03655	0.02624	0.07290
0.750	0.01553	0.04142	0.03106	0.08284
0.781	0.01829	0.04682	0.03658	0.09364
0.812	0.02140	0.05267	0.04280	0.10534
0.843	0.02487	0.05897	0.04974	0.11794
0.875	0.02877	0.06577	0.05755	0.1315
0.906	0.03311	0.07307	0.06622	0.1461
0.937	0.03793	0.08090	0.07586	0.1618
0.968	0.04323	0.08924	0.08646	0.1785
1.000	0.04909	0.09817	0.9817	0.1963
1.062	0.06245	0.1177	0.12490	0.2354
1.125	0.07863	0.1398	0.1573	0.2796
1.187	0.09762	0.1644	0.1952	0.3288
1.250	0.1198	0.1917	0.2397	0.3835
1.312	0.1457	0.2220	0.2914	0.4440
1.375	0.1755	0.2552	0.3509	0.5104
1.437	0.2093	0.2917	0.4186	0.5834
1.500	0.2485	0.3313	0.4970	0.6627
1.562	0.2926	0.3745	0.5952	0.7490
1.625	0.3431	0.4213	0.6862	0.8425
1.687	0.3981	0.4717	0.7962	0.9434
1.750	0.4604	0.5261	0.9208	1.052
1.812	0.5298	0.5846	1.1596	1.169
1.875	0.6067	0.6471	1.213	1.294
1.937	0.6914	0.7140	1.383	1.428
2.000	0.7854	0.7854	1.571	1.571
2.125	1.001	0.9421	2.002	1.884
2.250	1.258	1.118	2.516	2.236
2.375	1.562	1.315	3.124	2.630
2.500	1.917	1.534	3.835	3.068
2.625	2.331	1.776	4.661	3.551
2.750	2.807	2.042	5.615	4.083
2.875	3.354	2.332	6.707	4.664
3.000	3.976	2.651	7.952	5.301
3.125	4.681	2.996	9.363	5.992
3.250	5.476	3.370	10.95	6.740
3.375	6.369	3.774	12.74	7.548
3.500	7.366	4.209	14.73	8.418
3.625	8.476	4.676	16.95	9.353

WOODRUFF KEYS.



No. of Key and Cutter.	Diameter of Cutters in Inches.	Thickness of Key and Cutter in Inches.	Length of Key in Inches.	Key Cut Below Centre of Key Disc in Inches.	Diameter of Shafts in Inches.	Shearing Area in Square Inches.	Shearing Strength at 50,000 lb. per SquareInch.
	A.	B.	C.	D.	E.		lb.
1	$\frac{1}{2}$	$\frac{1}{16}$	$\frac{1}{2}$	$\frac{3}{64}$	$\frac{5}{16}$ to $\frac{3}{8}$	.0312	1,560
2	$\frac{1}{2}$	$\frac{3}{32}$	$\frac{1}{2}$	$\frac{3}{64}$	$\frac{7}{16}$ to $\frac{9}{16}$	.0469	2,345
3	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{2}$	$\frac{3}{64}$	$\frac{9}{16}$ to $\frac{3}{4}$	.0625	3,125
4	$\frac{5}{8}$	$\frac{3}{32}$	$\frac{5}{8}$	$\frac{1}{16}$	$\frac{7}{16}$ to $\frac{9}{16}$	.0586	2,930
5	$\frac{5}{8}$	$\frac{1}{8}$	$\frac{5}{8}$	$\frac{1}{16}$	$\frac{5}{8}$ to $\frac{11}{16}$	.0781	3,905
6	$\frac{5}{8}$	$\frac{5}{32}$	$\frac{5}{8}$	$\frac{1}{16}$	$\frac{3}{4}$ to $\frac{7}{8}$	.0976	4,880
7	$\frac{3}{4}$	$\frac{1}{8}$	$\frac{3}{4}$	$\frac{1}{16}$	$\frac{3}{4}$ to $\frac{7}{8}$	.0937	4,685
8	$\frac{3}{4}$	$\frac{5}{32}$	$\frac{3}{4}$	$\frac{1}{16}$	$\frac{3}{4}$ to $\frac{15}{16}$	.1172	5,860
9	$\frac{3}{4}$	$\frac{3}{16}$	$\frac{3}{4}$	$\frac{1}{16}$	$\frac{7}{8}$ to 1	.1406	7,030
10	$\frac{7}{8}$	$\frac{5}{32}$	$\frac{7}{8}$	$\frac{1}{16}$	$\frac{7}{8}$ to $\frac{15}{16}$	.1367	6,835
11	$\frac{7}{8}$	$\frac{3}{16}$	$\frac{7}{8}$	$\frac{1}{16}$	1 to $1\frac{1}{8}$	.1640	8,200
12	$\frac{7}{8}$	$\frac{7}{32}$	$\frac{7}{8}$	$\frac{1}{16}$	1 to $1\frac{1}{4}$	.1914	9,570
A	$\frac{7}{8}$	$\frac{1}{4}$	$\frac{7}{8}$	$\frac{1}{16}$	$1\frac{1}{16}$ to $1\frac{3}{8}$	.2187	10,935
13	1	$\frac{3}{16}$	1	$\frac{1}{16}$	1 to $1\frac{1}{4}$	.1875	9,375
14	1	$\frac{7}{32}$	1	$\frac{1}{16}$	$1\frac{1}{16}$ to $1\frac{3}{8}$	.2187	10,935
15	1	$\frac{1}{4}$	1	$\frac{1}{16}$	$1\frac{1}{8}$ to $1\frac{1}{2}$	.2500	12,500
B	1	$\frac{5}{16}$	1	$\frac{1}{16}$	$1\frac{3}{8}$ to $1\frac{5}{8}$	.3125	15,625
16	$1\frac{1}{8}$	$\frac{3}{16}$	$1\frac{1}{8}$	$\frac{5}{64}$	$1\frac{1}{8}$ to $1\frac{3}{8}$	.2109	10,545
17	$1\frac{1}{8}$	$\frac{7}{32}$	$1\frac{1}{8}$	$\frac{5}{64}$	$1\frac{1}{8}$ to $1\frac{1}{2}$	.2461	12,305
18	$1\frac{1}{8}$	$\frac{1}{4}$	$1\frac{1}{8}$	$\frac{5}{64}$	$1\frac{1}{4}$ to $1\frac{5}{8}$	.2812	14,060
C	$1\frac{1}{8}$	$\frac{5}{16}$	$1\frac{1}{8}$	$\frac{5}{64}$	$1\frac{1}{2}$ to $1\frac{3}{4}$	.3515	17,575
19	$1\frac{1}{4}$	$\frac{3}{16}$	$1\frac{1}{4}$	$\frac{5}{64}$	$1\frac{1}{4}$ to $1\frac{7}{16}$	.2343	11,715
20	$1\frac{1}{4}$	$\frac{7}{32}$	$1\frac{1}{4}$	$\frac{5}{64}$	$1\frac{1}{4}$ to $1\frac{5}{8}$	.2734	13,670
21	$1\frac{1}{4}$	$\frac{1}{4}$	$1\frac{1}{4}$	$\frac{5}{64}$	$1\frac{3}{8}$ to $1\frac{5}{8}$	.3125	15,625
D	$1\frac{1}{4}$	$\frac{5}{16}$	$1\frac{1}{4}$	$\frac{5}{64}$	$1\frac{1}{2}$ to $1\frac{7}{8}$	.3906	19,530
E	$1\frac{1}{4}$	$\frac{3}{8}$	$1\frac{1}{4}$	$\frac{5}{64}$	$1\frac{5}{8}$ to $2\frac{1}{4}$	.4687	23,435
22	$1\frac{3}{8}$	$\frac{1}{4}$	$1\frac{3}{8}$	$\frac{3}{32}$	$1\frac{1}{2}$ to $1\frac{3}{4}$	.3437	17,185
23	$1\frac{3}{8}$	$\frac{5}{16}$	$1\frac{3}{8}$	$\frac{3}{32}$	$1\frac{1}{2}$ to $1\frac{7}{8}$	.4297	21,485
F	$1\frac{3}{8}$	$\frac{3}{8}$	$1\frac{3}{8}$	$\frac{3}{32}$	$1\frac{3}{4}$ to $2\frac{3}{8}$	.5156	25,780
24	$1\frac{1}{2}$	$\frac{1}{4}$	$1\frac{1}{2}$	$\frac{7}{64}$	$1\frac{1}{2}$ to $1\frac{7}{8}$	.3750	18,750
25	$1\frac{1}{2}$	$\frac{5}{16}$	$1\frac{1}{2}$	$\frac{7}{64}$	$1\frac{5}{8}$ to $2\frac{1}{4}$	.4687	23,435
G	$1\frac{1}{2}$	$\frac{3}{8}$	$1\frac{1}{2}$	$\frac{7}{64}$	$2\frac{1}{8}$ to $2\frac{1}{2}$	.5625	28,125

TABLE OF VERSED SINES FOR LOCATING WOODRUFF KEY SEATS IN SHAFTS.



ALL DIMENSIONS IN INCHES.

Shaft Dia.	1/16 Key.	3/32 Key.	1/8 Key.	5/32 Key.	3/16 Key.	7/32 Key.	1/4 Key.	5/16 Key.	3/8 Key.	7/16 Key.	1/2 Key.
3/8	.002 3/4	.006	.010 3/4	.017	.025 1/4	—	—	—	—	—	—
7/16	.002 1/4	.005 3/4	.009 1/4	.014 1/2	.021	.029 1/4	—	—	—	—	—
1/2	.002	.004 1/2	.008	.012 1/2	.018 1/4	.025 1/4	.032 1/2	—	—	—	—
9/16	.001 3/4	.004	.007	.011 1/4	.016 1/4	.022 1/4	.029	—	—	—	—
5/8	.001 1/2	.003 1/2	.006 1/4	.010	.014 1/2	.019 3/4	.025 1/2	.041 1/4	—	—	—
11/16	.001 1/2	.003 1/4	.005 3/4	.009	.013	.017 3/4	.023 1/2	.038	—	—	—
3/4	.001 1/2	.003	.005 1/4	.008 1/4	.012	.016 1/4	.022	.034 1/2	.051	—	—
13/16	.001 1/4	.002 1/2	.004 3/4	.007 3/4	.011	.015	.019 3/4	.031 1/2	.046 1/2	—	—
7/8	.001	.002 1/2	.004 1/2	.007	.010 1/4	.013 3/4	.017 3/4	.028 1/4	.042	.058 1/4	—
15/16	.001	.002 1/4	.004 1/4	.006 1/2	.010 1/2	.012 3/4	.016 1/2	.026 1/2	.039 1/4	.054 1/2	—
1	.001	.002	.004	.006 1/4	.008 3/4	.012	.015 1/4	.024 1/2	.036 1/2	.050 1/2	.067
1 1/16	.000 3/4	.002	.003 3/4	.005 3/4	.008 1/4	.011 1/2	.014 1/4	.022 3/4	.034 1/4	.047 1/2	.062 1/2
1 1/8	.000 3/4	.002	.003 1/2	.005 1/2	.007 3/4	.010 3/4	.013 1/2	.021	.032	.044 1/2	.058
1 3/16	.000 3/4	.001 3/4	.003 1/4	.005 1/4	.007 1/2	.010 1/4	.013	.020 1/2	.030 1/2	.042	.055
1 1/4	.000 3/4	.001 3/4	.003	.005	.007	.010	.012 3/4	.019 3/4	.029	.039 3/4	.052 1/4
1 5/16	.000 3/4	.001 3/4	.003	.004 3/4	.006 3/4	.009 1/4	.012 1/4	.019	.028	.038	.050
1 3/8	.000 3/4	.001 1/2	.003	.004 1/2	.006 1/2	.008 3/4	.012	.018 1/2	.026 3/4	.036 1/2	.047 3/4
1 7/16	.000 3/4	.001 1/2	.002 3/4	.004 1/4	.006 1/4	.008 1/4	.011 1/2	.017 1/2	.025 1/2	.034 1/2	.045 1/4
1 1/2	.000 3/4	.001 1/2	.002 1/2	.004	.006	.008	.011	.016 1/2	.024	.032 3/4	.043
1 9/16	—	—	.002 1/2	.004	.005 1/2	.007 3/4	.010 3/4	.015 3/4	.023	.031	.041 1/4
1 5/8	—	—	.002 1/2	.003 3/4	.005 1/2	.007 1/2	.010 1/2	.015 1/4	.022	.029	.039 1/2
1 11/16	—	—	.002 1/4	.003 1/2	.005 1/4	.007	.010 1/4	.014 3/4	.021 1/2	.028 1/4	.038 1/4
1 3/4	—	—	.002 1/4	.003 1/2	.005	.006 3/4	.010	.014 1/4	.020 3/4	.027 1/2	.037
1 13/16	—	—	.002	.003 1/4	.004 3/4	.006 1/2	.009 1/2	.013 1/2	.019 3/4	.026 1/2	.035 1/2
1 7/8	—	—	.002	.003 1/4	.004 3/4	.006 1/2	.009 1/4	.013	.019	.025 3/4	.034
1 15/16	—	—	.002	.003 1/4	.004 1/2	.006 1/4	.009	.012 3/4	.018 1/2	.025	.032 3/4
2	—	—	.002	.003	.004 1/2	.006	.008 3/4	.012 1/2	.018	.024 1/4	.031 3/4
2 1/16	—	—	—	—	.004 1/4	.005 3/4	.008 1/4	.011 3/4	.017 1/4	.023 1/2	.030 3/4
2 1/8	—	—	—	—	.004 1/4	.005 3/4	.007 3/4	.011	.016 3/4	.023	.030
2 3/16	—	—	—	—	.004	.005 1/2	.007 1/4	.011	.016 1/4	.022 1/4	.029
2 1/4	—	—	—	—	.004	.005 1/4	.007	.010 3/4	.016	.021 1/2	.028 1/4

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7—1926. Copper Conductors, Insulated Annealed for **Electric Power and Light,** Dimensions of (including pressure tests). [*Add.* Feb., 1927, and June, 1927.]

21—1909. Pipe Threads for Iron or Steel Pipes and Tubes, Report on

45—1928. Sparking Plugs, Sparking Plug Holes, Taps for Sparking Plug Holes and Copper-Asbestos Washers for Automobile Engines, Dimensions of

46—1909. Keys and Keyways.

46 Part 1.—1924. Parallel Keys, Key-ways and Key Bars, Dimensions for. (Partly superseding No. 46–1909.)

56—1911. Yield Point and **Elastic Limit,** Definitions of (*Gratis.*)

57—1920. Heads for British Association Screws, Report on

69—1915. Tungsten Filament Glow Lamps (Vacuum Type) for **Automobiles,** Report on (*Under Revision.*)

71—1917. Wheel Rims and Tyre Bands for Solid Rubber Tyres for Automobiles, Report on Dimensions of (*Under Revision.*)

74—1917. Charging Plug and Socket, for Vehicles propelled by Electric Secondary Batteries.

83—1922. Aircraft Dope and Protective Covering, Standard of Reference for [*Add.*]

84—1918. Screw Threads, British Standard Fine and their Tolerances (superseding parts of Reports Nos. 20 and 38), Report on

86—1919. Magnetos for Aircraft Purposes, Report on Dimensions of

87—1919. Air Screw Hubs, Report on Dimensions of

88—1919. Electric Cut-outs. Low Pressure (Type O)

89—1926. Indicating Ammeters, Voltmeters, Wattmeters, Frequency and Power-Factor Meters. [*Add.* Nov., 1926.]

90—1927. Graphic (Recording or Chart-Recording) Ammeters, Voltmeters and Wattmeters.

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93—1919. (Formerly C.L. 7271.) **Screw Threads, British Association with Tolerances** for sizes Nos. 0 to 15 B.A. (Superseding No. 20.)

95—1919. Corrections to **Effective Diameter** required to compensate pitch and angle errors in **Screw Threads** of **Whitworth form.** Tables of

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122—1920. Milling Cutters and Reamers, Standards for [*Add.* March, 1928.]

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Copies of I.A.E. Data Sheets of S.M.M. & T. Provisional Standards may be obtained gratis on application to the Standards Department, Society of Motor Manufacturers and Traders, 83, Pall Mall, S.W.1.

HORSE-POWER FORMULÆ.

D = Diameter of cylinder. V = Swept volume of one cylinder.
N = Number of cylinders. r = Engine revolutions.
S = Stroke.
$R = \frac{S}{D}$ = ratio of stroke to bore.

ROYAL AUTOMOBILE CLUB (R.A.C.):

Measurement in inches. $\frac{D^2N}{2.5}$ Measurement in mm. $\frac{D^2N}{1613}$

This formula assumes a constant piston speed of 1,000 ft. per minute and a mean effective pressure of 67.2 lbs. per sq. in.

In addition to Great Britain, this formula is used in BRITISH GUIANA, CANADA, DOMINICAN REPUBLIC, QUEENSLAND, SOUTH AUSTRALIA, UNITED STATES and VICTORIA.

AUSTRIA, LATVIA, LUXEMBOURG, NORWAY, RUSSIA. $0.3\ N\ D^2\ S$ where D is in cm. S is in metres.

BELGIUM. $K\ N\ D^2\ S\ c$
where:
D and S are in decimetres.
The values of K and c are 4.25 and 1 for (1) light vehicles under 1,500 r.p.m.; 4 and 1.5 for (2) light vehicles over 1,500 and under 2,400 r.p.m.; 3 and 2.4 for (3) light vehicles, 2,400 and over; 4.25 and 1 for (4) heavy vehicles including tractors. When vehicles of (2) and (3) categories are over six years old, (2) becomes (1) and (3) becomes (2).

DENMARK. As Austria for four-stroke engines. Special factory ratings are adopted for two-stroke engines.

FRANCE. $K\ N\ D^2\ S\ r$
where:—
K = .00015 D and S are in cm.
r = engine revs. per second, which are fixed at 30 for cars and light vans up to 1,250 kgs.
25 for public service or goods chassis which, including tyres, weigh from 1,250 kgs. to 2,250 kgs. unladen.
20 for public service or goods chassis which, including tyres, weigh over 2,250 kgs. unladen.
All fractions of horse-power are taken to the nearest whole figure.

GERMANY. Taxation based on capacity of the engine. Capacity in c.c. = $.00078\ N\ D^2\ S$ where D and S are in mm.

HUNGARY. $\frac{N\ D^2}{20}$ where D is in cm.

IRISH FREE STATE. $\frac{N\ D^2}{2.5}$ (for engines having one piston per cylinder).
$\frac{N\ D^2}{1.6}$ (for engines having two pistons per cylinder).
where D is in in.

ITALY. $0.08782\ N\ V^{\cdot 6541}$, where V is in c.c.
and $V^{\cdot 6541}$ is an exponential function of V.

JAPAN. $\frac{N\ D^2}{3}$ where D is in inches.

SPAIN. $.08\ (.785\ D^2\ S)^{\cdot 6}\ N$ (for four-stroke engines).
$.11\ (.785\ D^2\ S)^{\cdot 6}\ N$ (for two-stroke engines).
where D and S are in cm.

SWEDEN. $\frac{N\ D^2\ S\ r}{K}$
where:
K = 180,000 (for Diesel engines).
200,000 (for four-stroke engines using petrol and oil).
240,000 (for two-stroke engines ignited by compression).
D and S are in cm.
r = maximum engine r.p.m.

SWITZERLAND. $0.4\ N\ D^2\ S$ where D is in cm. S is in metres.

Only in those cases specially indicated is there any specified difference between the Rated Horse-Powers of two- and four-stroke engines.

Further details regarding Taxation and Regulations of Motor Vehicles in various countries are given in the S.M.M. & T. Manual, Vol. 4.

Derivation of the R.A.C. Horse-power Formula.

The indicated horse-power of a single-cylinder four-cycle engine is equal to one-quarter times the mean effective pressure P acting throughout the working stroke, times the area of the piston A in square inches, times the piston speed S divided by 33,000, thus—

$$\text{I.H.P.} = \tfrac{1}{4}\frac{\text{P A S}}{33{,}000}$$

Multiplying this by the number of cylinders N gives the I.H.P. for an engine of the given number of cylinders, and further multiplying by the mechanical efficiency of the engine E gives the brake-horse-power. Therefore the complete equation for B.H.P. reads—

$$\text{B.H.P.} = \frac{\text{P A S N E}}{33{,}000 \times 4}$$

The R.A.C. has assumed that all motor car engines will deliver, or should deliver, their rated power at a piston speed of 1,000 ft. per minute, that the mean effective pressure in such engine cylinders will average 90 lb. per square inch, and that the mechanical efficiency will average 75%.

Substituting these values in the above B.H.P. equation, and substituting for A its equivalent in terms of the diameter, .7854 D^2, the equation reads—

$$\text{B.H.P.} = \frac{90 \times .7854\ D^2 \times 1{,}000 \times N \times .75}{33{,}000 \times 4}$$

and combining the numerical values as indicated, it becomes simplified to the form—

$$\text{B.H.P.} = \frac{D^2\ N}{2.489}$$

or in round numbers, with a denominator 2.5.

LANCHESTER'S FORMULA:

Measurement in inches. $.5\ D^2\ N \sqrt{R}$

Measurement in mm. $\frac{D^2\ N}{1290}\sqrt{R}$

This formula provides a correction for piston speed limited by the stroke.

SOCIETY OF MOTOR MANUFACTURERS' AND TRADERS' PROPOSED FORMULÆ:

Measurement in inches.

(A) for touring engines— $.197\ D\ (D - 1)\ (R + 2)\ N.$

(B) for racing engines— $.333\ D\ (D - 1)\ (R + 2)\ N.$

Measurement in mm.

(A) $\frac{D\ (D - 25.4)\ (R + 2)\ N}{3275}$

(B) $\frac{D\ (D - 25.4)\ (R + 2)\ N}{1937}$

These formulæ are a simplified modification of the Lanchester formula, and embody a factor to allow for differences of cooling due to size, and assume a piston speed of 1,000 R ½ ft. per minute for touring engines, and a greater speed for racing designs.

DENDY MARSHALL FORMULA:

Measurement in inches. $\frac{D^2\ S\ N}{12}$

Measurement in mm. $\frac{D^2\ S\ N}{200{,}000}$

This formula gives a close approximation to power, and assumes a revolution speed of 1,000 per minute, or with modification for effect of stroke-bore ratio on revolution speed.

$\frac{D^2\ S\ N\ \text{Revs.}}{12{,}000}$ $\frac{D^2\ S\ N\ \text{Revs.}}{200{,}000{,}000}$

INSTITUTION OF AUTOMOBILE ENGINEERS' FORMULA:

Measurement of inches. $.45\ (D + S)\ (D - 1.18)\ N$

Measurement in mm. $\frac{(D + S)\ (D - 29.97)\ N}{1433}$

This formula embodies a correction for mean effective pressure rising with bore and one for effect of stroke-bore ratio on speed.

BURL'S MAXIMUM RATING FORMULA:

Measurement in inches. $\tfrac{1}{2}\ D\ (D - 1.18)\sqrt{\frac{D^2\ S}{M}}$

Measurement in mm. $\frac{D}{1290}\left(D - 29.97\right)\sqrt{\frac{D^2\ S}{16390\ M}}$

This formula is similar to the I.A.E. formula, but embodies a speed limiting factor based on weight of reciprocating parts, and M = mass of weight of reciprocating parts in one cylinder. For cast-iron pistons.

$M = .08\ D^3\ (1 + .15\ R) + 1.5$ lb. $M = \frac{D^3}{204{,}700}\left(1 + .15\ R\right) + 1.5$ lb.

FORMULÆ FOR HORSE-POWER, TORQUE, AND BRAKE MEAN EFFECTIVE PRESSURE.

D = Cylinder bore, inches.
S = Stroke, inches.
A = Piston area, sq. ins.
r = Revs. per minute.
N = Number of cylinders.
K = Piston speed, ft. min. $= \frac{rS}{6}$

p = Brake mean effective pressure, lb. sq. in.
P = Horse-power.
T = Torque, lb. ft.
t = Torque, lb. in.
V = Total swept vol. of engine $= 0.785D^2SN$.

$P = \frac{Tr}{5252}$	$P = \frac{pD^2KN}{168000}$	Where D and S are in cms., and A in sq. cms.
$P = \frac{tr}{63025}$	$P = \frac{pASrN}{792000}$	$P = \frac{pD^2rSN}{16550000}$
$P = \frac{pD^2rSN}{1010000}$		$P = \frac{pASrN}{12960000}$
	$T = \frac{5252P}{r}$	$t = \frac{63025P}{r}$
	$T = \frac{pD^2SN}{192}$	$t = \frac{pD^2SN}{16}$
$p = \frac{792000P}{ASrN}$	$p = \frac{1010000P}{D^2SrN}$	Where D and S are in cms., and A in sq. cms.
$p = \frac{192T}{D^2SN}$	$p = \frac{168000P}{D^2KN}$	$p = \frac{1296000P}{ASrN}$
$p = \frac{16t}{D^2SN}$		$p = \frac{16550000P}{D^2SrN}$

EXPLOSION PRESSURES IN PETROL ENGINES.

(Research Association of British Motor & Allied Manufacturers.)

The following formula enables the explosion pressure in a petrol engine to be easily calculated with sufficient accuracy for most purposes. The notation is as follows:—

r = Compression-ratio;
P_3 = Explosion pressure, lb. per sq. in. absolute;
P_o = Pressure at the end of the suction stroke, which is assumed to lie between 12 and 14 lb. per sq. in. absolute;
P_e = Brake mean effective pressure, lb. per sq. in.;
γ = Ratio of specific heats; this for the explosion curve is assumed to be 1.3, and, for the compression curve, where the ratio is denoted by $\gamma' = 0.64 + 0.05\ P_o$;
P_i = Theoretical mean indicated effective pressure, and may be written $P_i = \frac{P_e}{\eta\ K}$ where η is the mechanical efficiency and K the diagram factor representing the proportion of the actual indicator diagram to the sharp-cornered constant-volume cycle diagram assumed in the calculations.

The general expression for the explosion pressure when reduced by Algebra is—

$$P_3 = \frac{0.3\ (r - 1)}{1 - r^{-3}} \left\{ P_i + P_o \cdot \frac{r}{r - 1} \cdot \frac{r^{\gamma' - 1} - 1}{\gamma' - 1} \right\}$$

and this has been reduced to the equivalent form:

$$P_3 = (0.72 + 0.482\ r) \left\{ \frac{P_e}{\eta\ K} + 5.427 + 0.780\ P_o + r\ (0642\ P_o - 4.801) \right\}$$

The last equation which is very easily computed, agrees with the preceding exact equation to within one part in 400.

Numerical Example:—

An engine with a compression-ratio of 6 gives a brake mean effective pressure of 100 lb. per sq. in. Assuming a mechanical efficiency of 80 per cent. and a diagram factor 0.96, we have from the second Equation—

$$P_3 = (0.72 + 0.482 \times 6) \left\{ \frac{100}{0.8 \times 0.96} + 5.427 + 0.780\ P_o + 6\ (0.642\ P_o - 4.810) \right\}$$

which becomes—

$$P_3 = 3.612 \left\{ 135.7 + 0.780\ P_o + 6\ (0.642\ P_o - 4.801) \right\}$$

If we assume P_o = 13 lb. per sq. in. absolute—

$$P_3 = 3.612 \left\{ 135.7 + 10.15 + 6\ (8.35 - 4.80) \right\}$$

= 603.7 lb. per sq. in. absolute.
or 589 lb. per sq. in. gauge.

HORSE-POWER TREASURY RATING.

Bore in mm.	Horse-power by Treasury rating.					Bore in mm.	Horse-power by Treasury rating.				
	1 cyl.	2 cyl.	4 cyl.	6 cyl.	8 cyl.		1 cyl.	2 cyl.	4 cyl.	6 cyl.	8 cyl.
50	1.55	3.10	6.20	9.30	12.40	100	6.20	12.40	24.80	37.20	49.60
51	1.61	3.23	6.45	9.68	12.90	101	6.32	12.65	25.30	37.94	50.59
52	1.68	3.35	6.70	10.05	13.40	102	6.45	12.90	25.80	38.70	51.60
53	1.74	3.48	6.97	10.45	13.93	103	6.58	13.15	26.31	39.46	52.62
54	1.81	3.62	7.23	10.85	14.46	104	6.71	13.41	26.82	40.23	53.64
55	1.88	3.75	7.50	11.25	15.00	105	6.84	13.67	27.34	41.01	54.68
56	1.94	3.89	7.78	11.67	15.55	106	6.97	13.93	27.86	41.79	55.72
57	2.01	4.03	8.06	12.09	16.11	107	7.10	14.20	28.39	42.59	56.78
58	2.09	4.17	8.34	12.51	16.68	108	7.23	14.46	28.93	43.39	57.85
59	2.16	4.32	8.63	12.95	17.26	109	7.37	14.73	29.46	44.19	58.92
60	2.23	4.46	8.93	13.39	17.85	110	7.50	15.00	30.00	45.01	60.01
61	2.31	4.61	9.23	13.84	18.45	111	7.64	15.28	30.55	45.83	61.10
62	2.38	4.77	9.53	14.30	19.06	112	7.78	15.55	31.11	46.66	62.21
63	2.46	4.92	9.84	14.76	19.68	113	7.92	15.83	31.67	47.50	63.33
64	2.54	5.08	10.15	15.24	20.29	114	8.06	16.11	32.23	48.34	64.46
65	2.62	5.24	10.48	15.72	20.95	115	8.20	16.40	32.80	49.19	65.59
66	2.70	5.40	10.80	16.20	21.60	116	8.34	16.68	33.37	50.05	66.74
67	2.78	5.57	11.13	16.70	22.26	117	8.49	16.97	33.95	50.92	67.89
68	2.87	5.73	11.47	17.20	22.93	118	8.63	17.26	34.53	51.79	69.06
69	2.95	5.90	11.81	17.71	23.61	119	8.78	17.56	35.12	52.67	70.23
70	3.04	6.07	12.15	18.22	24.30	120	8.93	17.86	35.71	53.57	71.42
71	3.13	6.25	12.50	18.75	25.00	121	9.08	18.15	36.31	54.46	72.62
72	3.21	6.43	12.86	19.28	25.71	122	9.23	18.46	36.91	55.37	73.82
73	3.30	6.61	13.22	19.82	26.43	123	9.38	18.76	37.52	56.27	75.03
74	3.39	6.79	13.58	20.37	27.16	124	9.53	19.06	38.13	57.19	76.26
75	3.49	6.97	13.95	20.92	27.90	125	9.69	19.37	38.75	58.12	77.50
76	3.58	7.16	14.32	21.49	28.65	126	9.84	19.68	39.37	59.05	78.74
77	3.68	7.35	14.70	22.05	29.41	127	10.00	20.00	40.00	60.00	79.99
78	3.77	7.54	15.09	22.63	30.17	128	10.16	20.32	40.63	60.95	81.26
79	3.87	7.74	15.48	23.22	30.94	129	10.32	20.63	41.27	61.90	82.53
80	3.97	7.94	15.87	23.81	31.74	130	10.48	20.96	41.91	62.86	83.82
81	4.07	8.14	16.27	24.41	32.54	131	10.64	21.28	42.57	63.84	85.11
82	4.17	8.34	16.67	25.01	33.35	132	10.80	21.60	43.21	64.81	86.42
83	4.27	8.54	17.08	25.63	34.17	133	10.97	21.93	43.87	65.81	87.73
84	4.37	8.75	17.50	26.25	35.00	134	11.13	22.26	44.53	66.79	89.06
85	4.48	8.96	17.92	26.88	35.83	135	11.30	22.60	45.20	67.79	90.39
86	4.59	9.17	18.34	27.51	36.68	136	11.47	22.93	45.87	68.80	91.73
87	4.69	9.38	18.77	28.15	37.53	137	11.64	23.27	46.54	69.81	93.09
88	4.80	9.60	19.20	28.81	38.41	138	11.81	23.61	47.23	70.84	94.45
89	4.91	9.82	19.64	29.46	39.29	139	11.98	23.96	47.91	71.86	95.83
90	5.02	10.04	20.09	30.13	40.17	140	12.15	24.30	48.61	72.91	97.21
91	5.13	10.27	20.53	30.80	41.07	141	12.33	24.65	49.30	73.95	98.60
92	5.25	10.49	21.98	31.48	41.98	142	12.50	25.00	50.01	75.01	100.01
93	5.36	10.72	21.45	32.17	42.90	143	12.68	25.36	50.71	76.07	101.42
94	5.48	10.96	21.91	32.87	43.82	144	12.86	25.71	51.42	77.13	102.84
95	5.60	11.19	22.38	33.57	44.76	145	13.03	26.07	52.14	78.21	104.28
96	5.71	11.43	22.85	34.28	45.71	146	13.22	26.43	52.86	79.29	105.72
97	5.83	11.67	23.33	35.00	46.67	147	13.40	26.79	53.59	80.38	107.17
98	5.95	11.91	23.82	35.72	47.63	148	13.58	27.16	54.32	81.48	108.64
99	6.08	12.15	24.30	36.46	48.61	149	13.76	27.53	55.06	82.58	110.11
						150	13.95	27.90	55.80	83.69	111.59

Bore in inches	Horse-power by Treasury rating.					Bore in inches	Horse-power by Treasury rating.				
	1 cyl.	2 cyl.	4 cyl.	6 cyl.	8 cyl.		1 cyl.	2 cyl.	4 cyl.	6 cyl.	8 cyl.
2	1.60	3.20	6.40	9.60	12.80	4	6.40	12.80	25.60	38.40	51.20
2 1/16	1.70	3.40	6.81	10.21	13.62	4 1/16	6.60	13.20	26.41	39.61	52.82
2 1/8	1.81	3.61	7.23	10.84	14.45	4 1/8	6.81	13.61	27.23	40.84	54.45
2 3/16	1.91	3.83	7.66	11.48	15.32	4 3/16	7.01	14.03	28.06	42.08	56.12
2 1/4	2.03	4.05	8.10	12.16	16.21	4 1/4	7.23	14.45	28.90	43.35	57.80
2 5/16	2.14	4.28	8.56	12.84	17.12	4 5/16	7.44	14.88	29.76	44.64	59.52
2 3/8	2.26	4.51	9.02	13.54	18.05	4 3/8	7.66	15.31	30.63	45.94	61.25
2 7/16	2.38	4.75	9.51	14.26	19.02	4 7/16	7.88	15.75	31.51	47.28	63.02
2 1/2	2.50	5.00	10.00	15.00	20.00	4 1/2	8.10	16.20	32.40	48.60	64.80
2 9/16	2.63	5.25	10.51	15.76	21.02	4 9/16	8.33	16.65	33.31	49.96	66.62
2 5/8	2.76	5.51	11.03	16.54	22.05	4 5/8	8.56	17.11	34.23	51.34	68.45
2 11/16	2.89	5.78	11.56	17.34	23.12	4 11/16	8.79	17.58	35.16	52.74	70.32
2 3/4	3.03	6.05	12.10	18.15	24.20	4 3/4	9.03	18.05	36.10	54.15	72.20
2 13/16	3.16	6.33	12.66	18.98	25.32	4 13/16	9.26	18.53	37.06	55.58	74.12
2 7/8	3.31	6.61	13.23	19.84	26.45	4 7/8	9.51	19.01	38.03	57.04	76.05
2 15/16	3.45	6.90	13.81	20.71	27.62	4 15/16	9.75	19.50	39.01	58.51	78.02
3	3.60	7.20	14.40	21.60	28.80	5	10.00	20.00	40.00	60.00	80.00
3 1/16	3.75	7.50	15.01	22.51	30.02	5 1/16	10.25	20.50	41.01	61.51	82.02
3 1/8	3.91	7.81	15.63	23.44	31.25	5 1/8	10.51	21.01	42.03	63.04	84.05
3 3/16	4.06	8.13	16.26	24.38	32.52	5 3/16	10.76	21.53	43.06	64.58	86.12
3 1/4	4.23	8.45	16.90	25.35	33.80	5 1/4	11.03	22.05	44.10	66.15	88.20
3 5/16	4.39	8.78	17.56	26.34	35.12	5 5/16	11.29	22.58	45.16	67.74	90.32
3 3/8	4.56	9.11	18.23	27.34	36.45	5 3/8	11.56	23.11	46.23	69.34	92.45
3 7/16	4.73	9.45	18.91	28.36	37.82	5 7/16	11.83	23.65	47.31	70.96	94.62
3 1/2	4.90	9.80	19.60	29.40	39.20	5 1/2	12.10	24.20	48.40	72.60	96.80
3 9/16	5.08	10.15	20.31	30.46	40.62	5 9/16	12.38	24.75	49.51	74.26	99.02
3 5/8	5.26	10.51	21.03	31.54	42.05	5 5/8	12.66	25.31	50.63	75.94	101.25
3 11/16	5.44	10.88	21.76	32.64	43.52	5 11/16	12.94	25.88	51.76	77.64	103.52
3 3/4	5.63	11.25	22.50	33.75	45.00	5 3/4	13.23	26.45	52.90	79.35	105.80
3 13/16	5.81	11.63	23.26	34.88	46.52	5 13/16	13.51	27.03	54.06	81.08	108.12
3 7/8	6.01	12.01	24.03	36.04	48.05	5 7/8	13.81	27.61	55.23	82.84	110.45
3 15/16	6.20	12.40	24.81	37.21	49.62	5 15/16	14.10	28.20	56.41	84.61	112.82
						6	14.40	28.80	57.60	86.40	115.20

TABLE OF ELECTRICAL HORSE-POWER.

AMPERES.

Volts.	1	10	20	30	40	50	60	70	80	90	100	110
1	.00134	.0134	.0268	.0402	.0536	.0670	.0804	.0938	.0172	.1206	.1341	.1475
5	.00670	.0670	.1341	.2011	.2681	.3351	.4022	.4692	.5362	.6032	.6703	.7373
10	.01341	.1341	.2681	.4022	.5362	.6703	.8043	.9383	1.072	1.206	1.341	1.475
15	.02011	.2011	.4022	.6032	.8043	1.005	1.206	1.408	1.609	1.810	2.011	2.212
20	.02681	.2681	.5362	.8043	1.072	1.340	1.609	1.877	2.145	2.413	2.681	2.949
25	.03351	.3351	.6703	1.005	1.341	1.676	2.011	2.346	2.681	3.016	3.351	3.686
30	.04022	.4022	.8043	1.206	1.609	2.011	2.413	2.815	3.217	3.619	4.022	4.424
35	.04692	.4692	.9384	1.408	1.877	2.346	2.815	3.284	3.753	4.223	4.692	5.161
40	.05362	.5362	1.072	1.609	2.145	2.681	3.217	3.753	4.290	4.826	5.362	5.898
45	.06032	.6032	1.206	1.810	2.413	3.016	3.619	4.223	4.826	5.439	6.032	6.635
50	.06703	.6703	1.341	2.011	2.681	3.351	4.022	4.692	5.362	6.032	6.703	7.373
75	.10054	1.005	2.011	3.016	4.021	5.027	6.032	7.037	8.043	9.048	10.05	11.06
100	.13405	1.341	2.681	4.022	5.362	6.703	8.043	9.384	10.72	12.06	13.41	14.75
500	.67025	6.703	13.41	20.11	26.81	33.51	40.22	46.92	53.62	60.32	67.03	73.73
1,000	1.3405	13.41	26.81	40.22	53.62	67.03	80.43	93.84	107.2	120.6	134.1	147.5
5,000	6.7025	67.03	134.1	201.1	268.1	335.1	402.2	469.2	536.2	603.2	670.3	737.3
10,000	13.405	134.1	268.1	402.2	536.2	670.3	804.3	938.3	1072.0	1206.0	1341.0	1475.0

Rule: $\frac{\text{Volts} \times \text{Amperes}}{746} = \text{H.P.}$

TABLE OF GRADIENTS.

Showing the comparative lengths of the three sides of a right-angled triangle and the gravity due to incline for every degree of the quadrant.

No. of Degrees.	Inclination per Yard, in inches.	One in	Horizontal Measure, Hypothenuse being 1.	Vertical Measure Hypothenuse being 1.	Gravity due to Incline per Ton, in lb.
1	0.63	57.29	.99985	.01745	39.08
2	1.26	28.63	.99939	.03490	78.18
3	1.88	19.08	.99863	.05234	117.24
4	2.51	14.29	.99756	.06976	156.26
5	3.15	11.43	.99619	.08716	195.24
6	3.78	9.51	.99452	.10453	234.14
7	4.42	8.14	.99255	.12187	272.98
8	5.06	7.11	.99027	.13917	311.74
9	5.70	6.31	.98769	.15643	350.40
10	6.34	5.67	.98481	.17365	388.97
11	6.99	5.14	.98163	.19081	427.41
12	7.65	4.70	.97815	.20791	465.71
13	8.31	4.33	.97437	.22495	503.88
14	8.97	4.01	.97030	.24192	541.90
15	9.64	3.73	.96593	.25882	579.75
16	10.32	3.49	.96126	.27564	617.43
17	11.00	3.27	.95630	.29237	654.90
18	11.69	3.08	.95106	.30902	692.20
19	12.39	2.90	.94552	.32557	629.27
20	13.10	2.75	.93969	.34202	766.12
21	13.82	2.60	.93358	.35837	802.74
22	14.54	2.47	.92718	.37461	839.12
23	15.27	2.35	.92050	.39073	875.23
24	16.02	2.24	.91355	.40674	911.09
25	16.78	2.14	.90631	.42262	946.66
26	17.56	2.05	.89879	.43837	981.94
27	18.34	1.96	.89101	.45399	1016.93
28	19.14	1.88	.88295	.46947	1051.61
29	19.95	1.80	.87462	.48481	1085.97
30	20.78	1.73	.86602	.50000	1120.00
31	21.62	1.66	.85717	.51504	1153.68
32	22.49	1.60	.84805	.52992	1187.02
33	23.37	1.54	.83867	.54464	1219.99
34	24.28	1.48	.82904	.55919	1252.58
35	25.20	1.43	.81915	.57358	1284.81
36	26.15	1.37	.80902	.58778	1316.62
37	27.12	1.33	.79864	.60181	1348.05
38	28.12	1.28	.78801	.61566	1379.07
39	29.14	1.23	.77715	.62932	1409.67
40	30.21	1.19	.76604	.64279	1439.84
41	31.29	1.15	.75471	.65606	1469.57

TABLE OF GRADIENTS (*Continued*).

Showing the comparative lengths of the three sides of a right-angled triangle, and the gravity due to incline, for every degree of the quadrant.

No. of Degrees.	Inclination per Yard, in inches.	One in	Horizontal Measure, Hypothenuse being 1.	Vertical Measure, Hypothenuse being 1.	Gravity due to Incline per Ton, in lb.
42	32.41	1.11	.74314	.66913	1498.85
43	33.56	1.07	.73135	.68200	1527.68
44	34.76	1.03	.71934	.69466	1556.03
45	36.00	1.00	.70711	.70711	1583.92
46	37.27	.96	.69466	.71934	1611.32
47	38.60	.93	.68200	.73135	1638.22
48	39.98	.90	.66913	.74314	1664.63
49	41.41	.87	.65606	.75471	1690.55
50	42.90	.84	.64279	.76604	1715.92
51	44.46	.81	.62932	.77715	1740.81
52	46.07	.78	.61566	.78801	1765.14
53	47.77	.75	.60181	.79864	1788.95
54	49.54	.73	.58778	.80902	1812.20
55	51.41	.70	.57358	.81915	1834.89
56	53.36	.67	.55919	.82904	1857.04
57	55.44	.65	.54464	.83867	1878.62
58	57.61	.62	.52992	.84805	1899.63
59	59.92	.60	.51504	.85717	1920.06
60	62.35	.58	.50000	.86602	1939.88
61	64.94	.55	.48481	.87462	1959.14
62	67.69	.53	.46947	.88295	1977.80
63	70.65	.51	.45399	.89101	1995.86
64	73.80	.49	.43837	.89879	2013.28
65	77.20	.47	.42262	.90631	2030.13
66	80.86	.44	.40674	.91355	2046.35
67	84.81	.42	.39073	.92050	2061.92
68	89.10	.40	.37461	.92718	2076.88
69	93.77	.38	.35837	.93358	2091.21
70	98.91	.36	.34202	.93969	2104.90
71	104.53	.34	.32557	.94552	2117.96
72	110.80	.32	.30902	.95106	2130.37
73	117.73	.31	.29237	.95630	2140.11
74	125.56	.29	.27564	.96126	2153.22
75	134.37	.27	.25882	.96593	2163.68
76	144.40	.25	.24192	.97030	2173.47
77	155.90	.23	.22495	.97437	2182.58
78	169.36	.21	.20791	.97815	2191.05
79	185.20	.19	.19081	.98163	2198.85
80	204.10	.18	.17365	.98481	2205.97
81	227.34	.16	.15643	.98769	2212.42
82	256.11	.14	.13917	.99027	2218.20
83	293.13	.12	.12187	.99255	2223.26
84	342.60	.10	.10453	.99452	2227.72
85	411.27	.09	.08716	.99619	2231.46
86	514.52	.07	.06976	.99756	2234.53
87	—	.05	.05234	.99863	2236.93
88	—	.03	.03490	.99939	2238.63
89	—	.02	.01745	.99985	2239.66

HORSE-POWER TO HAUL ONE TON UP VARIOUS GRADES AT DIFFERENT SPEEDS, INCLUDING ONLY THE RESISTANCE DUE TO THE GRADE.

Speed in Miles per Hour.	Speed in Feet per Minute.	PERCENTAGE OF GRADE.									
		0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
1	88	0.027	0.053	0.08	0.107	0.133	0.16	0.187	0.213	0.24	0.267
2	176	0.053	0.107	0.16	0.213	0.267	0.32	0.373	0.427	0.480	0.533
3	264	0.080	0.160	0.24	0.320	0.400	0.48	0.560	0.64	0.72	0.800
4	352	0.107	0.213	0.32	0.427	0.533	0.64	0.747	0.853	0.96	1.07
5	440	0.133	0.267	0.40	0.533	0.667	0.80	0.933	1.07	1.20	1.33
6	526	0.159	0.319	0.48	0.638	0.797	0.956	1.12	1.28	1.43	1.59
7	616	0.187	0.373	0.56	0.747	0.933	1.12	1.31	1.49	1.68	1.87
8	704	0.213	0.427	0.64	0.853	1.07	1.28	1.49	1.71	1.92	2.13
9	792	0.240	0.480	0.72	0.960	1.20	1.44	1.68	1.92	2.16	2.40
10	880	0.267	0.533	0.80	1.07	1.33	1.60	1.87	2.13	2.40	2.67
12	1056	0.320	0.640	0.96	1.28	1.60	1.92	2.24	2.56	2.88	3.20
14	1232	0.373	0.747	1.12	1.49	1.87	2.24	2.61	2.99	3.36	3.73
16	1408	0.427	0.854	1.27	1.71	2.13	2.56	2.99	3.41	3.84	4.27
18	1584	0.480	0.960	1.44	1.92	2.40	2.88	3.36	3.84	4.32	4.80
20	1760	0.533	1.07	1.60	2.13	2.67	3.20	3.73	4.27	4.80	5.33
22	1936	0.587	1.17	1.76	2.35	2.93	3.52	4.11	4.69	5.26	5.87
24	2112	0.640	1.28	1.92	2.56	3.20	3.84	4.48	5.12	5.76	6.40
26	2288	0.693	1.39	2.08	2.77	3.47	4.16	4.85	5.55	6.24	6.93
28	2464	0.747	1.49	2.24	2.99	3.73	4.48	5.23	5.97	6.72	7.47
30	2640	0.800	1.60	2.40	3.20	4.00	4.80	5.60	6.40	7.20	8.00
35	3080	0.933	1.87	2.80	3.73	4.67	5.60	6.53	7.47	8.40	9.33
40	3520	1.07	2.13	3.20	4.27	5.33	6.40	7.47	8.53	9.60	10.7
45	3960	1.20	2.40	3.60	4.80	6.00	7.20	8.40	9.60	10.8	12.0
50	4400	1.33	2.67	4.00	5.33	6.67	8.00	9.33	10.7	12.0	13.3
55	4840	1.47	2.93	4.40	5.87	7.33	8.80	10.3	11.7	13.2	14.7
60	5280	1.60	3.20	4.80	6.40	8.00	9.60	11.2	12.8	14.4	16.0
65	5720	1.73	3.47	5.20	6.93	8.67	10.4	12.1	13.9	15.6	17.3
70	6160	1.87	3.73	5.60	7.47	9.33	11.2	13.1	14.9	16.8	18.7
75	6600	2.00	4.00	6.00	8.00	10.0	12.0	14.0	16.0	18.0	20.0
80	7040	2.13	4.27	6.40	8.54	10.7	12.8	14.9	17.1	19.2	21.3
85	7480	2.27	4.53	6.80	9.07	11.3	13.6	15.9	18.1	20.4	22.7
90	7920	2.40	4.80	7.20	9.60	12.0	14.4	16.8	19.2	21.6	24.0
95	8360	2.53	5.07	7.60	10.1	12.7	15.2	17.7	20.3	22.8	25.3
100	8808	2.67	5.33	8.00	10.7	13.3	16.0	18.7	21.3	24.0	26.7
Grade in Feet per mile		26.4	52.8	79.2	105.6	132.0	158.4	184.8	211.2	237.6	264.0

BROOKLANDS LAPS.

50ft. Line for Cars. **75-139.8 Secs.**

Seconds per Lap.	Miles per Hour.	Seconds per Lap.	Miles per Hour.	Seconds per Lap.	Miles per Hour.	Seconds per Lap.	Miles per Hour.	Seconds per Lap.	Miles per Hour.
75	132.80	**88**	113.19	**101**	98.62	**114**	87.38	**127**	78.43
75.2	132.46	88.2	112.93	101.2	98.43	114.2	87.22	127.2	78.31
75.4	132.11	88.4	112.68	101.4	98.23	114.4	87.07	127.4	78.18
75.6	131.76	88.6	112.42	101.6	98.04	114.6	86.92	127.6	78.06
75.8	131.41	88.8	112.17	101.8	97.85	114.8	86.77	127.8	77.93
76	131.06	**89**	111.92	**102**	97.65	**115**	86.62	**128**	77.81
76.2	130.72	89.2	111.67	102.2	97.46	115.2	86.46	128.2	77.69
76.4	130.38	89.4	111.42	102.4	97.27	115.4	86.32	128.4	77.57
76.6	130.04	89.6	111.17	102.6	97.08	115.6	86.17	128.6	77.45
76.8	129.70	89.8	110.92	102.8	96.90	115.8	86.02	128.8	77.33
77	129.36	**90**	110.68	**103**	96.71	**116**	85.87	**129**	77.21
77.2	129.03	90.2	110.43	103.2	96.52	116.2	85.72	129.2	77.09
77.4	128.69	90.4	110.19	103.4	96.33	116.4	85.57	129.4	76.97
77.6	128.36	90.6	109.94	103.6	96.15	116.6	85.43	129.6	76.85
77.8	128.03	90.8	109.70	103.8	95.96	116.8	85.28	129.8	76.73
78	127.70	**91**	109.46	**104**	95.78	**117**	85.13	**130**	76.62
78.2	127.38	91.2	109.22	104.2	95.59	117.2	84.99	130.2	76.51
78.4	127.05	91.4	108.98	104.4	95.41	117.4	84.84	130.4	76.39
78.6	126.73	91.6	108.74	104.6	95.23	117.6	84.70	130.6	76.27
78.8	126.41	91.8	108.51	104.8	95.05	117.8	84.56	130.8	76.15
79	126.09	**92**	108.27	**105**	94.86	**118**	84.41	**131**	76.03
79.2	125.77	92.2	108.03	105.2	94.68	118.2	84.27	131.2	75.92
79.4	125.45	92.4	107.80	105.4	94.50	118.4	84.13	131.4	75.80
79.6	125.14	92.6	107.57	105.6	94.33	118.6	83.99	131.6	75.69
79.8	124.82	92.8	107.34	105.8	94.15	118.8	83.84	131.8	75.57
80	124.51	**93**	107.10	**106**	93.97	**119**	83.70	**132**	75.46
80.2	124.20	93.2	106.88	106.2	93.79	119.2	83.56	132.2	75.34
80.4	123.89	93.4	106.65	106.4	93.62	119.4	83.42	132.4	75.23
80.6	123.58	93.6	106.42	106.6	93.44	119.6	83.28	132.6	75.12
80.8	123.28	93.8	106.19	106.8	93.27	119.8	83.14	132.8	75.01
81	122.97	**94**	105.97	**107**	93.09	**120**	83.00	**133**	74.89
81.2	122.67	94.2	105.74	107.2	92.92	120.2	82.86	133.2	74.78
81.4	122.37	94.4	105.52	107.4	92.74	120.4	82.73	133.4	74.66
81.6	122.07	94.6	105.29	107.6	92.57	120.6	82.59	133.6	74.55
81.8	121.77	94.8	105.07	107.8	92.40	120.8	82.45	133.8	74.44
82	121.47	**95**	104.85	**108**	92.23	**121**	82.31	**134**	74.33
82.2	121.18	95.2	104.63	108.2	92.06	121.2	82.18	134.2	74.22
82.4	120.88	95.4	104.41	108.4	91.89	121.4	82.04	134.4	74.11
82.6	120.59	95.6	104.19	108.6	91.72	121.6	81.91	134.6	74.00
82.8	120.30	95.8	103.97	108.8	91.55	121.8	81.77	134.8	73.89
83	120.01	**96**	103.76	**109**	91.38	**122**	81.64	**135**	73.78
83.2	119.72	96.2	103.54	109.2	91.22	122.2	81.51	135.2	73.67
83.4	119.43	96.4	103.33	109.4	91.05	122.4	81.37	135.4	73.56
83.6	119.15	96.6	103.11	109.6	90.88	122.6	81.24	135.6	73.46
83.8	118.86	96.8	102.90	109.8	90.72	122.8	81.11	135.8	73.35
84	118.58	**97**	102.69	**110**	90.55	**123**	80.98	**136**	73.24
84.2	118.30	97.2	102.48	110.2	90.39	123.2	80.85	136.2	73.13
84.4	118.02	97.4	102.27	110.4	90.22	123.4	80.72	136.4	73.02
84.6	117.74	97.6	102.06	110.6	90.06	123.6	80.59	136.6	72.92
84.8	117.46	97.8	101.85	110.8	89.90	123.8	80.46	136.8	72.81
85	117.19	**98**	101.64	**111**	89.74	**124**	80.33	**137**	72.71
85.2	116.91	98.2	101.43	111.2	89.58	124.2	80.20	137.2	72.60
85.4	116.64	98.4	101.23	111.4	89.41	124.4	80.07	137.4	72.49
85.6	116.36	98.6	101.02	111.6	89.25	124.6	79.94	137.6	72.39
85.8	116.09	98.8	100.82	111.8	89.09	124.8	79.81	137.8	72.28
86	115.82	**99**	100.61	**112**	88.94	**125**	79.68	**138**	72.18
86.2	115.55	99.2	100.41	112.2	88.78	125.2	79.55	138.2	72.07
86.4	115.29	99.4	100.21	112.4	88.62	125.4	79.43	138.4	71.97
86.6	115.02	99.6	100.01	112.6	88.46	125.6	79.30	138.6	71.87
86.8	114.75	99.8	99.81	112.8	88.30	125.8	79.17	138.8	71.76
87	114.49	**100**	99.61	**113**	88.15	**126**	79.05	**139**	71.66
87.2	114.23	100.2	99.41	113.2	87.99	126.2	78.92	139.2	71.56
87.4	113.97	100.4	99.21	113.4	87.84	126.4	78.79	139.4	71.45
87.6	113.71	100.6	99.01	113.6	87.68	126.6	78.67	139.6	71.35
87.8	113.45	100.8	98.82	113.8	87.53	126.8	78.55	139.8	71.25

BROOKLANDS LAPS. 50ft. Line for Cars (*Continued*).

140-204.8 Secs.

Seconds per Lap.	Miles per Hour.	Seconds per Lap.	Miles per Hour.	Seconds per Lap.	Miles per Hour.	Seconds per Lap.	Miles per Hour.	Seconds per Lap.	Miles per Hour.
140	71.15	**153**	65.10	**166**	60.00	**179**	55.65	**192**	51.88
140.2	71.05	153.2	65.01	166.2	59.93	179.2	55.58	192.2	51.82
140.4	70.95	153.4	64.93	166.4	59.86	179.4	55.52	192.4	51.77
140.6	70.84	153.6	64.84	166.6	59.78	179.6	55.46	192.6	51.72
140.8	70.74	153.8	64.76	166.8	59.71	179.8	55.40	192.8	51.66
141	70.64	**154**	64.67	**167**	59.64	**180**	55.34	**193**	51.61
141.2	70.54	154.2	64.59	167.2	59.57	180.2	55.28	193.2	51.56
141.4	70.44	154.4	64.50	167.4	59.50	180.4	55.22	193.4	51.50
141.6	70.34	154.6	64.42	167.6	59.43	180.6	55.16	193.6	51.44
141.8	70.24	154.8	64.34	167.8	59.36	180.8	55.09	193.8	51.39
142	70.14	**155**	64.26	**168**	59.29	**181**	55.03	**194**	51.34
142.2	70.05	155.2	64.17	168.2	59.22	181.2	54.97	194.2	51.29
142.4	69.95	155.4	64.09	168.4	59.15	181.4	54.91	194.4	51.23
142.6	69.85	155.6	64.01	168.6	59.08	181.6	54.85	194.6	51.18
142.8	69.75	155.8	63.92	168.8	59.01	181.8	54.79	194.8	51.13
143	69.66	**156**	63.84	**169**	58.94	**182**	54.73	**195**	51.08
143.2	69.56	156.2	63.76	169.2	58.87	182.2	54.67	195.2	51.03
143.4	69.46	156.4	63.68	169.4	58.80	182.4	54.61	195.4	50.98
143.6	69.36	156.6	63.60	169.6	58.73	182.6	54.55	195.6	50.93
143.8	69.27	156.8	63.52	169.8	58.66	182.8	54.49	195.8	50.88
144	69.17	**157**	63.44	**170**	58.59	**183**	54.43	**196**	50.83
144.2	69.08	157.2	63.35	170.2	58.52	183.2	54.37	196.2	50.77
144.4	68.98	157.4	63.27	170.4	58.45	183.4	54.31	196.4	50.72
144.6	68.88	157.6	63.19	170.6	58.38	183.6	54.25	196.6	50.67
144.8	68.79	157.8	63.11	170.8	58.32	183.8	54.20	196.8	50.62
145	68.69	**158**	63.03	**171**	58.25	**184**	54.14	**197**	50.57
145.2	68.60	158.2	62.95	171.2	58.18	184.2	54.08	197.2	50.52
145.4	68.50	158.4	62.87	171.4	58.11	184.4	54.02	197.4	50.46
145.6	68.41	158.6	62.80	171.6	58.04	184.6	53.96	197.6	50.41
145.8	68.31	158.8	62.72	171.8	57.98	184.8	53.90	197.8	50.36
146	68.22	**159**	62.64	**172**	57.91	**185**	53.84	**198**	50.31
146.2	68.13	159.2	62.56	172.2	57.84	185.2	53.79	198.2	50.26
146.4	68.03	159.4	62.48	172.4	57.78	185.4	53.73	198.4	50.21
146.6	67.94	159.6	62.40	172.6	57.71	185.6	53.67	198.6	50.16
146.8	67.85	159.8	62.32	172.8	57.64	185.8	53.61	198.8	50.11
147	67.76	**160**	62.25	**173**	57.58	**186**	53.55	**199**	50.06
147.2	67.66	160.2	62.17	173.2	57.51	186.2	53.50	199.2	50.01
147.4	67.57	160.4	62.09	173.4	57.44	186.4	53.44	199.4	49.96
147.6	67.48	160.6	62.02	173.6	57.38	186.6	53.39	199.6	49.91
147.8	67.39	160.8	61.94	173.8	57.31	186.8	53.33	199.8	49.86
148	67.30	**161**	61.86	**174**	57.25	**187**	53.27	**200**	49.81
148.2	67.21	161.2	61.79	174.2	57.18	187.2	53.21	200.2	49.76
148.4	67.12	161.4	61.71	174.4	57.11	187.4	53.15	200.4	49.71
148.6	67.03	161.6	61.64	174.6	57.05	187.6	53.10	200.6	49.66
148.8	66.94	161.8	61.56	174.8	56.98	187.8	53.04	200.8	49.61
149	66.85	**162**	61.48	**175**	56.92	**188**	52.99	**201**	49.56
149.2	66.76	162.2	61.41	175.2	56.85	188.2	52.93	201.2	49.51
149.4	66.67	162.4	61.33	175.4	56.79	188.4	52.87	201.4	49.46
149.6	66.58	162.6	61.26	175.6	56.72	188.6	52.81	201.6	49.41
149.8	66.48	162.8	61.18	175.8	56.66	188.8	52.76	201.8	49.36
150	66.39	**163**	61.11	**176**	56.59	**189**	52.70	**202**	49.31
150.2	66.30	163.2	61.03	176.2	56.53	189.2	52.65	202.2	49.27
150.4	66.22	163.4	60.96	176.4	56.47	189.4	52.59	202.4	49.22
150.6	66.13	163.6	60.88	176.6	56.40	189.6	52.54	202.6	49.17
150.8	66.04	163.8	60.81	176.8	56.34	189.8	52.48	202.8	49.12
151	65.96	**164**	60.73	**177**	56.27	**190**	52.43	**203**	49.07
151.2	65.87	164.2	60.66	177.2	56.21	190.2	52.37	203.2	49.02
151.4	65.78	164.4	60.59	177.4	56.15	190.4	52.32	203.4	48.98
151.6	65.70	164.6	60.51	177.6	56.08	190.6	52.26	203.6	48.93
151.8	65.61	164.8	60.44	177.8	56.02	190.8	52.21	203.8	48.88
152	65.52	**165**	60.37	**178**	55.96	**191**	52.15	**204**	48.83
152.2	65.44	165.2	60.29	178.2	55.89	191.2	52.10	204.2	48.78
152.4	65.35	165.4	60.22	178.4	55.83	191.4	52.04	204.4	48.74
152.6	65.26	165.6	60.15	178.6	55.77	191.6	51.99	204.6	48.69
152.8	65.18	165.8	60.07	178.8	55.71	191.8	51.94	204.8	48.64

BROOKLANDS LAPS. 50ft. Line for Cars (*Continued*).

205-264.8 Secs.

Seconds per Lap.	Miles per Hour.	Seconds per Lap.	Miles per Hour.	Seconds per Lap.	Miles per Hour.	Seconds per Lap.	Miles per Hour.	Seconds per Lap.	Miles per Hour.
205	48.59	**217**	45.91	**229**	43.50	**241**	41.33	**253**	39.37
205.2	48.54	217.2	45.86	229.2	43.46	241.2	41.29	253.2	39.34
205.4	48.50	217.4	45.82	229.4	43.43	241.4	41.26	253.4	39.31
205.6	48.45	217.6	45.78	229.6	43.39	241.6	41.22	253.6	39.27
205.8	48.40	217.8	45.74	229.8	43.35	241.8	41.19	253.8	39.24
206	48.36	**218**	45.70	**230**	43.31	**242**	41.16	**254**	39.21
206.2	48.31	218.2	45.65	230.2	43.28	242.2	41.12	254.2	39.18
206.4	48.26	218.4	45.61	230.4	43.24	242.4	41.09	254.4	39.15
206.6	48.22	218.6	45.57	230.6	43.20	242.6	41.06	254.6	39.12
206.8	48.17	218.8	45 53	230.8	43.16	242.8	41.02	254.8	39.09
207	48.12	**219**	45.49	**231**	43.13	**243**	40.99	**255**	39.06
207.2	48.08	219.2	45.45	231.2	43.09	243.2	40.96	255.2	39.03
207.4	48.03	219.4	45.40	231.4	43.05	243.4	40.92	255.4	39.00
207.6	47.98	219.6	45.36	231.6	43.01	243.6	40.89	255.6	38.97
207.8	47.94	219.8	45.32	231.8	42.98	243.8	40.85	255.8	38.94
208	47.89	**220**	45.28	**232**	42.94	**244**	40.82	**256**	38.91
208.2	47.85	220.2	45.24	232.2	42.90	244.2	40.79	256.2	38.88
208.4	47.80	220.4	45.20	232.4	42.87	244.4	40.75	256.4	38.85
208.6	47.75	220.6	45.16	232.6	42.83	244.6	40.72	256.6	38.82
208.8	47.71	220.8	45.12	232.8	42.79	244.8	40.69	256.8	38.79
209	47.66	**221**	45.08	**233**	42.75	**245**	40.65	**257**	38.76
209.2	47.62	221.2	45.03	233.2	42.72	245.2	40.62	257.2	38.73
209.4	47.57	221.4	44.99	233.4	42.68	245.4	40.59	257.4	38.70
209.6	47.53	221.6	44.95	233.6	42.65	245.6	40.55	257.6	38.67
209.8	47.48	221.6	44.91	233.8	42.61	245.8	40.52	257.8	38.64
210	47.43	**222**	44.87	**234**	42.57	**246**	40.49	**258**	38.62
210.2	47.39	222.2	44.83	234.2	42.54	246.2	40.45	258.2	38.59
210.4	47.34	222.4	44.79	234.4	42.50	246.4	40.42	258.4	38.55
210.6	47.29	222.6	44.75	234.6	42.46	246.6	40.39	258.6	38.52
210.8	47.25	222.8	44.71	234.8	42.43	246.8	40.36	258.8	38.49
211	47.20	**223**	44.67	**235**	42.39	**247**	40.32	**259**	38.46
211.2	47.16	223.2	44.63	235.2	42.36	247.2	40.29	259.2	38.43
211.4	47.12	223.4	44.59	235.4	42.32	247.4	40.26	259.4	38.40
211.6	47.07	223.6	44.55	235.6	42.28	247.6	40.23	259.6	38.37
211.8	47.03	223.8	44.51	235.8	42.25	247.8	40.19	259.8	38.34
212	46.99	**224**	44.47	**236**	42.21	**248**	40.16	**260**	38.31
212.2	46.94	224.2	44.43	236.2	42.17	248.2	40.13	260.2	38.28
212.4	46.90	224.4	44.39	236.4	42.13	248.4	40.10	260.4	38.25
212.6	46.85	224.6	44.35	236.6	42.10	248.6	40.07	260.6	38.22
212.8	46.81	224.8	44.31	236.8	42.06	248.8	40.03	260.8	38.19
213	46.77	**225**	44.27	**237**	42.03	**249**	40.00	**261**	38.16
213.2	46.72	225.2	44.23	237.2	42.00	249.2	39.97	261.2	38.13
213.4	46.68	225.4	44.19	237.4	41.96	249.4	39.94	261.4	38.10
213.6	46.63	225.6	44.16	237.6	41.93	249.6	39.90	261.6	38.07
213.8	46.59	225.8	44.12	237.8	41.89	249.8	39.87	261.8	38.05
214	46.55	**226**	44.08	**238**	41.86	**250**	39.84	**262**	38.02
214.2	46.51	226.2	44.04	238.2	41.82	250.2	39.81	262.2	37.99
214.4	46.46	226.4	44.00	238.4	41.79	250.4	39.78	262.4	37.96
214.6	46.42	226.6	43.96	238.6	41.75	250.6	39.74	262.6	37.93
214.8	46.37	226.8	43.92	238.8	41.72	250.8	39.71	262.8	37.90
215	46.33	**227**	43.88	**239**	41.68	**251**	39.68	**263**	37.87
215.2	46.29	227.2	43.85	239.2	41.65	251.2	39.65	263.2	37.84
215.4	46.25	227.4	43.81	239.4	41.61	251.4	39.62	263.4	37.81
215.6	46.20	227.6	43.77	239.6	41.58	251.6	39.59	263.6	37.79
215.8	46.16	227.8	43.73	239.8	41.54	251.8	39.56	263.8	37.76
216	46.12	**228**	43.69	**240**	41.50	**252**	39.52	**264**	37.73
216.2	46.08	228.2	43.65	240.2	41.47	252.2	39.49	264.2	37.70
216.4	46.03	228.4	43.62	240.4	41.43	252.4	39.46	264.4	37.67
216.6	45.99	228.6	43.58	240.6	41.40	252.6	39.43	264.6	37.64
216.8	45.95	228.8	43.54	240.8	41.36	252.8	39.40	264.8	37.61

BROOKLANDS LAP DISTANCES TO THE NEAREST YARD.

On the 50ft. line for Cars.

Laps.	Miles.	Yards.	Laps.	Miles.	Yards.	Laps.	Miles.	Yards.	Laps.	Miles.	Yards.	Laps.	Miles.	Yards.
1	2	1350	21	58	184	41	113	778	61	168	372	81	224	206
2	5	939	22	60	1533	42	116	367	62	171	962	82	226	1556
3	8	529	23	63	1123	43	118	1717	63	174	551	83	229	1145
4	11	119	24	66	713	44	121	1307	64	177	141	84	232	735
5	13	1469	25	69	303	45	124	897	65	179	1491	85	235	325
6	16	1058	26	71	1652	46	127	486	66	182	1080	86	237	1674
7	19	648	27	74	1242	47	130	76	67	185	670	87	240	1264
8	22	238	28	77	831	48	132	1426	68	188	260	88	243	854
9	24	1587	29	80	421	49	135	1016	69	190	1610	89	246	444
10	27	1177	30	83	11	50	138	605	70	193	1199	90	249	33
11	30	967	31	85	1361	51	141	195	71	196	789	91	251	1383
12	33	356	32	88	950	52	143	1545	72	199	379	92	254	973
13	35	1706	33	91	540	53	146	1134	73	201	1728	93	257	562
14	38	1296	34	94	130	54	149	724	74	204	1318	94	260	152
15	41	885	35	96	1480	55	152	314	75	207	908	95	262	1502
16	44	475	36	99	1069	56	154	1663	76	210	497	96	265	1092
17	47	65	37	102	659	57	157	1253	77	213	87	97	268	681
18	49	1415	38	105	249	58	160	843	78	215	1437	98	271	271
19	52	1004	39	107	1598	59	163	432	79	218	1027	99	273	1621
20	55	594	40	110	1188	60	166	22	80	221	616	100	276	1210

REFERENCE TABLE showing equivalent speed in miles and kilometres per hour for elapsed time over a measured mile or measured kilometre from 24 secs. progressively by .2 sec. to 60 secs. and from 60 secs. progressively by secs. to 120 secs.

The Table was compiled approximating in the fourth figure, so that the last figure must be accepted as an approximation only.

Time in Seconds.	For One Mile equals		For One Kilometre equals	
	Miles per hour.	Kilometres per hour.	Kilometres per hour.	Miles per hour.
24	150.0	241.3	150.0	93.24
.2	148.8	239.3	148.8	92.47
.4	147.5	237.3	147.5	91.70
.6	146.3	235.5	146.3	90.97
.8	145.2	233.5	145.2	90.22
25	144.0	231.7	144.0	89.52
.2	142.9	229.8	142.9	88.80
.4	141.8	228.0	141.8	88.10
.6	140.6	226.2	140.6	87.42
.8	139.5	224.5	139.5	86.74
26	138.5	222.7	138.5	86.06
.2	137.4	221.3	137.4	85.41
.4	136.3	219.4	136.3	84.76
.6	135.3	217.7	135.3	84.12
.8	134.4	216.1	134.4	83.51
27	133.3	214.5	133.3	82.85
.2	132.3	212.9	132.3	82.26
.4	131.4	211.3	131.4	81.47
.6	130.4	209.8	130.4	81.08
.8	129.5	208.4	129.5	80.50
28	128.5	206.8	128.5	79.91
.2	127.6	205.4	127.6	79.36
.4	126.8	203.9	126.8	78.79
.6	125.9	202.5	125.9	78.23
.8	125.0	201.1	125.0	77.69
29	124.2	199.7	124.2	77.14
.2	123.3	198.4	123.3	76.63
.4	122.5	197.0	122.5	76.19
.6	121.6	195.6	121.6	75.60
.8	120.8	194.4	120.8	75.09
30	120.0	193.1	120.0	74.59
.2	119.2	191.8	119.2	74.09
.4	118.4	190.5	118.4	73.60
.6	117.7	189.2	117.7	73.13
.8	116.9	188.0	116.9	72.64
31	116.1	186.8	116.1	72.18
.2	115.3	185.7	115.3	71.71
.4	114.7	184.5	114.7	71.27
.6	114.0	183.2	114.0	70.81
.8	113.2	182.2	113.2	70.37
32	112.5	180.9	112.5	69.92
.2	111.8	179.9	111.8	69.49
.4	111.1	178.7	111.1	69.07
.6	110.4	177.6	110.4	68.64
.8	109.7	176.6	109.7	68.22
33	109.1	175.5	109.1	67.81
.2	108.4	174.5	108.4	67.41
.4	107.7	173.4	107.7	67.01
.6	107.2	172.4	107.2	66.61
.8	106.5	171.4	106.5	66.21
34	105.9	170.3	105.9	65.82
.2	105.3	169.3	105.3	65.43
.4	104.7	168.4	104.7	65.04
.6	104.0	167.4	104.0	64.68
.8	103.5	166.4	103.5	64.30

REFERENCE TABLE (*Continued*).

Time in Seconds.	For One Mile equals		For One Kilometre equals	
	Miles per hour.	Kilometres per hour.	Kilometres per hour.	Miles per hour.
35	102.8	165.5	102.8	63.93
.2	102.3	164.5	102.3	63.57
.4	101.7	163.6	101.7	63.22
.6	101.0	162.8	101.0	62.87
.8	100.6	161.7	100.6	62.50
36	100.0	160.9	100.0	62.16
.2	99.45	160.0	99.45	61.81
.4	98.91	159.2	98.91	61.48
.6	98.35	158.2	98.35	61.13
.8	97.83	157.4	97.83	60.81
37	97.29	156.5	97.29	60.47
.2	96.79	155.7	96.79	60.16
.4	96.25	154.8	96.25	59.82
.6	95.74	154.0	95.74	59.51
.8	95.23	153.2	95.23	59.20
38	94.72	152.4	94.72	58.88
.2	94.23	151.6	94.23	58.57
.4	93.76	150.9	93.76	58.28
.6	93.26	150.1	93.26	57.97
.8	92.79	149.3	92.79	57.68
39	92.30	148.5	92.30	57.35
.2	91.83	147.8	91.83	57.09
.4	91.37	147.0	91.37	56.79
.6	90.90	146.2	90.90	56.50
.8	90.44	145.5	90.44	56.22
40	89.99	144.7	89.99	55.94
.2	89.56	144.1	89.56	55.67
.4	89.10	143.3	89.10	55.39
.6	88.67	142.7	88.67	55.12
.8	88.26	141.9	88.26	54.84
41	87.80	141.3	87.80	54.58
.2	87.38	140.6	87.38	54.31
.4	86.96	139.9	86.96	54.05
.6	86.54	139.2	86.54	53.79
.8	86.12	138.6	86.12	53.53
42	85.72	137.9	85.72	53.28
.2	85.31	137.3	85.31	53.03
.4	85.09	136.6	85.09	52.77
.6	84.50	135.9	84.50	52.53
.8	84.12	135.3	84.12	52.29
43	83.71	134.7	83.71	52.04
.2	83.33	134.1	83.33	51.80
.4	82.94	133.5	82.94	51.56
.6	82.56	132.8	82.56	51.33
.8	82.19	132.2	82.19	51.09
44	81.81	131.6	81.81	50.86
.2	81.45	131.0	81.45	50.54
.4	81.08	130.4	81.08	50.40
.6	80.72	129.9	80.72	50.18
.8	80.35	129.3	80.35	49.95
45	80.00	128.7	80.00	49.73
.2	79.66	128.1	79.66	49.51
.4	79.29	127.6	79.29	49.28
.6	78.94	127.0	78.94	49.18
.8	78.59	126.5	78.59	48.85
46	78.25	125.9	78.25	48.64
.2	77.93	125.4	77.93	48.44
.4	77.59	124.8	77.59	48.22
.6	77.25	124.3	77.25	48.01
.8	76.93	123.8	76.93	47.82

REFERENCE TABLE (*Continued*).

Time in Seconds.	For One Mile equals		For One Kilometre equals	
	Miles per hour.	Kilometres per hour.	Kilometres per hour.	Miles per hour.
47	76.60	123.2	76.60	47.61
.2	76.28	122.8	76.28	47.42
.4	75.95	122.2	75.95	47.21
.6	75.63	121.7	75.63	47.01
.8	75.32	121.2	75.32	46.81
48	75.01	120.7	75.01	46.62
.2	74.69	120.1	74.69	46.43
.4	74.39	119.7	74.39	46.24
.6	74.08	119.2	74.08	46.05
.8	73.77	118.7	73.77	45.85
49	73.47	118.2	73.47	45.66
.2	73.16	117.7	73.16	45.47
.4	72.88	117.2	72.88	45.30
.6	72.57	116.8	72.57	45.11
.8	72.30	116.3	72.30	44.93
50	71.99	115.8	71.99	44.75
.2	71.71	115.3	71.71	44.58
.4	71.44	114.9	71.44	44.40
.6	71.14	114.5	71.14	44.22
.8	70.86	114.0	70.86	44.04
51	70.58	113.6	70.58	43.87
.2	70.31	113.1	70.31	43.70
.4	70.03	112.7	70.03	43.53
.6	69.77	112.3	69.77	43.37
.8	69.50	111.8	69.50	43.20
52	69.23	111.4	69.23	43.03
.2	68.96	110.9	68.96	42.86
.4	68.71	110.5	68.71	42.71
.6	68.44	110.1	68.44	42.54
.8	68.19	109.7	68.19	42.38
53	67.92	109.2	67.92	42.22
.2	67.67	108.8	67.67	42.07
.4	67.42	108.5	67.42	41.91
.6	67.16	108.0	67.16	41.75
.8	66.91	107.6	66.91	41.59
54	66.67	107.3	66.67	41.44
.2	66.42	106.9	66.42	41.29
.4	66.08	106.4	66.08	41.13
.6	65.94	106.0	65.94	40.99
.8	65.69	105.7	65.69	40.83
55	65.45	105.3	65.45	40.68
.2	65.22	104.9	65.22	40.54
.4	64.98	104.6	64.98	40.39
.6	64.74	104.2	64.74	40.24
.8	64.52	103.8	64.52	40.11
56	64.28	103.4	64.28	39.96
.2	64.06	103.0	64.06	39.82
.4	63.83	102.7	63.83	39.68
.6	63.60	102.3	63.60	39.54
.8	63.39	102.0	63.39	39.41
57	63.16	101.6	63.16	39.25
.2	62.94	101.3	62.94	39.12
.4	62.72	100.9	62.72	38.98
.6	62.50	100.6	62.50	38.86
.8	62.29	100.2	62.29	38.72
58	62.07	99.86	62.07	38.59
.2	61.86	99.49	61.86	38.45
.4	61.65	99.17	61.65	38.32
.6	61.44	98.83	61.44	38.19
.8	61.22	98.49	61.22	38.06
59	61.01	98.15	61.01	37.92
.2	60.81	97.83	60.81	37.80
.4	60.60	97.50	60.60	37.67
.6	60.40	97.18	60.40	37.55
.8	60.20	96.85	60.20	37.42

REFERENCE TABLE (*Continued*).

Time in Seconds.	For One Mile equals		For One Kilometre equals	
	Miles per hour.	Kilometres per hour.	Kilometres per hour.	Miles per hour.
60	60.00	96.51	60.00	37.29
61	59.02	94.95	59.02	36.68
62	58.06	93.42	58.06	36.09
63	57.15	91.94	57.15	35.52
64	56.24	90.48	56.24	34.96
65	55.43	89.10	55.43	34.43
66	54.55	87.76	54.55	33.90
67	53.73	86.44	53.73	33.40
68	52.94	85.17	52.94	32.91
69	52.18	83.95	52.18	32.43
70	51.42	82.73	51.42	31.97
71	50.70	81.56	50.70	31.52
72	50.00	80.44	50.00	31.09
73	49.32	79.34	49.32	30.66
74	48.65	78.27	48.65	30.24
75	47.99	77.21	47.99	29.84
76	47.37	76.21	47.37	29.44
77	46.76	75.21	46.76	29.06
78	46.15	74.42	46.15	28.69
79	45.57	73.31	45.57	28.32
80	45.00	72.40	45.00	27.97
81	44.44	71.50	44.44	27.63
82	43.90	70.63	43.90	27.29
83	43.37	69.77	43.37	26.96
84	42.85	68.95	42.85	26.64
85	42.36	68.14	42.36	26.32
86	41.86	67.35	41.86	26.02
87	41.38	66.58	41.38	25.72
88	40.91	65.82	40.91	25.43
89	40.44	65.07	40.44	25.14
90	40.00	64.36	40.00	24.86
91	39.57	63.65	39.57	24.60
92	39.13	62.95	39.13	24.32
93	38.71	62.27	38.71	24.06
94	38.30	61.62	38.30	23.81
95	37.89	60.96	37.89	23.56
96	37.50	60.33	37.50	23.31
97	37.11	59.70	37.11	23.07
98	36.74	59.10	36.74	22.83
99	36.37	58.51	36.37	22.60
100	36.00	57.92	36.00	22.38
101	35.65	57.35	35.65	22.16
102	35.30	56.78	35.30	21.94
103	34.95	56.23	34.95	21.73
104	34.61	55.69	34.61	21.52
105	34.29	55.16	34.29	21.31
106	33.96	54.64	33.96	21.11
107	33.64	54.13	33.64	20.91
108	33.34	53.63	33.34	20.72
109	33.03	53.14	33.03	20.53
110	32.73	52.65	32.73	20.34
111	32.43	52.18	32.43	20.16
112	32.15	51.71	32.15	19.98
113	31.85	51.25	31.85	19.80
114	31.58	50.81	31.58	19.63
115	31.30	50.36	31.30	19.45
116	31.03	49.92	31.03	19.29
117	30.77	49.50	30.77	19.13
118	30.51	49.08	30.51	18.96
119	30.26	48.67	30.26	18.80
120	30.00	48.26	30.00	18.65

CYLINDER CAPACITIES IN CUBIC INCHES.

VOLUMES IN CUBIC INCHES OF SINGLE CYLINDERS. From 2in. × 2in. to 2 15/16in. × 6in.

STROKE IN INCHES.	BORE IN INCHES.															
	2	2 1/16	2 1/8	2 3/16	2 1/4	2 5/16	2 3/8	2 7/16	2 1/2	2 9/16	2 5/8	2 11/16	2 3/4	2 13/16	2 7/8	2 15/16
2	6.3	6.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2 1/8	6.7	7.1	7.5	8.0	—	—	—	—	—	—	—	—	—	—	—	—
2 1/4	7.1	7.5	8.0	8.5	8.9	9.5	—	—	—	—	—	—	—	—	—	—
2 3/8	7.5	7.9	8.4	8.9	9.4	10.0	10.5	11.1	—	—	—	—	—	—	—	—
2 1/2	7.9	8.4	8.9	9.4	9.9	10.5	11.1	11.7	12.3	12.9	—	—	—	—	—	—
2 5/8	8.2	8.8	9.3	9.9	10.4	11.0	11.6	12.3	12.9	13.5	14.2	14.9	—	—	—	—
2 3/4	8.6	9.2	9.8	10.3	10.9	11.6	12.2	12.8	13.5	14.2	14.9	15.6	16.3	17.1	—	—
2 7/8	9.0	9.6	10.2	10.8	11.4	12.1	12.7	13.4	14.1	14.8	15.6	16.3	17.1	17.9	18.7	19.5
3	9.4	10.0	10.6	11.3	11.9	12.6	13.3	14.0	14.7	15.5	16.2	17.0	17.8	18.6	19.5	20.3
3 1/8	9.8	10.4	11.1	11.7	12.4	13.1	13.8	14.6	15.3	16.1	16.9	17.7	18.6	19.4	20.3	21.2
3 1/4	10.2	10.9	11.5	12.2	12.9	13.7	14.4	15.2	16.0	16.8	17.6	18.4	19.3	20.2	21.1	22.0
3 3/8	10.6	11.3	12.0	12.7	13.4	14.2	15.0	15.8	16.6	17.4	18.3	19.1	20.0	21.0	21.9	22.9
3 1/2	11.0	11.7	12.4	13.2	13.9	14.7	15.5	16.3	17.2	18.1	18.9	19.9	20.8	21.7	22.7	23.7
3 5/8	11.4	12.1	12.9	13.6	14.4	15.2	16.1	16.9	17.8	18.7	19.6	20.6	21.5	22.5	23.5	24.6
3 3/4	11.8	12.5	13.3	14.1	14.9	15.8	16.6	17.5	18.4	19.3	20.3	21.3	22.3	23.3	24.3	25.4
3 7/8	12.2	12.9	13.7	14.6	15.4	16.3	17.2	18.1	19.0	20.0	21.0	22.0	23.0	24.1	25.2	26.3
4	12.6	13.4	14.2	15.0	15.9	16.8	17.7	18.7	19.6	20.6	21.6	22.7	23.8	24.9	26.0	27.1
4 1/8	13.0	13.8	14.6	15.5	16.4	17.3	18.3	19.2	20.2	21.3	22.3	23.4	24.5	25.6	26.8	28.0
4 1/4	—	14.2	15.1	16.0	16.9	17.9	18.8	19.8	20.9	21.9	23.0	24.1	25.2	26.4	27.6	28.8
4 3/8	—	—	15.5	16.4	17.4	18.4	19.4	20.4	21.5	22.6	23.7	24.8	26.0	27.2	28.4	29.6
4 1/2	—	—	—	16.9	17.9	18.9	19.9	21.0	22.1	23.2	24.4	25.5	26.7	28.0	29.2	30.5
4 5/8	—	—	—	—	18.4	19.4	20.5	21.6	22.7	23.9	25.0	26.2	27.5	28.7	30.0	31.3
4 3/4	—	—	—	—	—	20.0	21.0	22.2	23.3	24.5	25.7	26.9	28.2	29.5	30.8	32.2
4 7/8	—	—	—	—	—	—	21.6	22.7	23.9	25.1	26.4	27.7	29.0	30.3	31.7	33.0
5	—	—	—	—	—	—	—	23.3	24.5	25.8	27.1	28.4	29.7	31.1	32.5	33.9
5 1/8	—	—	—	—	—	—	—	—	25.2	26.4	27.7	29.1	30.4	31.8	33.3	34.7
5 1/4	—	—	—	—	—	—	—	—	—	27.1	28.4	29.8	31.2	32.6	34.1	35.6
5 3/8	—	—	—	—	—	—	—	—	—	—	29.1	30.5	31.9	33.4	34.9	36.4
5 1/2	—	—	—	—	—	—	—	—	—	—	—	31.2	32.7	34.2	35.7	37.3
5 5/8	—	—	—	—	—	—	—	—	—	—	—	—	33.4	34.9	36.5	38.1
5 3/4	—	—	—	—	—	—	—	—	—	—	—	—	—	35.7	37.3	40.0
5 7/8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	38.2	39.8
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40.7

VOLUMES IN CUBIC INCHES OF SINGLE CYLINDERS. From 3in. × 3in. to 3 1/16 in. × 8in.

STROKE IN INCHES.	BORE IN INCHES															
	3	3 1/16	3 1/8	3 3/16	3 1/4	3 5/16	3 3/8	3 7/16	3 1/2	3 9/16	3 5/8	3 11/16	3 3/4	3 13/16	3 7/8	3 15/16
3	21.2	22.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3 1/8	22.1	23.0	24.0	24.9	—	—	—	—	—	—	—	—	—	—	—	—
3 1/4	23.0	23.9	24.9	25.9	26.9	28.0	—	—	—	—	—	—	—	—	—	—
3 3/8	23.8	24.8	25.9	26.9	28.0	29.1	30.2	31.3	—	—	—	—	—	—	—	—
3 1/2	24.7	25.8	26.8	27.9	29.0	30.2	31.3	32.5	33.7	34.9	—	—	—	—	—	—
3 5/8	25.6	26.7	27.8	28.9	30.1	31.2	32.4	33.6	34.9	36.1	37.4	38.7	—	—	—	—
3 3/4	26.5	27.6	28.7	29.9	31.1	32.3	33.5	34.8	36.1	37.4	38.7	40.0	41.4	42.8	—	—
3 7/8	27.4	28.5	29.7	30.9	32.1	33.4	34.7	35.9	37.3	38.6	40.0	41.4	42.8	44.2	45.7	47.2
4	28.3	29.5	30.7	31.9	33.2	34.5	35.8	37.1	38.5	39.9	41.3	42.7	44.2	45.7	47.2	48.7
4 1/8	29.1	30.4	31.6	32.9	34.2	35.5	36.9	38.3	39.7	41.1	42.6	44.0	45.5	47.1	48.6	50.2
4 1/4	30.0	31.3	32.6	33.9	35.2	36.6	38.0	39.4	40.9	42.4	43.9	45.4	46.9	48.5	50.1	51.7
4 3/8	30.9	32.2	33.5	34.9	36.3	37.7	39.1	40.6	42.1	43.6	45.1	46.7	48.3	49.9	51.6	53.3
4 1/2	31.8	33.1	34.5	35.9	37.3	38.8	40.2	41.8	43.3	44.8	46.4	48.0	49.7	51.4	53.1	54.8
4 5/8	32.7	34.1	35.5	36.9	38.4	39.8	41.4	42.9	44.5	46.1	47.7	49.4	51.1	52.8	54.5	56.3
4 3/4	33.6	35.0	36.4	37.9	39.4	40.9	42.5	44.1	45.7	47.3	49.0	50.7	52.4	54.2	56.0	57.8
4 7/8	34.4	35.9	37.4	38.9	40.4	42.0	43.6	45.2	46.9	48.6	50.3	52.1	53.8	55.6	57.5	59.3
5	35.3	36.8	38.3	39.9	41.5	43.1	44.7	46.4	48.1	49.8	51.6	53.4	55.2	57.1	59.0	60.9
5 1/8	36.2	37.7	39.3	40.9	42.5	44.0	45.8	47.6	49.3	51.1	52.9	54.7	56.6	58.5	60.4	62.4
5 1/4	37.1	38.7	40.3	41.9	43.5	45.2	47.0	48.7	50.5	52.3	54.2	56.1	58.0	59.9	61.9	63.9
5 3/8	38.0	39.6	41.2	42.9	44.6	46.3	48.1	49.9	51.7	53.6	55.5	57.4	59.4	61.3	63.4	65.4
5 1/2	38.9	40.5	42.2	43.9	45.6	47.4	49.2	51.0	52.9	54.8	56.8	58.7	60.7	62.8	64.9	67.0
5 5/8	39.7	41.4	43.1	44.9	46.6	48.5	50.3	51.9	54.1	56.1	58.0	60.1	62.1	64.2	66.3	68.5
5 3/4	40.6	42.3	44.1	45.9	47.7	49.5	51.4	53.4	55.3	57.3	59.3	61.4	63.5	65.6	67.8	70.0
5 7/8	41.5	43.3	45.0	46.9	48.7	50.6	52.5	54.5	56.5	58.5	60.6	62.7	64.9	67.1	69.3	71.5
6	42.4	44.2	46.0	47.9	49.8	51.7	53.7	55.7	57.7	59.8	61.9	64.1	66.3	68.5	70.7	73.0
6 1/8	43.3	45.1	47.0	48.9	50.8	52.8	54.8	56.8	58.9	61.0	63.2	65.1	67.6	69.9	72.2	74.6
6 1/4	—	46.0	47.9	49.9	51.8	53.8	55.9	58.0	60.1	62.3	64.5	66.7	69.0	71.3	73.7	76.1
6 3/8	—	—	48.9	50.9	52.9	54.9	57.0	59.2	61.3	63.5	65.8	68.1	70.4	72.8	75.2	77.6
6 1/2	—	—	—	51.9	53.9	56.0	58.1	60.3	62.5	64.8	67.1	69.4	71.8	74.2	76.6	79.1
6 5/8	—	—	—	—	54.9	57.1	59.3	61.5	63.7	66.0	68.4	70.7	73.2	75.6	78.1	80.7
6 3/4	—	—	—	—	—	58.2	60.4	62.6	64.9	67.3	69.7	72.1	74.5	77.0	79.6	82.2
6 7/8	—	—	—	—	—	—	61.5	63.8	66.1	68.5	70.9	73.4	75.9	78.5	81.1	83.7
7	—	—	—	—	—	—	—	65.0	67.3	69.8	72.2	74.7	77.3	79.9	82.5	85.2
7 1/8	—	—	—	—	—	—	—	—	68.5	71.0	73.5	76.1	78.7	81.3	84.0	86.7
7 1/4	—	—	—	—	—	—	—	—	—	72.3	74.8	77.4	80.1	82.8	85.5	88.3
7 3/8	—	—	—	—	—	—	—	—	—	—	76.1	78.7	81.4	84.2	87.0	89.8
7 1/2	—	—	—	—	—	—	—	—	—	—	—	80.1	82.8	85.6	88.4	91.3
7 5/8	—	—	—	—	—	—	—	—	—	—	—	—	84.2	87.0	89.9	92.8
7 3/4	—	—	—	—	—	—	—	—	—	—	—	—	—	88.5	91.4	94.4
7 7/8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	92.9	95.9
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	97.4

VOLUMES IN CUBIC INCHES OF SINGLE CYLINDERS. From 4in. × 4in. to $4\frac{15}{16}$in. × 8in.

STROKE IN INCHES.	BORE IN INCHES.															
	4	$4\frac{1}{16}$	$4\frac{1}{8}$	$4\frac{3}{16}$	$4\frac{1}{4}$	$4\frac{5}{16}$	$4\frac{3}{8}$	$4\frac{7}{16}$	$4\frac{1}{2}$	$4\frac{9}{16}$	$4\frac{5}{8}$	$4\frac{11}{16}$	$4\frac{3}{4}$	$4\frac{13}{16}$	$4\frac{7}{8}$	$4\frac{15}{16}$
4	50.3	51.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—
$4\frac{1}{8}$	51.8	53.5	55.1	56.8	—	—	—	—	—	—	—	—	—	—	—	—
$4\frac{1}{4}$	53.4	55.1	56.8	58.5	60.3	62.1	—	—	—	—	—	—	—	—	—	—
$4\frac{3}{8}$	55.0	56.7	58.5	60.2	62.1	63.9	65.8	67.6	—	—	—	—	—	—	—	—
$4\frac{1}{2}$	56.5	58.3	60.1	62.0	63.8	65.7	67.6	69.6	71.6	73.6	—	—	—	—	—	—
$4\frac{5}{8}$	58.1	59.9	61.8	63.7	65.6	67.5	69.5	71.5	73.5	75.6	77.7	79.8	—	—	—	—
$4\frac{3}{4}$	59.7	61.6	63.5	65.4	67.4	69.4	71.4	73.4	75.5	77.6	79.8	82.0	84.4	86.4	—	—
$4\frac{7}{8}$	61.2	63.2	65.1	67.1	69.1	71.2	73.3	75.4	77.5	79.7	81.9	84.1	86.4	88.7	91.0	93.3
5	62.8	64.8	66.8	68.8	70.9	73.0	75.2	77.3	79.5	81.7	84.2	86.3	88.6	90.9	93.3	95.7
$5\frac{1}{8}$	64.4	66.4	68.5	70.6	72.7	74.8	77.0	79.2	81.5	83.8	86.1	88.4	90.8	93.2	95.6	98.1
$5\frac{1}{4}$	66.0	68.0	70.1	72.3	74.5	76.7	78.9	81.2	83.5	85.8	88.2	90.6	93.0	95.5	98.0	100.5
$5\frac{3}{8}$	67.5	69.7	71.8	74.0	76.2	78.5	80.8	83.1	85.5	87.9	90.3	92.7	95.2	97.8	100.3	102.9
$5\frac{1}{2}$	69.1	71.3	73.5	75.7	78.0	80.3	82.7	85.0	87.5	89.9	92.4	94.9	97.5	100.0	102.6	105.3
$5\frac{5}{8}$	70.4	72.9	75.2	77.5	79.8	82.1	84.5	87.0	89.4	92.0	94.5	97.1	99.7	102.3	105.0	107.7
$5\frac{3}{4}$	72.2	74.5	76.8	79.2	81.6	84.0	86.4	88.9	91.4	94.0	96.6	99.2	101.9	104.6	107.3	110.1
$5\frac{7}{8}$	73.8	76.1	78.5	80.9	83.3	85.6	88.3	90.8	93.4	96.0	98.7	101.4	104.1	106.9	109.6	112.5
6	75.4	77.8	80.2	82.6	85.1	87.6	90.2	92.8	95.4	98.1	100.8	103.5	106.3	109.1	112.0	114.9
$6\frac{1}{8}$	77.0	79.4	81.8	84.3	86.9	89.5	92.1	94.7	97.4	100.1	102.9	105.7	108.5	111.4	114.3	117.3
$6\frac{1}{4}$	78.5	81.0	83.5	86.1	88.9	91.3	93.9	96.6	99.4	102.2	105.0	107.8	110.7	113.7	116.6	119.7
$6\frac{3}{8}$	80.1	82.6	85.2	87.8	90.4	93.1	95.8	98.6	101.4	104.2	107.1	110.0	113.0	115.9	119.0	122.1
$6\frac{1}{2}$	81.7	84.2	86.9	89.5	92.2	94.9	97.7	100.5	103.4	106.3	109.2	112.2	115.2	118.2	121.4	124.4
$6\frac{5}{8}$	83.2	85.9	88.5	91.2	94.0	96.8	99.6	102.4	105.4	108.3	111.3	114.3	117.4	120.5	123.1	126.8
$6\frac{3}{4}$	84.8	87.5	90.2	92.9	95.7	98.6	101.5	104.4	107.3	110.3	113.4	116.5	119.6	122.8	126.0	129.2
$6\frac{7}{8}$	86.4	89.1	91.9	94.7	97.5	100.4	103.3	106.3	109.3	112.4	115.5	118.6	121.8	125.0	128.3	131.6
7	88.0	90.7	93.5	96.4	99.3	102.2	105.2	108.2	111.3	114.4	117.6	120.8	124.0	127.3	130.6	134.0
$7\frac{1}{8}$	89.5	92.3	95.2	98.1	101.1	104.1	107.1	110.2	113.3	116.5	119.7	122.9	126.2	129.6	133.0	136.4
$7\frac{1}{4}$	91.1	94.0	96.9	99.8	102.3	105.9	109.0	112.1	115.3	118.5	121.8	125.1	128.5	131.9	135.3	138.8
$7\frac{3}{8}$	92.7	95.6	98.5	101.6	104.6	107.7	110.9	114.0	117.3	120.6	123.9	127.3	130.7	134.1	137.6	141.2
$7\frac{1}{2}$	94.2	97.2	100.2	103.3	106.4	109.5	112.7	116.0	119.3	122.6	126.0	129.4	132.9	136.4	140.0	143.6
$7\frac{5}{8}$	95.8	98.8	101.9	105.0	108.2	111.4	114.6	117.9	121.3	124.6	128.1	131.6	135.1	138.7	142.3	146.0
$7\frac{3}{4}$	97.4	100.4	103.6	106.7	109.9	113.2	116.5	119.8	123.2	126.7	130.2	133.7	137.3	141.0	144.6	148.4
$7\frac{7}{8}$	98.9	102.1	105.2	108.4	111.7	115.0	118.4	121.8	125.2	128.7	132.3	135.9	139.5	143.2	147.0	150.8
8	100.5	103.7	106.9	110.2	113.5	116.8	120.3	123.7	127.2	130.8	134.4	138.0	141.8	145.5	149.3	153.2

VOLUMES IN CUBIC INCHES OF SINGLE CYLINDERS.

From 5in. × 5in. to 5¾in. × 8in.

STROKE IN INCHES.	BORE IN INCHES.												
	5	5 1/16	5 1/8	5 3/16	5 1/4	5 5/16	5 3/8	5 7/16	5 1/2	5 9/16	5 5/8	5 11/16	5 3/4
5	98.2	100.6	—	—	—	—	—	—	—	—	—	—	—
5 1/8	100.6	103.1	105.7	108.3	—	—	—	—	—	—	—	—	—
5 1/4	103.1	105.7	108.3	110.9	113.6	116.4	—	—	—	—	—	—	—
5 3/8	105.5	108.2	110.9	113.6	116.3	119.1	121.9	124.8	—	—	—	—	—
5 1/2	108.0	110.7	113.4	116.2	119.0	121.9	124.8	127.7	130.7	133.6	—	—	—
5 5/8	110.6	113.2	116.0	118.9	121.8	124.7	127.6	130.6	133.6	136.7	139.8	142.9	—
5 3/4	112.9	115.7	118.6	121.5	124.5	127.4	130.5	133.5	136.6	139.7	142.9	146.1	149.3
5 7/8	115.3	118.2	121.2	124.2	127.2	130.2	133.3	136.4	139.6	142.8	146.0	149.2	152.5
6	117.8	120.8	123.8	126.8	129.9	133.0	136.1	139.3	142.5	145.8	149.1	152.4	155.8
6 1/8	120.3	123.3	126.3	129.4	132.6	135.8	139.0	142.2	145.5	148.8	152.2	155.6	159.0
6 1/4	122.7	125.8	128.9	132.1	135.0	138.5	141.8	145.1	148.5	151.9	155.3	158.8	162.3
6 3/8	125.2	128.3	131.5	134.7	138.0	141.3	144.6	148.0	151.4	154.9	158.4	161.9	165.5
6 1/2	127.6	130.8	134.1	137.4	140.7	144.1	147.5	150.9	154.4	157.9	161.5	165.1	168.8
6 5/8	130.1	133.3	136.7	140.0	143.4	146.8	150.3	153.8	157.4	161.0	164.6	168.3	172.0
6 3/4	132.5	135.9	139.2	142.6	146.1	149.6	153.1	156.7	160.4	164.0	167.7	171.5	175.3
6 7/8	135.0	138.4	141.8	145.3	148.8	152.4	156.0	159.6	163.3	167.1	170.8	174.7	178.5
7	137.4	140.9	144.4	147.9	151.5	155.1	158.8	162.5	166.3	170.1	173.9	177.8	181.8
7 1/8	139.9	143.4	147.0	150.6	154.2	157.9	161.7	165.4	169.3	173.1	177.0	181.0	185.0
7 1/4	142.3	145.9	149.5	153.2	156.9	160.7	164.5	168.3	172.2	176.2	180.2	184.2	188.2
7 3/8	144.8	148.4	152.1	155.9	159.6	163.5	167.3	171.2	175.2	179.2	183.3	187.4	191.5
7 1/2	147.2	151.0	154.7	158.5	162.3	166.2	170.2	174.1	178.2	182.2	186.4	190.5	194.7
7 5/8	149.7	153.5	157.3	161.1	165.0	169.0	173.0	177.1	181.1	185.3	189.5	193.7	198.0
7 3/4	152.2	156.0	159.9	163.8	167.8	171.8	175.8	180.0	181.4	188.3	192.6	196.9	201.2
7 7/8	154.6	158.5	162.4	166.4	170.5	174.5	178.7	182.9	187.1	191.4	195.7	200.1	204.5
8	157.1	161.0	165.0	169.1	173.2	177.3	181.5	185.8	190.1	194.4	198.8	203.2	207.7

VOLUMES IN CUBIC INCHES OF FOUR CYLINDERS. From 2in. × 2in. to $2\frac{15}{16}$ in. × 6in.

STROKE IN INCHES.	BORE IN INCHES.															
	2	$2\frac{1}{16}$	$2\frac{1}{8}$	$2\frac{3}{16}$	$2\frac{1}{4}$	$2\frac{5}{16}$	$2\frac{3}{8}$	$2\frac{7}{16}$	$2\frac{1}{2}$	$2\frac{9}{16}$	$2\frac{5}{8}$	$2\frac{11}{16}$	$2\frac{3}{4}$	$2\frac{13}{16}$	$2\frac{7}{8}$	$2\frac{15}{16}$
2	25.1	26.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—
$2\frac{1}{8}$	26.7	28.4	30.1	31.9	—	—	—	—	—	—	—	—	—	—	—	—
$2\frac{1}{4}$	28.3	30.1	31.9	33.8	35.8	37.8	—	—	—	—	—	—	—	—	—	—
$2\frac{3}{8}$	29.8	31.7	33.7	35.7	37.8	39.9	42.1	44.3	—	—	—	—	—	—	—	—
$2\frac{1}{2}$	31.4	33.4	35.5	37.6	39.8	42.0	44.3	46.7	49.1	51.6	—	—	—	—	—	—
$2\frac{5}{8}$	33.0	35.1	37.2	39.5	41.7	44.1	46.5	49.0	51.5	54.2	56.8	59.6	—	—	—	—
$2\frac{3}{4}$	34.6	36.8	39.0	41.3	43.7	46.2	48.7	51.3	54.0	56.7	59.5	62.4	65.3	68.3	—	—
$2\frac{7}{8}$	36.1	38.4	40.8	43.2	45.7	48.3	50.9	53.7	56.5	59.3	62.2	65.2	68.3	71.4	74.7	77.9
3	37.7	40.1	42.6	45.1	47.7	50.4	53.2	56.0	58.9	61.9	64.9	68.0	71.3	74.6	77.9	81.3
$3\frac{1}{8}$	39.3	41.8	44.3	47.0	49.7	52.5	55.4	58.3	61.4	64.5	67.6	70.9	74.2	77.7	81.2	84.7
$3\frac{1}{4}$	40.8	43.4	46.1	48.9	51.7	54.6	57.6	60.7	63.8	67.0	70.4	73.7	77.2	80.8	84.4	88.1
$3\frac{3}{8}$	42.4	45.1	47.9	50.7	53.7	56.7	59.8	63.0	66.3	69.6	73.1	76.6	80.2	83.9	87.7	91.5
$3\frac{1}{2}$	44.0	46.8	49.7	52.6	55.7	58.8	62.0	65.3	68.7	72.2	75.8	79.4	83.2	87.0	90.9	94.9
$3\frac{5}{8}$	45.6	48.4	51.4	54.5	57.7	60.9	64.2	67.7	71.2	74.8	78.5	82.3	86.1	90.1	94.2	98.3
$3\frac{3}{4}$	47.1	50.1	53.2	56.4	59.6	63.0	66.5	70.0	73.6	77.4	81.2	85.1	89.1	93.2	97.4	101.7
$3\frac{7}{8}$	48.7	51.8	55.0	58.3	61.6	65.1	68.7	72.3	76.1	79.9	83.9	87.9	92.1	96.3	100.7	105.0
4	50.3	53.5	56.7	60.1	63.6	67.2	70.9	74.7	78.5	82.5	86.6	90.8	95.0	99.4	103.9	108.4
$4\frac{1}{8}$	51.8	55.1	58.5	62.0	65.6	69.3	73.1	77.0	81.0	85.1	89.3	93.6	98.0	102.5	107.2	111.8
$4\frac{1}{4}$	—	56.8	60.3	63.9	67.6	71.4	75.3	79.3	83.4	87.7	92.0	96.4	101.0	106.6	110.4	115.2
$4\frac{3}{8}$	—	—	62.1	65.8	69.6	73.5	77.5	81.7	85.9	90.3	94.7	99.3	103.9	108.7	113.7	118.6
$4\frac{1}{2}$	—	—	—	67.7	71.6	75.6	79.7	84.0	88.4	92.8	97.4	102.1	106.9	111.8	116.9	122.0
$4\frac{5}{8}$	—	—	—	—	73.6	77.7	82.0	86.3	90.8	95.4	100.1	104.9	109.9	114.9	120.2	125.4
$4\frac{3}{4}$	—	—	—	—	—	79.8	84.2	88.7	93.3	98.0	102.8	107.8	112.9	118.0	123.4	128.8
$4\frac{7}{8}$	—	—	—	—	—	—	86.4	91.0	95.7	100.6	105.5	110.6	115.8	121.1	126.7	132.2
5	—	—	—	—	—	—	—	93.3	98.2	103.1	108.2	113.5	118.8	124.3	129.9	135.5
$5\frac{1}{8}$	—	—	—	—	—	—	—	—	100.6	105.7	110.9	116.3	121.8	127.4	133.2	138.9
$5\frac{1}{4}$	—	—	—	—	—	—	—	—	—	108.3	113.7	119.1	124.7	130.5	136.4	142.3
$5\frac{3}{8}$	—	—	—	—	—	—	—	—	—	—	116.4	122.0	127.7	133.6	139.7	145.7
$5\frac{1}{2}$	—	—	—	—	—	—	—	—	—	—	—	124.8	130.7	136.7	142.9	149.1
$5\frac{5}{8}$	—	—	—	—	—	—	—	—	—	—	—	—	133.6	139.8	146.2	152.5
$5\frac{3}{4}$	—	—	—	—	—	—	—	—	—	—	—	—	—	142.9	149.4	155.9
$5\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—	—	—	—	—	152.7	159.3
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	162.7

VOLUMES N CUBIC INCHES OF FOUR CYLINDERS. From 3in. × 3in. to 3 15/16in. × 8in.

BORE IN INCHES.

STROKE IN INCHES.	3	3 1/16	3 1/8	3 3/16	3 1/4	3 5/16	3 3/8	3 7/16	3 1/2	3 9/16	3 5/8	3 11/16	3 3/4	3 13/16	3 7/8	3 15/16
3	84.82	88.39	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3 1/8	88.36	92.08	95.87	99.75	—	—	—	—	—	—	—	—	—	—	—	—
3 1/4	91.89	95.76	99.71	103.74	107.85	112.03	—	—	—	—	—	—	—	—	—	—
3 3/8	95.43	99.44	103.54	107.73	111.99	116.34	120.77	125.29	—	—	—	—	—	—	—	—
3 1/2	98.96	103.13	107.38	111.72	116.14	120.65	125.25	129.93	134.70	139.55	—	—	—	—	—	—
3 5/8	102.49	106.81	111.21	115.71	120.29	124.96	129.72	134.57	139.51	144.53	149.65	154.85	—	—	—	—
3 3/4	106.03	110.49	115.05	119.70	124.44	129.27	134.19	139.21	144.32	149.52	154.81	160.19	165.67	171.24	—	—
3 7/8	109.56	114.17	118.88	123.69	128.58	133.58	138.67	143.85	149.13	154.50	159.97	165.53	171.19	176.95	182.80	188.74
4	113.10	117.86	122.72	127.68	132.73	137.89	143.14	148.49	153.94	159.49	165.13	170.87	176.71	182.65	188.69	194.83
4 1/8	116.63	121.54	126.55	131.67	136.88	142.20	147.61	153.13	158.75	164.47	170.29	176.21	182.24	188.36	194.59	200.92
4 1/4	120.17	125.23	130.39	135.66	141.03	146.50	152.09	157.77	163.56	169.45	175.45	181.55	187.76	194.07	200.49	207.01
4 3/8	123.70	128.91	134.22	139.65	145.18	150.81	156.56	162.41	168.37	174.44	180.61	186.89	193.28	199.78	206.38	213.09
4 1/2	127.23	132.59	138.06	143.64	149.32	155.12	161.03	167.05	173.18	179.42	185.77	192.23	198.80	205.49	212.28	219.18
4 5/8	130.77	136.27	141.89	147.63	153.47	159.43	165.50	171.69	177.99	184.40	190.93	197.57	204.33	211.19	218.18	225.27
4 3/4	134.30	139.96	145.73	151.62	157.62	163.74	169.98	176.33	182.80	189.39	196.09	202.91	209.85	216.90	224.07	231.36
4 7/8	137.84	143.64	149.56	155.61	161.77	168.05	174.45	180.97	187.61	194.37	201.25	208.25	215.37	222.61	229.97	237.45
5	141.37	147.32	153.40	159.60	165.92	172.36	178.92	185.61	192.42	199.36	206.41	213.59	220.89	228.32	235.87	243.54
5 1/8	144.91	151.01	157.23	163.59	170.06	176.67	183.40	190.25	197.23	204.34	211.57	218.93	226.42	234.03	241.76	249.62
5 1/4	148.44	154.69	161.07	167.58	174.21	180.98	187.87	194.89	202.04	209.32	216.73	224.27	231.94	239.73	247.66	255.71
5 3/8	151.97	158.37	164.90	171.57	178.36	185.29	192.34	199.53	206.85	214.31	221.89	229.61	237.46	245.44	253.56	261.80
5 1/2	155.51	162.06	168.74	175.56	182.51	189.59	196.82	204.17	211.67	219.29	227.05	234.95	242.98	251.05	259.45	267.89
5 5/8	159.04	165.74	172.57	179.55	186.66	193.90	201.29	208.81	216.48	224.28	232.21	240.29	248.51	256.86	265.35	273.98
5 3/4	162.58	169.42	176.41	183.54	190.80	198.21	205.76	213.45	221.29	229.26	237.37	245.63	254.03	262.57	271.25	280.07
5 7/8	166.11	173.11	180.24	187.53	194.95	202.52	210.23	218.09	226.10	234.24	242.54	250.97	259.55	268.27	277.14	286.15
6	169.65	176.79	184.08	191.52	199.10	206.83	214.71	222.73	230.91	239.23	247.70	256.31	265.07	273.98	283.04	292.24
6 1/8	173.18	180.47	187.91	195.50	203.25	211.14	219.18	227.37	235.72	244.21	252.86	261.65	270.59	279.69	288.94	298.33
6 1/4	—	184.15	191.75	199.49	207.39	215.45	223.65	232.01	240.53	249.20	258.02	266.99	276.12	285.40	294.83	304.42
6 3/8	—	—	195.58	203.48	211.54	219.76	228.13	236.66	245.34	254.18	263.18	262.33	281.64	291.10	300.73	310.51
6 1/2	—	—	—	207.47	215.69	224.07	232.60	241.30	250.15	259.16	268.34	277.67	287.16	296.81	306.63	316.60
6 5/8	—	—	—	—	219.84	228.37	237.07	245.93	254.96	264.15	273.50	283.01	292.68	302.52	312.52	322.68
6 3/4	—	—	—	—	—	232.68	241.55	250.57	259.77	269.13	278.66	288.35	298.21	308.23	318.42	328.77
6 7/8	—	—	—	—	—	—	246.02	255.22	264.58	274.12	283.82	293.69	303.73	313.94	324.31	334.86
7	—	—	—	—	—	—	—	259.86	269.39	279.10	288.98	299.03	309.25	319.65	330.21	340.95
7 1/8	—	—	—	—	—	—	—	—	274.20	284.08	294.14	304.37	314.77	325.35	336.11	347.04
7 1/4	—	—	—	—	—	—	—	—	—	289.07	299.30	309.71	320.30	331.06	342.00	353.13
7 3/8	—	—	—	—	—	—	—	—	—	—	304.46	315.05	325.82	336.77	347.90	359.21
7 1/2	—	—	—	—	—	—	—	—	—	—	—	320.39	331.34	342.48	353.80	365.30
7 5/8	—	—	—	—	—	—	—	—	—	—	—	—	336.86	348.19	359.70	371.39
7 3/4	—	—	—	—	—	—	—	—	—	—	—	—	—	353.89	365.60	377.48
7 7/8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	371.49	383.57
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	389.66

VOLUMES IN CUBIC INCHES OF FOUR CYLINDERS. From 4in. × 4in. to $4\frac{15}{16}$in. × 8in.

STROKE IN INCHES.	BORE IN INCHES.															
	4	$4\frac{1}{16}$	$4\frac{1}{8}$	$4\frac{3}{16}$	$4\frac{1}{4}$	$4\frac{5}{16}$	$4\frac{3}{8}$	$4\frac{7}{16}$	$4\frac{1}{2}$	$4\frac{9}{16}$	$4\frac{5}{8}$	$4\frac{11}{16}$	$4\frac{3}{4}$	$4\frac{13}{16}$	$4\frac{7}{8}$	$4\frac{15}{16}$
4	201.06	207.39	—	—	—	—	—	—	—	—	—	—	—	—	—	—
$4\frac{1}{8}$	207.35	213.88	220.51	227.24	—	—	—	—	—	—	—	—	—	—	—	—
$4\frac{1}{4}$	213.63	220.36	227.15	234.13	241.17	248.31	—	—	—	—	—	—	—	—	—	—
$4\frac{3}{8}$	219.91	226.84	233.87	241.01	248.26	255.62	263.08	270.65	—	—	—	—	—	—	—	—
$4\frac{1}{2}$	226.20	233.32	240.55	247.90	255.35	262.92	270.59	278.38	286.28	294.29	—	—	—	—	—	—
$4\frac{5}{8}$	232.48	239.80	247.24	254.78	262.45	270.22	278.11	286.11	294.23	302.46	310.80	319.26	—	—	—	—
$4\frac{3}{4}$	238.76	246.28	253.92	261.67	269.54	277.53	285.63	293.85	302.18	310.63	319.20	327.89	336.69	345.61	—	—
$4\frac{7}{8}$	245.04	252.76	260.60	268.56	276.63	284.83	293.14	301.58	310.13	318.81	327.6	336.52	345.55	354.70	363.98	373.37
5	251.33	259.24	267.28	275.44	283.73	292.13	300.66	309.31	318.09	326.98	336.0	345.15	354.41	363.80	373.31	382.94
$5\frac{1}{8}$	257.61	265.72	273.96	282.33	290.82	299.44	308.18	317.05	326.84	335.16	344.4	353.78	363.27	372.89	382.64	392.52
$5\frac{1}{4}$	263.89	272.21	280.65	289.31	297.91	306.74	315.69	324.78	333.99	343.33	352.8	362.40	372.13	381.99	391.98	402.09
$5\frac{3}{8}$	270.18	278.69	287.33	296.10	305.01	314.04	323.21	332.51	341.94	351.51	361.2	371.03	380.99	391.08	401.31	411.66
$5\frac{1}{2}$	276.46	285.17	294.01	302.99	312.10	321.35	330.73	340.24	349.89	359.68	369.6	379.66	389.85	400.18	410.64	421.24
$5\frac{5}{8}$	282.74	291.65	300.69	309.87	319.19	328.65	338.24	347.98	357.85	367.86	378.0	388.29	398.71	409.27	419.97	430.81
$5\frac{3}{4}$	289.03	298.13	307.37	316.76	326.28	335.95	345.76	355.71	365.80	376.03	386.4	396.92	407.57	418.37	429.31	440.39
$5\frac{7}{8}$	295.31	304.61	314.06	323.64	333.38	343.26	353.28	363.44	373.75	384.21	394.8	405.55	416.43	427.46	438.64	449.96
6	301.59	311.09	320.74	330.53	340.47	350.56	360.79	371.18	381.70	392.38	403.2	414.18	425.29	436.56	447.97	459.53
$6\frac{1}{8}$	307.88	317.57	327.42	337.42	347.56	357.86	368.31	378.91	389.66	400.56	411.6	422.80	434.15	445.65	457.31	469.11
$6\frac{1}{4}$	314.16	324.05	334.10	344.30	354.61	365.16	375.83	386.64	397.61	408.73	420.0	431.43	443.01	454.75	466.64	478.68
$6\frac{3}{8}$	320.44	330.54	340.78	351.19	361.75	372.47	383.34	394.37	405.56	416.90	428.4	440.06	451.87	463.84	474.97	488.25
$6\frac{1}{2}$	326.73	337.02	347.47	358.07	368.84	379.77	390.86	402.11	413.51	425.08	436.8	448.69	460.74	472.94	485.30	497.83
$6\frac{5}{8}$	333.01	343.50	354.15	364.96	375.94	387.07	398.38	409.84	421.47	433.25	445.2	457.32	469.60	482.03	494.64	507.40
$6\frac{3}{4}$	339.29	349.98	360.83	371.85	383.03	394.38	405.89	417.57	429.42	441.43	453.6	465.95	478.46	491.13	503.97	516.97
$6\frac{7}{8}$	345.58	356.46	367.51	378.73	390.12	401.68	413.41	425.30	437.37	449.60	462.0	474.58	487.32	500.22	513.30	526.55
7	351.86	362.94	374.19	385.62	397.22	408.98	420.93	433.04	445.32	457.78	470.4	483.21	496.18	509.32	522.63	536.12
$7\frac{1}{8}$	358.14	369.42	380.88	392.51	404.31	416.29	428.44	440.77	453.27	465.95	478.8	491.83	505.04	518.41	531.97	545.69
$7\frac{1}{4}$	364.43	375.90	387.56	399.39	411.40	423.59	435.96	448.50	461.23	474.13	487.2	500.46	513.90	527.51	541.30	555.27
$7\frac{3}{8}$	370.71	382.38	394.24	406.28	418.50	430.89	443.47	456.24	469.18	482.30	495.6	509.09	522.76	536.60	550.63	564.84
$7\frac{1}{2}$	376.99	388.87	400.92	413.16	425.59	438.20	450.99	463.97	477.13	490.48	504.0	517.72	531.62	545.70	559.97	574.42
$7\frac{5}{8}$	383.28	395.35	407.60	420.05	432.68	445.50	458.51	471.70	485.08	498.65	512.4	526.35	540.48	554.79	569.30	583.99
$7\frac{3}{4}$	389.56	401.83	414.29	426.94	439.77	452.80	466.02	479.43	493.03	506.83	520.8	534.98	549.34	563.89	578.63	593.56
$7\frac{7}{8}$	395.84	408.31	420.97	433.82	446.87	460.11	473.54	487.17	500.99	515.00	529.2	543.61	558.20	572.98	587.96	603.14
8	402.12	414.78	427.65	440.71	453.96	467.41	481.06	494.90	508.94	523.17	537.6	552.23	567.06	582.08	597.30	612.71

VOLUMES IN CUBIC INCHES OF FOUR CYLINDERS. From 5in. × 5in. to 5¾in. × 8in.

STROKE IN INCHES.	BORE IN INCHES.												
	5	5 1/16	5 1/8	5 3/16	5 1/4	5 5/16	5 3/8	5 7/16	5 1/2	5 9/16	5 5/8	5 11/16	5 3/4
5	392.70	402.58	—	—	—	—	—	—	—	—	—	—	—
5 1/8	402.52	412.64	422.89	443.84	—	—	—	—	—	—	—	—	—
5 1/4	412.34	422.71	433.21	454.41	454.60	465.49	—	—	—	—	—	—	—
5 3/8	422.15	432.77	443.52	464.98	465.42	476.57	487.85	499.26	—	—	—	—	—
5 1/2	431.97	442.84	453.84	475.54	476.25	487.65	499.20	510.87	522.68	534.63	—	—	—
5 5/8	441.79	452.90	464.15	486.11	487.07	498.74	510.54	522.48	534.56	546.78	559.14	571.63	—
5 3/4	451.61	462.97	474.47	496.68	497.89	509.82	521.89	534.09	546.44	558.93	571.56	584.33	597.25
5 7/8	461.42	473.03	484.78	507.25	508.72	520.90	533.23	545.70	558.32	571.08	583.99	597.04	610.23
6	471.24	483.10	495.10	517.81	519.54	531.99	544.58	557.31	570.20	583.23	596.41	609.74	623.21
6 1/8	481.06	493.16	505.41	528.38	530.37	543.07	555.92	568.93	582.08	595.38	608.84	622.44	636.20
6 1/4	490.88	503.22	515.73	538.95	541.19	554.15	567.27	580.54	593.96	607.53	621.26	635.15	649.18
6 3/8	500.69	513.29	526.04	549.52	552.01	565.23	578.61	592.15	605.84	619.69	633.69	647.85	662.17
6 1/2	510.51	523.35	536.35	560.08	562.84	576.32	589.96	603.76	617.72	631.84	646.11	660.55	675.15
6 5/8	520.33	533.42	546.67	570.65	573.66	587.40	601.30	615.37	629.60	643.99	658.54	673.25	688.13
6 3/4	530.15	543.48	556.98	581.22	584.48	598.48	612.65	626.98	641.48	656.14	670.96	685.96	701.12
6 7/8	539.96	553.55	567.30	591.79	595.31	609.57	623.99	638.59	653.35	668.29	683.39	698.66	714.10
7	549.78	563.61	577.61	602.35	606.13	620.65	635.34	650.20	665.23	680.44	695.82	711.36	727.08
7 1/8	559.60	573.67	587.93	612.92	616.96	631.73	646.68	661.81	667.11	692.59	708.24	724.07	740.07
7 1/4	569.42	583.74	598.24	623.49	627.78	642.82	658.03	673.42	688.99	704.74	720.67	736.77	753.05
7 3/8	579.23	593.80	608.56	634.06	638.60	653.90	669.38	685.03	700.87	716.89	733.09	749.47	766.03
7 1/2	589.05	603.87	618.87	644.62	649.92	664.98	680.72	696.64	712.75	729.04	745.52	762.18	779.02
7 5/8	598.87	613.93	629.19	655.19	660.25	676.07	692.07	708.25	724.63	741.19	757.94	774.88	792.00
7 3/4	608.69	624.00	639.50	665.76	671.08	687.15	703.41	719.87	736.51	753.34	770.37	787.58	804.99
7 7/8	618.50	634.06	649.84	676.33	681.90	698.23	714.76	731.48	748.39	765.49	782.79	800.28	817.97
8	628.32	644.13	660.13	686.90	692.72	707.31	726.10	743.09	760.27	777.64	795.22	812.99	830.95

VOLUMES IN CUBIC INCHES OF SIX CYLINDERS. From 2in. × 2in. to $2\frac{15}{16}$in. × 6in.

STROKE IN INCHES.	BORE IN INCHES.															
	2	$2\frac{1}{16}$	$2\frac{1}{8}$	$2\frac{3}{16}$	$2\frac{1}{4}$	$2\frac{5}{16}$	$2\frac{3}{8}$	$2\frac{7}{16}$	$2\frac{1}{2}$	$2\frac{9}{16}$	$2\frac{5}{8}$	$2\frac{11}{16}$	$2\frac{3}{4}$	$2\frac{13}{16}$	$2\frac{7}{8}$	$2\frac{15}{16}$
2	37.7	40.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
$2\frac{1}{8}$	40.1	42.6	45.2	47.9	—	—	—	—	—	—	—	—	—	—	—	—
$2\frac{1}{4}$	42.4	45.1	47.9	50.7	53.7	56.7	—	—	—	—	—	—	—	—	—	—
$2\frac{3}{8}$	44.8	47.6	50.5	53.6	56.7	59.9	63.1	66.5	—	—	—	—	—	—	—	—
$2\frac{1}{2}$	47.1	50.1	53.2	56.4	59.6	63.0	66.5	70.0	73.6	77.4	—	—	—	—	—	—
$2\frac{5}{8}$	49.5	52.6	55.9	59.2	62.6	66.2	69.8	73.5	77.3	81.2	85.2	89.3	—	—	—	—
$2\frac{3}{4}$	51.8	55.1	58.5	62.0	65.6	69.3	73.1	77.0	81.0	85.1	89.3	93.6	98.0	102.5	—	—
$2\frac{7}{8}$	54.2	57.6	61.2	64.8	68.6	72.5	76.4	80.5	84.7	89.0	93.4	97.9	102.5	107.2	112.0	116.9
3	56.5	60.1	63.8	67.6	71.6	75.6	79.7	84.0	88.4	92.8	97.4	102.1	106.9	111.8	116.9	122.0
$3\frac{1}{8}$	58.9	62.6	66.5	70.5	74.6	78.8	83.1	87.5	92.0	96.7	101.5	106.4	111.4	116.5	121.8	127.1
$3\frac{1}{4}$	61.3	65.1	69.2	73.3	77.5	81.9	86.4	91.0	95.7	100.6	105.5	110.6	115.8	121.1	126.7	132.2
$3\frac{3}{8}$	63.6	67.7	71.8	76.1	80.5	85.1	89.7	94.5	99.4	104.4	109.6	114.9	120.3	125.8	131.5	137.2
$3\frac{1}{2}$	66.0	70.2	74.5	78.9	83.5	88.2	93.0	98.0	103.1	108.3	113.7	119.1	124.7	130.5	136.4	142.3
$3\frac{5}{8}$	68.3	72.7	77.1	81.7	86.5	91.4	96.4	101.5	106.8	112.2	117.7	123.4	129.2	135.1	141.3	147.4
$3\frac{3}{4}$	70.7	75.2	79.8	84.6	89.5	94.5	99.7	105.0	110.4	116.0	121.8	127.6	133.6	139.8	146.2	152.5
$3\frac{7}{8}$	73.0	77.7	82.5	87.4	92.4	97.7	103.0	108.5	114.1	119.9	125.8	131.9	138.1	144.4	151.0	157.6
4	75.4	80.2	85.1	90.2	95.4	100.8	106.3	112.0	117.8	123.8	129.9	136.1	142.6	149.1	155.9	162.7
$4\frac{1}{8}$	77.8	82.7	87.8	93.0	98.4	104.0	109.6	115.5	121.5	127.6	133.9	140.4	147.0	153.8	160.8	167.7
$4\frac{1}{4}$	—	85.2	90.4	95.8	101.4	107.1	113.0	119.0	125.2	131.5	138.0	144.7	151.5	158.4	165.7	172.8
$4\frac{3}{8}$	—	—	93.1	98.7	104.4	110.3	116.3	122.5	128.9	135.4	142.1	148.9	155.9	163.1	170.5	177.9
$4\frac{1}{2}$	—	—	—	101.5	107.4	113.4	119.6	126.0	132.5	139.2	146.1	153.2	160.4	167.7	175.4	183.0
$4\frac{5}{8}$	—	—	—	—	110.3	116.6	122.9	129.5	136.2	143.1	150.2	157.4	164.8	172.4	180.3	188.1
$4\frac{3}{4}$	—	—	—	—	—	119.7	126.3	133.0	139.9	147.0	154.2	161.7	169.3	177.1	185.1	193.1
$4\frac{7}{8}$	—	—	—	—	—	—	129.6	136.5	143.6	150.8	158.3	165.9	173.7	181.7	190.0	198.2
5	—	—	—	—	—	—	—	140.0	147.3	154.7	162.4	170.2	178.2	186.4	194.9	203.3
$5\frac{1}{8}$	—	—	—	—	—	—	—	—	150.9	158.6	166.4	174.4	182.6	191.0	199.8	208.4
$5\frac{1}{4}$	—	—	—	—	—	—	—	—	—	162.5	170.5	178.7	187.1	195.7	204.6	213.5
$5\frac{3}{8}$	—	—	—	—	—	—	—	—	—	—	174.5	182.9	191.6	200.4	209.5	218.6
$5\frac{1}{2}$	—	—	—	—	—	—	—	—	—	—	—	187.2	196.0	205.0	214.4	223.6
$5\frac{5}{8}$	—	—	—	—	—	—	—	—	—	—	—	—	200.5	209.7	219.3	228.7
$5\frac{3}{4}$	—	—	—	—	—	—	—	—	—	—	—	—	—	214.3	224.2	233.8
$5\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—	—	—	—	—	229.0	238.9
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	244.0

VOLUMES IN CUBIC INCHES OF SIX CYLINDERS. From 3in. × 3in. to 3 1/16in. × 8in.

STROKE IN INCHES.	BORE IN INCHES.															
	3	3 1/16	3 1/8	3 3/16	3 1/4	3 5/16	3 3/8	3 7/16	3 1/2	3 9/16	3 5/8	3 11/16	3 3/4	3 13/16	3 7/8	3 15/16
3	127.2	132.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3 1/8	132.5	138.1	143.8	149.6	—	—	—	—	—	—	—	—	—	—	—	—
3 1/4	137.8	143.6	149.6	155.6	161.8	168.0	—	—	—	—	—	—	—	—	—	—
3 3/8	143.1	149.2	155.3	161.6	168.0	174.5	181.2	187.9	—	—	—	—	—	—	—	—
3 1/2	148.4	154.7	161.1	167.6	174.2	181.0	187.9	194.9	202.0	209.3	—	—	—	—	—	—
3 5/8	153.7	160.2	166.8	173.6	180.4	187.4	194.6	201.9	209.3	216.8	224.5	232.3	—	—	—	—
3 3/4	159.0	165.7	172.6	179.5	186.7	193.9	201.3	208.8	216.5	224.3	232.2	240.3	248.5	256.9	—	—
3 7/8	164.3	171.3	178.3	185.5	192.9	200.4	208.0	215.8	223.7	231.8	240.0	248.3	256.8	265.4	274.2	283.1
4	169.6	176.8	184.1	191.5	199.1	206.8	214.7	222.7	230.9	239.2	247.7	256.3	265.1	274.0	283.0	292.2
4 1/8	174.9	182.3	189.8	197.5	205.3	213.3	221.4	229.7	238.1	246.7	255.4	264.3	273.4	282.5	291.9	301.4
4 1/4	180.2	187.8	195.6	203.5	211.5	219.8	228.1	236.7	245.3	254.2	262.0	272.3	281.6	291.1	300.7	310.5
4 3/8	185.5	193.4	201.3	209.5	217.8	226.2	234.8	243.6	252.6	261.7	270.9	280.3	289.9	299.7	309.6	319.6
4 1/2	190.8	198.9	207.1	215.5	224.0	232.7	241.5	250.6	259.8	269.1	278.7	288.3	298.2	308.2	318.4	328.8
4 5/8	196.1	204.4	212.8	221.4	230.2	239.1	248.3	257.5	267.0	276.6	286.4	296.4	306.5	316.8	327.3	337.9
4 3/4	201.4	209.9	218.6	227.4	236.4	245.6	255.0	264.5	274.2	284.1	294.1	304.4	314.8	325.4	336.1	347.0
4 7/8	206.7	215.5	224.3	233.4	242.7	252.1	261.7	271.5	281.4	291.6	301.9	312.4	323.1	333.9	345.0	356.2
5	212.1	221.0	230.1	239.4	248.9	258.5	268.4	278.4	288.6	299.0	309.6	320.4	331.3	342.5	353.8	365.3
5 1/8	217.4	226.5	235.9	245.4	255.1	265.0	275.1	285.4	295.9	306.5	317.4	328.4	339.6	351.0	362.6	374.4
5 1/4	222.7	232.0	241.6	251.4	261.3	271.5	281.8	292.3	303.1	314.0	325.1	336.4	347.9	359.6	371.5	383.6
5 3/8	228.0	237.6	247.4	257.3	267.5	277.9	288.5	299.3	310.3	321.5	332.8	344.4	356.2	368.2	380.3	392.7
5 1/2	233.3	243.1	253.1	263.3	273.8	284.4	295.2	306.3	317.5	328.9	340.6	352.4	364.5	376.7	389.2	401.8
5 5/8	238.6	248.6	258.9	269.3	280.0	290.9	301.9	313.2	324.7	336.4	348.3	360.4	372.8	385.3	398.0	411.0
5 3/4	243.9	254.1	264.6	275.3	286.2	297.3	308.6	320.2	331.9	343.9	356.1	368.4	381.0	393.8	406.9	420.1
5 7/8	249.2	259.7	270.4	281.3	292.4	303.8	315.4	327.1	339.1	351.4	363.8	376.5	389.3	402.4	415.7	429.2
6	254.5	265.2	276.1	287.3	298.6	310.2	322.1	334.1	346.4	358.8	371.5	384.5	397.6	411.0	424.6	438.4
6 1/8	259.8	270.7	281.9	293.3	304.9	316.7	328.8	341.1	353.6	366.3	379.3	392.5	405.9	419.5	433.4	447.5
6 1/4	—	276.2	287.6	299.2	311.1	323.2	335.5	348.0	360.8	373.8	387.0	400.5	414.2	428.1	442.2	456.6
6 3/8	—	—	293.4	305.2	317.3	329.6	342.2	355.0	368.1	381.3	394.8	408.5	422.5	436.7	451.1	465.8
6 1/2	—	—	—	311.2	323.5	336.1	348.9	361.9	375.2	388.7	402.5	416.5	430.7	445.2	459.9	474.9
6 5/8	—	—	—	—	329.8	342.6	355.6	368.9	382.4	396.2	410.2	424.5	439.0	453.8	468.8	484.0
6 3/4	—	—	—	—	—	349.0	362.3	375.9	389.7	403.7	418.0	432.5	447.3	462.3	477.6	493.2
6 7/8	—	—	—	—	—	—	369.0	382.8	396.9	411.2	425.7	440.5	455.6	470.9	486.5	502.3
7	—	—	—	—	—	—	—	389.8	404.1	418.6	433.5	448.5	463.9	479.5	495.3	511.4
7 1/8	—	—	—	—	—	—	—	—	411.3	426.1	441.2	456.6	472.2	488.0	504.2	520.6
7 1/4	—	—	—	—	—	—	—	—	—	433.6	448.9	464.6	480.4	496.6	513.0	529.7
7 3/8	—	—	—	—	—	—	—	—	—	—	456.7	472.6	488.7	505.2	521.9	538.8
7 1/2	—	—	—	—	—	—	—	—	—	—	—	480.6	497.0	513.7	530.7	548.0
7 5/8	—	—	—	—	—	—	—	—	—	—	—	—	505.3	522.3	539.5	557.1
7 3/4	—	—	—	—	—	—	—	—	—	—	—	—	—	530.8	548.4	566.2
7 7/8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	557.2	575.4
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	584.5

VOLUMES IN CUBIC INCHES OF SIX CYLINDERS. From 4in. × 4in. to $4\frac{15}{16}$in. × 8in.

STROKE IN INCHES.	BORE IN INCHES.															
	4	$4\frac{1}{16}$	$4\frac{1}{8}$	$4\frac{3}{16}$	$4\frac{1}{4}$	$4\frac{5}{16}$	$4\frac{3}{8}$	$4\frac{7}{16}$	$4\frac{1}{2}$	$4\frac{9}{16}$	$4\frac{5}{8}$	$4\frac{11}{16}$	$4\frac{3}{4}$	$4\frac{13}{16}$	$4\frac{7}{8}$	$4\frac{15}{16}$
4	301.6	311.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
$4\frac{1}{8}$	311.0	320.8	330.8	340.9	—	—	—	—	—	—	—	—	—	—	—	—
$4\frac{1}{4}$	320.4	330.5	340.8	351.2	361.7	372.5	—	—	—	—	—	—	—	—	—	—
$4\frac{3}{8}$	330.0	340.3	350.8	361.5	372.4	383.4	394.6	406.0	—	—	—	—	—	—	—	—
$4\frac{1}{2}$	339.3	350.0	360.8	371.8	383.0	394.4	405.9	417.6	429.4	441.4	—	—	—	—	—	—
$4\frac{5}{8}$	348.7	359.7	370.9	382.2	393.7	405.3	417.2	429.2	441.3	453.7	466.2	478.9	—	—	—	—
$4\frac{3}{4}$	355.1	369.4	380.9	392.5	404.3	416.3	428.4	440.8	453.3	466.0	478.8	491.8	505.0	518.4	—	—
$4\frac{7}{8}$	367.6	379.1	390.9	402.8	414.9	427.2	439.7	452.4	465.2	478.2	491.4	504.8	518.3	532.1	546.0	560.1
5	377.0	388.9	400.9	413.2	425.6	438.2	451.0	464.0	477.1	490.5	504.0	517.8	531.6	545.7	560.0	574.4
$5\frac{1}{8}$	386.4	398.6	410.9	423.5	436.2	449.2	462.3	475.6	489.1	502.7	516.6	530.7	544.9	559.3	574.0	588.8
$5\frac{1}{4}$	395.8	408.3	421.0	433.8	446.9	460.1	473.5	487.2	501.0	515.0	529.2	543.6	558.2	573.0	588.0	603.1
$5\frac{3}{8}$	405.3	418.0	431.0	444.2	457.5	471.1	484.8	498.8	512.9	527.3	541.8	556.5	571.5	586.6	602.0	617.5
$5\frac{1}{2}$	414.7	427.8	441.0	454.5	468.1	482.0	496.1	510.4	524.8	539.5	554.4	569.5	584.8	600.3	616.0	631.9
$5\frac{5}{8}$	424.1	437.5	451.0	464.8	478.8	493.0	507.4	522.0	536.8	551.8	567.0	582.4	598.1	613.9	630.0	646.2
$5\frac{3}{4}$	433.5	447.2	461.1	475.1	489.4	503.9	518.6	533.6	548.7	564.0	579.6	595.4	611.4	627.6	644.0	660.6
$5\frac{7}{8}$	443.0	456.9	471.1	485.5	500.1	514.9	529.9	545.2	560.6	576.3	592.2	608.3	624.7	641.2	658.0	674.9
6	452.4	466.6	481.1	495.8	510.7	525.8	541.2	556.8	572.6	588.6	604.8	621.3	637.9	654.8	672.0	689.3
$6\frac{1}{8}$	461.8	476.4	491.1	506.1	521.3	536.8	552.5	568.4	584.5	600.8	617.4	634.2	651.2	668.5	686.0	703.7
$6\frac{1}{4}$	471.2	486.1	501.2	516.5	532.0	547.7	563.7	580.0	596.4	613.1	630.0	647.1	664.5	682.1	700.0	718.0
$6\frac{3}{8}$	480.7	495.8	511.2	526.8	542.6	558.7	575.0	591.6	608.3	625.4	642.6	660.1	677.8	695.8	714.0	732.4
$6\frac{1}{2}$	490.1	505.5	521.2	537.1	553.3	569.7	586.3	603.2	620.3	637.6	655.2	673.0	691.1	709.4	728.0	746.7
$6\frac{5}{8}$	499.5	515.3	531.2	547.4	563.9	580.6	597.6	614.8	632.2	649.9	667.8	686.0	704.4	723.1	742.0	761.1
$6\frac{3}{4}$	508.9	525.0	541.2	557.8	574.5	591.6	608.8	626.4	644.1	662.1	680.4	698.9	717.7	736.7	756.0	775.5
$6\frac{7}{8}$	518.4	534.7	551.3	568.1	585.2	602.5	620.1	638.0	656.1	674.4	693.0	711.9	731.0	750.3	770.0	789.8
7	527.8	544.4	561.3	578.4	595.8	613.5	631.4	649.6	668.0	686.7	705.6	724.8	744.3	764.0	784.0	804.2
$7\frac{1}{8}$	537.2	554.1	571.3	588.8	606.5	624.4	642.7	661.2	679.9	698.9	718.2	737.8	757.6	777.6	798.0	818.5
$7\frac{1}{4}$	546.6	563.9	581.3	599.1	617.1	635.4	653.9	672.8	691.8	711.2	730.8	750.7	770.8	791.2	812.0	832.9
$7\frac{3}{8}$	556.1	573.6	591.4	609.4	627.7	646.3	665.2	684.4	703.8	723.5	743.4	763.6	784.1	804.9	826.0	847.3
$7\frac{1}{2}$	565.5	583.3	601.4	619.7	638.4	657.3	676.5	696.0	715.7	735.7	756.0	776.6	797.4	818.5	840.0	861.6
$7\frac{5}{8}$	574.9	593.0	611.4	630.1	649.0	668.3	687.8	707.6	727.6	748.0	768.6	789.5	810.7	832.2	854.0	876.0
$7\frac{3}{4}$	584.3	602.7	621.4	640.4	659.7	679.2	699.0	719.2	739.6	760.2	781.2	802.5	824.0	845.8	868.0	890.3
$7\frac{7}{8}$	593.8	612.5	631.5	650.7	670.3	690.2	710.3	730.8	751.5	772.5	793.8	815.4	837.3	859.5	881.9	904.7
8	603.2	622.2	641.5	661.1	680.9	701.1	721.6	742.4	763.4	784.8	806.4	828.4	850.6	873.1	895.9	919.1

VOLUMES IN CUBIC INCHES OF SIX CYLINDERS.

From 5in. × 5in. to 5¾in. × 8in.

STROKE IN INCHES.	BORE IN INCHES.												
	5	5 1/16	5 1/8	5 3/16	5 1/4	5 5/16	5 3/8	5 7/16	5 1/2	5 9/16	5 5/8	5 11/16	5 3/4
5	589.1	603.9	—	—	—	—	—	—	—	—	—	—	—
5 1/8	603.8	619.0	643.3	649.9	—	—	—	—	—	—	—	—	—
5 1/4	618.5	634.1	649.8	665.8	681.9	698.2	—	—	—	—	—	—	—
5 3/8	633.2	649.2	665.3	681.6	698.1	714.9	731.8	748.9	—	—	—	—	—
5 1/2	648.0	664.2	680.8	697.5	714.4	731.5	748.8	766.3	784.0	801.9	—	—	—
5 5/8	662.7	679.4	696.2	713.3	730.6	748.1	765.8	783.7	801.8	820.2	838.7	857.4	—
5 3/4	677.4	694.4	711.7	729.2	746.8	764.7	782.8	801.1	819.7	838.4	857.3	876.5	895.9
5 7/8	692.1	709.5	727.2	745.0	763.1	781.4	799.8	818.6	837.5	856.6	876.0	895.6	915.3
6	706.9	724.6	742.6	760.9	779.3	798.0	816.9	836.0	855.3	874.8	894.6	914.6	934.8
6 1/8	721.6	739.7	758.1	776.7	795.5	814.6	833.9	853.4	873.1	893.1	913.3	933.7	954.3
6 1/4	736.3	754.8	773.6	792.6	811.8	831.2	850.9	870.8	890.9	911.3	931.9	952.7	973.8
6 3/8	751.0	769.9	789.1	808.4	828.0	847.9	867.9	888.2	908.8	929.5	950.5	971.8	993.2
6 1/2	765.8	785.0	804.5	824.3	844.3	864.5	884.9	905.6	926.6	947.8	969.2	996.8	1012.7
6 5/8	780.5	801.0	820.0	840.1	860.5	881.1	902.0	923.1	944.4	966.0	987.8	1009.9	1032.2
6 3/4	795.2	815.2	835.5	856.0	876.7	897.7	919.0	940.5	962.2	984.2	1006.4	1028.9	1051.7
6 7/8	809.9	830.3	850.9	871.8	893.0	914.4	936.0	957.9	980.0	1002.4	1025.1	1048.0	1071.2
7	824.7	845.4	866.4	887.7	909.2	931.0	953.0	975.3	997.9	1020.7	1043.7	1067.0	1090.6
7 1/8	839.4	860.5	881.9	903.5	925.4	947.6	970.0	992.7	1015.7	1038.9	1062.4	1086.1	1110.1
7 1/4	854.1	875.6	897.4	919.4	941.7	964.2	987.0	1010.1	1033.5	1057.1	1081.0	1105.2	1129.6
7 3/8	868.8	890.7	912.8	935.2	957.9	980.8	1004.1	1027.5	1051.3	1075.3	1099.6	1124.2	1149.1
7 1/2	883.6	905.8	928.3	951.1	974.1	997.5	1021.1	1045.0	1069.1	1093.6	1118.3	1143.3	1168.5
7 5/8	898.3	920.9	943.8	966.9	990.4	1014.1	1038.1	1062.4	1086.9	1111.8	1136.9	1162.3	1188.0
7 3/4	913.0	936.0	959.2	982.8	1006.6	1030.7	1055.1	1079.8	1104.8	1130.0	1155.6	1181.4	1207.5
7 7/8	927.8	951.1	974.7	998.6	1022.8	1047.3	1072.1	1097.2	1122.6	1148.2	1174.2	1204.4	1227.0
8	942.5	966.2	990.2	1014.5	1039.1	1064.0	1089.2	1114.6	1140.4	1166.5	1192.8	1219.5	1246.4

CYLINDER CAPACITIES IN CUBIC CENTIMETRES.

VOLUMES IN C.C. OF SINGLE CYLINDERS.

From 50mm. × 50mm. to 69mm. × 130mm.

BORE IN MM.

STROKE IN MM.	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69
1	1.963	2.043	2.123	2.206	2.290	2.375	2.463	2.551	2.642	2.734	2.827	2.922	3.019	3.117	3.217	3.318	3.421	3.525	3.631	3.739
2	3.926	4.086	4.246	4.412	4.580	4.751	4.926	5.103	5.284	5.468	5.654	5.844	6.038	6.234	6.434	6.636	6.842	7.050	7.262	7.478
3	5.889	6.129	6.369	6.618	6.870	7.127	7.389	7.655	7.926	8.202	8.481	8.766	9.057	9.351	9.651	9.954	10.263	10.575	10.893	11.217
4	7.852	8.172	8.492	8.824	9.160	9.503	9.852	10.206	10.568	10.936	11.308	11.688	12.076	12.468	12.868	13.272	13.684	14.100	14.524	14.956
50	98.17	102.14	106.18	110.30	114.51	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
55	107.99	112.35	116.80	121.33	125.96	130.67	135.46	140.34	145.31	150.36	—	—	—	—	—	—	—	—	—	—
60	117.81	122.56	127.42	132.37	137.41	142.54	147.78	153.10	158.52	164.03	169.64	175.32	181.14	187.03	193.01	—	—	—	—	—
65	127.62	132.78	138.04	143.40	148.86	154.42	160.09	165.86	171.73	177.70	183.78	189.93	196.23	202.62	209.10	215.69	222.38	229.26	236.05	243.05
70	137.44	142.99	148.66	154.43	160.31	166.30	172.41	178.62	184.94	191.37	197.92	204.54	211.33	218.20	225.19	232.28	239.48	246.89	254.21	261.74
75	147.26	153.21	159.27	165.46	171.76	178.18	184.72	191.38	198.15	205.04	212.05	219.15	226.43	233.79	241.27	248.87	256.59	264.52	272.37	280.44
80	157.08	163.42	169.89	176.49	183.21	190.06	197.04	204.14	211.36	218.71	226.19	233.76	241.52	249.37	257.35	265.46	273.69	282.15	290.53	299.14
85	166.89	173.63	180.51	187.52	194.66	201.94	209.35	216.89	224.57	232.38	240.33	248.37	256.62	264.96	273.44	282.05	290.80	299.78	308.69	317.83
90	176.71	183.85	191.13	198.55	206.11	213.82	221.67	229.65	237.78	246.05	254.47	262.98	271.71	280.55	289.52	298.64	307.90	317.40	326.84	336.53
95	186.53	194.06	201.75	209.58	217.57	225.70	233.98	242.41	250.99	259.72	268.60	277.59	286.81	296.13	305.61	315.23	325.01	335.03	345.00	355.23
100	196.35	204.28	212.37	220.61	229.02	237.58	246.30	255.17	264.20	273.39	282.74	292.20	301.90	311.72	321.60	331.83	342.12	352.66	363.16	373.92
105	—	—	—	—	—	249.46	258.61	267.93	277.41	287.06	296.88	306.81	317.00	327.31	337.78	348.42	359.22	370.29	381.32	392.62
110	—	—	—	—	—	261.34	270.93	280.69	290.62	300.73	311.01	321.42	332.09	342.89	353.86	365.01	376.33	387.92	399.48	411.32
115	—	—	—	—	—	—	—	—	—	—	325.15	336.03	347.19	358.48	369.95	381.60	393.43	405.54	417.63	430.01
120	—	—	—	—	—	—	—	—	—	—	339.29	350.64	362.28	374.06	386.03	398.19	410.54	423.17	435.79	448.71
125	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	414.78	427.65	440.80	453.95	467.41
130	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	431.38	444.75	458.43	472.11	486.10

At the top of each table are volumes for differences of 1mm., 2mm., 3mm., and 4mm., so that the volume for odd strokes not given in the tables is obtained by simple addition.

VOLUMES IN C.C. OF SINGLE CYLINDERS. From 70mm. × 70mm. to 89mm. × 170mm.

BORE IN MM.

STROKE IN MM.	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
1	3.848	3.959	4.072	4.185	4.300	4.418	4.536	4.657	4.778	4.902	5.027	5.153	5.281	5.410	5.542	5.675	5.801	5.945	6.082	6.221
2	7.696	7.918	8.144	8.370	8.600	8.836	9.072	9.314	9.556	9.804	10.054	10.306	10.562	10.820	11.084	11.349	11.602	11.890	12.164	12.442
3	11.544	11.877	12.216	12.555	12.900	13.254	13.608	13.971	14.334	14.706	15.081	15.459	15.843	16.230	16.626	17.024	17.403	17.835	18.246	18.663
4	15.392	15.836	16.288	16.740	17.200	17.673	18.144	18.628	19.112	19.608	20.108	20.612	21.124	21.640	22.168	22.698	23.204	23.780	24.328	24.884
70	269.39	277.14	285.00	292.97	301.05	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
75	288.63	296.94	305.36	313.90	322.56	331.34	340.23	349.24	358.37	367.62	—	—	—	—	—	—	—	—	—	—
80	307.87	316.73	325.72	334.83	344.06	353.42	362.91	372.53	382.26	392.13	402.12	412.24	422.48	432.84	443.34	—	—	—	—	—
85	327.11	336.53	346.08	355.76	365.57	375.51	385.59	395.81	406.16	416.64	427.25	438.00	448.88	459.90	471.05	482.33	493.74	505.29	516.98	528.79
90	346.36	356.32	366.43	376.69	387.07	397.60	408.28	419.09	430.05	441.15	452.39	463.77	475.29	486.95	498.76	510.71	522.79	535.02	547.39	559.90
95	365.60	376.12	386.79	397.61	408.58	419.69	430.96	442.37	453.94	465.65	477.52	489.53	501.69	514.01	526.46	539.08	551.83	564.74	577.80	591.00
100	384.84	395.92	407.15	418.54	430.08	441.78	453.64	465.66	477.83	490.16	502.65	515.30	528.10	541.06	554.17	567.45	580.88	594.46	608.21	622.11
105	404.08	415.71	427.50	439.46	451.58	463.87	476.32	488.94	501.72	514.67	527.78	541.06	554.50	568.11	581.88	595.82	609.92	624.19	638.62	653.22
110	423.33	435.51	447.86	460.39	473.09	485.96	499.01	512.22	525.62	539.18	552.92	556.83	580.91	595.17	609.59	624.19	638.96	653.91	669.03	684.32
115	442.57	455.30	468.22	481.32	494.59	508.05	521.69	535.51	549.51	563.69	578.05	592.59	607.31	622.22	637.30	652.57	668.01	683.63	699.44	715.43
120	461.81	475.00	488.58	502.25	516.10	530.14	544.37	558.79	573.40	588.20	603.18	618.36	633.72	649.27	665.01	680.94	697.05	713.36	729.85	746.54
125	481.05	494.80	508.93	523.17	537.60	552.23	567.05	582.07	597.29	612.71	628.32	644.12	660.12	676.32	692.72	709.31	726.10	743.08	760.26	777.64
130	500.29	514.59	529.29	544.10	559.11	574.32	589.74	605.36	621.18	637.21	653.45	669.89	686.53	703.38	720.43	737.69	755.14	772.81	790.67	808.75
135	519.54	534.39	549.65	565.03	580.61	596.41	612.42	628.64	645.07	661.72	678.58	695.65	712.93	730.43	748.14	766.06	784.18	802.53	821.08	839.85
140	538.78	554.18	570.00	585.95	602.11	618.50	635.10	651.92	668.97	686.23	703.71	721.42	739.34	757.48	775.84	794.43	813.23	832.25	851.49	870.96
145	—	—	—	—	—	640.59	657.78	675.21	692.86	710.74	728.85	747.18	765.74	784.54	803.55	822.80	842.27	861.97	881.90	902.06
150	—	—	—	—	—	662.68	680.47	698.49	716.75	735.25	753.98	772.95	792.15	811.59	831.26	851.18	871.32	891.70	912.31	933.17
155	—	—	—	—	—	—	—	—	—	—	779.11	798.71	818.55	838.64	858.97	879.55	900.36	921.42	942.72	964.27
160	—	—	—	—	—	—	—	—	—	—	804.24	824.48	844.96	865.69	886.68	907.92	929.41	951.14	973.14	995.38
165	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	936.29	958.45	980.87	1003.55	1026.49
170	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	964.67	987.49	1010.59	1033.96	1057.59

VOLUMES IN C.C. OF SINGLE CYLINDERS. From 90mm. × 90mm. to 109mm. × 200mm.

BORE IN MM.

STROKE IN MM.	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109
1	6.362	6.504	6.648	6.793	6.940	7.088	7.238	7.390	7.543	7.698	7.854	8.012	8.171	8.332	8.495	8.659	8.825	8.992	9.161	9.331
2	12.724	13.008	13.296	13.586	13.880	14.176	14.476	14.780	15.086	15.396	15.708	16.024	16.342	16.664	16.990	17.318	17.650	17.984	18.322	18.662
3	19.086	19.512	19.944	20.379	20.820	21.264	21.714	22.170	22.629	23.094	23.562	24.036	24.513	24.996	25.485	25.977	26.475	26.976	27.483	27.993
4	25.448	26.016	26.592	27.172	27.760	28.352	28.952	29.560	30.172	30.792	31.416	32.048	32.684	33.328	33.980	34.636	35.300	35.968	36.644	37.324
90	572.55	585.35	598.28	611.36	624.58	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
95	604.36	617.86	631.52	645.32	659.28	673.38	687.63	702.03	716.58	731.28	—	—	—	—	—	—	—	—	—	—
100	636.17	650.38	664.76	679.29	693.97	708.82	723.82	738.98	754.29	769.76	785.40	801.18	817.13	833.23	849.49	865.90	882.47	899.20	916.09	933.13
105	667.98	682.91	698.00	713.25	728.67	744.26	760.01	775.93	792.01	808.25	824.67	841.24	857.98	874.89	891.96	909.19	926.59	944.16	961.89	979.79
110	699.79	715.42	731.24	747.22	763.37	779.70	796.20	812.88	829.72	846.74	863.94	881.30	898.84	916.55	934.43	952.49	970.72	989.12	1007.69	1026.44
115	731.60	747.94	764.47	781.18	798.07	815.14	832.39	849.82	867.44	885.23	903.21	921.36	939.70	958.21	976.91	995.79	1014.84	1034.08	1053.50	1073.10
120	763.41	780.46	797.71	815.15	832.77	850.58	868.59	886.77	905.15	923.72	942.48	961.42	980.55	999.87	1019.38	1039.08	1058.96	1079.04	1099.31	1119.76
125	795.21	812.98	830.95	849.11	867.47	886.03	904.78	923.72	942.87	962.20	981.75	1001.48	1021.41	1041.53	1061.86	1082.37	1103.09	1124.00	1145.11	1166.41
130	827.02	845.50	864.19	883.08	902.17	921.47	940.97	960.67	980.58	1000.69	1021.02	1041.54	1062.27	1083.19	1104.33	1125.67	1147.21	1168.96	1190.91	1213.07
135	858.83	878.02	897.43	917.04	936.87	956.91	977.16	997.62	1018.30	1039.18	1060.29	1081.60	1103.12	1124.86	1146.80	1168.97	1191.34	1213.92	1236.72	1259.73
140	890.64	910.54	930.66	951.01	971.57	992.35	1013.35	1034.57	1056.01	1077.67	1099.56	1121.66	1143.98	1166.52	1189.28	1212.26	1235.46	1258.88	1282.52	1306.38
145	922.45	943.06	963.90	984.97	1006.27	1027.79	1049.54	1071.52	1093.73	1116.16	1138.83	1161.72	1184.84	12.0818	1231.75	1255.56	1279.58	1303.84	1328.33	1353.04
150	954.26	975.58	997.14	1018.94	1049.68	1063.23	1085.73	1108.47	1131.44	1154.64	1178.10	1201.78	1225.69	1249.84	1274.23	1298.85	1323.71	1348.80	1374.13	1399.69
155	986.07	1008.10	1030.38	1052.90	1075.66	1098.67	1121.92	1145.42	1169.16	1193.13	1217.37	1241.84	1266.55	1291.50	1316.70	1342.14	1367.85	1393.76	1419.94	1446.35
160	1017.87	1040.62	1063.62	1086.86	1113.65	1134.11	1158.12	1182.37	1206.87	1231.62	1256.64	1281.89	1307.41	1333.17	1359.17	1385.44	1411.96	1438.72	1465.74	1493.01
165	1049.68	1073.14	1096.85	1120.83	1145.06	1169.55	1194.31	1219.32	1244.59	1270.11	1295.91	1321.95	1348.26	1374.83	1401.65	1428.74	1456.08	1483.68	1511.55	1539.67
170	1081.49	1105.66	1130.09	1154.79	1179.76	1204.99	1230.50	1256.26	1282.30	1308.60	1335.18	1362.01	1389.12	1416.49	1444.12	1472.03	1500.20	1528.64	1557.35	1586.32
175	1113.30	1138.18	1163.33	1188.76	1214.46	1240.44	1266.69	1293.21	1320.02	1347.08	1374.45	1402.07	1429.97	1458.15	1486.59	1515.33	1544.33	1573.60	1603.15	1632.98
180	1145.11	1170.70	1196.57	1222.72	1249.16	1275.88	1302.88	1330.16	1357.73	1385.57	1413.72	1442.13	1470.83	1499.81	1529.07	1558.62	1588.45	1618.56	1648.96	1679.64
185	—	—	—	—	—	1311.32	1339.07	1367.11	1395.45	1424.06	1452.99	1482.19	1511.69	1541.47	1571.54	1601.92	1632.57	1663.52	1694.76	1726.29
190	—	—	—	—	—	1346.76	1375.26	1404.06	1433.16	1462.56	1492.26	1522.25	1552.54	1483.13	1614.02	1645.21	1676.70	1708.48	1740.57	1772.95
195	—	—	—	—	—	—	—	—	—	—	1531.53	1562.31	1593.40	1624.79	1656.49	1688.51	1720.82	1753.44	1786.37	1819.61
200	—	—	—	—	—	—	—	—	—	—	1570.80	1602.37	1634.26	1666.46	1698.97	1731.80	1764.95	1798.40	1832.18	1866.26

VOLUMES IN C.C. OF SINGLE CYLINDERS. From 110mm. × 110mm. to 129mm. × 200mm.

BORE IN MM.

STROKE IN MM.	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129
1	9.503	9.677	9.852	10.029	10.207	10.387	10.568	10.751	10.936	11.122	11.310	11.499	11.690	11.882	12.076	12.272	12.469	12.668	12.868	13.070
2	19.006	19.354	19.704	20.058	20.414	20.774	21.136	21.502	21.872	22.244	22.620	22.998	23.380	23.764	24.152	24.544	24.938	25.336	25.736	26.140
3	28.509	29.031	29.556	30.087	30.621	31.161	31.704	32.253	32.808	33.366	33.930	34.497	35.070	35.646	36.228	36.816	37.407	38.004	38.604	39.210
4	38.012	38.708	39.408	40.116	40.828	41.548	42.272	43.004	43.744	44.488	45.240	45.996	46.760	47.528	48.304	49.088	49.876	50.672	51.472	52.280
110	1045.36	1064.45	1083.72	1103.15	1122.77	1142.55	1162.51	1182.64	1202.95	1223.42	—	—	—	—	—	—	—	—	—	—
115	1092.88	1112.84	1132.98	1153.29	1173.80	1194.49	1215.35	1236.39	1257.63	1279.03	—	—	—	—	—	—	—	—	—	—
120	1140.40	1161.22	1182.24	1203.44	1224.84	1246.42	1268.19	1290.15	1312.31	1334.64	1357.11	1379.89	1402.79	1425.87	1449.15	1472.62	1496.28	1520.12	1544.17	1568.37
125	1187.91	1209.61	1231.50	1253.58	1275.87	1298.36	1321.03	1343.91	1366.98	1390.25	1413.71	1437.37	1461.22	1485.28	1509.53	1533.97	1558.62	1583.46	1608.48	1633.72
130	1235.43	1257.99	1280.76	1303.72	1326.91	1350.29	1373.88	1397.67	1421.66	1445.86	1470.26	1494.87	1519.67	1544.69	1569.92	1595.33	1620.97	1646.80	1672.82	1699.07
135	1282.95	1306.38	1330.02	1353.87	1377.94	1402.23	1426.72	1451.42	1476.34	1501.47	1526.81	1552.36	1578.12	1604.11	1630.30	1656.69	1683.31	1710.14	1737.16	1764.42
140	1330.46	1354.76	1379.28	1404.01	1428.98	1454.16	1479.56	1505.18	1531.02	1557.08	1583.36	1609.86	1636.57	1663.52	1690.68	1718.05	1745.66	1773.48	1801.50	1829.77
145	1377.98	1403.15	1428.54	1454.15	1480.01	1506.10	1532.40	1558.94	1585.70	1612.69	1639.90	1667.35	1695.02	1722.93	1751.06	1779.41	1808.00	1836.81	1865.84	1895.12
150	1425.50	1451.53	1477.80	1504.30	1531.05	1558.03	1585.24	1612.69	1640.38	1668.30	1696.45	1724.85	1753.47	1782.34	1811.44	1840.77	1870.35	1900.15	1930.18	1960.47
155	1473.01	1499.92	1527.06	1554.45	1582.08	1609.97	1638.08	1666.45	1695.06	1723.91	1753.00	1782.34	1811.92	1841.75	1871.82	1902.13	1932.69	1963.49	1994.52	2025.82
160	1520.53	1548.30	1576.32	1604.59	1633.12	1661.90	1690.93	1720.21	1749.74	1779.52	1809.55	1839.84	1870.37	1901.17	1932.21	1963.49	1995.04	2026.83	2058.86	2091.17
165	1568.05	1596.69	1625.58	1654.73	1684.15	1713.84	1743.77	1773.96	1804.42	1835.13	1866.10	1897.33	1928.81	1960.58	1992.59	2024.84	2057.38	2090.17	2123.20	2156.51
170	1615.56	1645.07	1674.84	1704.88	1735.19	1765.77	1796.61	1827.72	1859.10	1890.74	1922.65	1954.83	1987.26	2019.99	2052.97	2086.20	2119.73	2153.50	2187.54	2221.86
175	1663.08	1693.46	1724.11	1755.02	1786.22	1817.70	1849.45	1881.47	1913.78	1946.35	1979.19	2012.32	2045.71	2079.40	2113.35	2147.56	2182.07	2216.84	2251.88	2287.21
180	1710.60	1741.84	1773.37	1805.16	1837.26	1869.64	1902.29	1935.23	1968.46	2001.96	2035.74	2069.82	2104.16	2138.81	2173.73	2208.92	2244.42	2280.18	2316.22	2352.56
185	1758.12	1790.22	1822.63	1855.31	1888.29	1921.57	1955.13	1988.99	2023.14	2057.57	2092.29	2127.31	2162.61	2198.22	2234.11	2270.28	2306.76	2343.52	2380.56	2417.91
190	1805.63	1838.61	1871.89	1905.45	1939.33	1973.51	2007.97	2042.74	2077.82	2113.18	2148.84	2184.81	2221.06	2257.63	2294.49	2331.64	2369.11	2406.86	2444.90	2483.26
195	1853.15	1886.99	1921.14	1955.59	1990.36	2025.44	2060.82	2096.50	2132.50	2168.79	2205.39	2242.30	2279.51	2317.05	2354.88	2393.00	2431.45	2470.20	2509.24	2548.61
200	1900.67	1935.38	1970.41	2005.74	2041.40	2077.38	2113.66	2150.26	2187.18	2224.40	2261.94	2299.80	2337.96	2376.46	2415.26	2454.36	2493.80	2533.54	2573.58	2613.96

VOLUMES IN C.C. OF SINGLE CYLINDERS.

From 130mm. × 130mm. to 150mm. × 200mm.

BORE IN MM.

STROKE IN MM.	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
1	13.273	13.478	13.685	13.893	14.103	14.314	14.527	14.741	14.957	15.175	15.394	15.615	15.837	16.061	16.286	16.513	16.742	16.972	17.203	17.437	17.672
2	26.546	26.956	27.370	27.786	28.206	28.628	29.054	29.482	29.914	30.350	30.788	31.230	31.674	32.122	32.572	33.026	33.484	33.944	34.406	34.874	35.344
3	39.819	40.434	41.055	41.679	42.309	42.942	43.581	44.223	44.871	45.525	46.182	46.845	47.511	48.183	48.858	49.539	50.226	50.916	51.609	52.311	53.016
4	53.092	53.912	54.740	55.572	56.412	57.256	58.108	58.964	59.828	60.700	61.576	62.460	63.348	64.244	65.144	66.052	66.968	67.888	68.812	69.748	70.688
130	1725.51	1752.16	1779.02	1806.09	1833.34	1860.80	1888.47	1916.34	1944.42	1972.71	—	—	—	—	—	—	—	—	—	—	—
135	1791.88	1819.55	1847.45	1875.56	1903.85	1932.37	1961.10	1990.05	2019.21	2048.58	—	—	—	—	—	—	—	—	—	—	—
140	1858.25	1886.95	1915.87	1945.02	1974.36	2003.94	2033.73	2063.75	2093.99	2124.46	2155.13	2186.03	2217.15	2248.48	2280.04	2311.82	2343.81	2376.04	2408.47	2441.12	2474.01
145	1924.61	1954.34	1984.29	2014.49	2044.87	2075.51	2106.37	2137.46	2168.78	2200.33	2232.10	2264.10	2296.33	2328.78	2361.47	2394.38	2427.51	2460.89	2494.49	2528.30	2562.37
150	1990.98	2021.73	2052.72	2083.95	2115.39	2147.08	2179.00	2211.16	2243.56	2276.20	2309.07	2342.17	2375 .52	2409.09	2442.90	2476.95	2511.22	2545.75	2580.51	2615.49	2650.72
155	2057.34	2089.12	2121.14	2153.42	2185.90	2218.65	2251.64	2284.87	2318.35	2352.08	2386.04	2420.24	2454.70	2489.39	2524.33	2559.51	2594.93	2630.61	2666.52	2702.67	2739.08
160	2123.71	2156.51	2189.57	2222.88	2256.41	2290.22	2324.27	2358.57	2393.13	2427.95	2463.01	2498.32	2533.89	2569.69	2605.76	2642.08	2678.64	2715.47	2752.54	2789.85	2827.44
165	2190.08	2223.90	2257.99	2292.35	2326.93	2361.79	2396.90	2432.28	2467.92	2503.82	2539.97	2576.39	2613.07	2650.00	2687.19	2724.64	2762.34	2800.33	2838.56	2877.04	2915.79
170	2256.44	2291.29	2326.41	2361.81	2397.44	2433.36	2469.54	2505.98	2542.70	2579.69	2616.94	2654.46	2692.25	2730.30	2768.62	2807.21	2846.05	2885.19	2924.58	2964.22	3004.15
175	2322.81	2358.68	2394.84	2431.28	2467.95	2504.93	2542.17	2579.69	2617.49	2655.57	2693.91	2732.53	2771.44	2810.60	2850.05	2889.77	2929.76	2970.04	3010.59	3051.40	3092.51
180	2389.17	2426.07	2463.26	2500.74	2538.47	2576.50	2614.80	2653.39	2692.28	2731.44	2770.88	2810.61	2850.62	2890.91	2931.48	2972.34	3013.47	3054.90	3096.61	3138.59	3180.87
185	2455.54	2493.46	2531.69	2570.21	2608.98	2648.07	2687.44	2727.10	2767.06	2807.32	2847.85	2888.68	2929.81	2971.21	3012.91	3054.90	3097.17	3139.76	3182.63	3225.77	3269.22
190	2521.91	2560.86	2600.11	2639.67	2679.49	2719.64	2760.07	2800.81	2841.85	2883.19	2924.82	2966.75	3008.99	3051.51	3094.34	3137.47	3180.88	3224.62	3268.64	3312.95	3357.58
195	2588.27	2628.25	2668.53	2709.14	2750.00	2791.21	2832.70	2874.51	2916.63	2959.06	3001.79	3044.82	3088.17	3131.81	3175.77	3220.03	3264.59	3309.48	3354.66	3400.13	3445.94
200	2654.64	2695.64	2736.96	2778.60	2820.52	2862.78	2905.34	2948.22	2991.42	3034.94	3078.76	3122.90	3167.36	3212.12	3257.20	3302.60	3348.30	3394.34	3440.68	3487.32	3534.30

VOLUMES IN C.C. OF FOUR CYLINDERS. From 50mm. × 50mm. to 69mm. × 130mm.

STROKE IN MM.	BORE IN MM.																			
	50	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**
1	7.852	8.172	8.492	8.824	9.160	9.500	9.852	10.204	10.568	10.936	11.310	11.688	12.076	12.469	12.868	13.273	13.685	14.106	14.526	14.957
2	15.704	16.344	16.984	17.648	18.320	19.004	19.704	20.412	21.136	21.872	22.619	23.376	24.152	24.938	25.735	26.546	27.370	28.213	29.053	29.914
3	23.556	24.516	25.476	26.472	27.480	28.508	29.556	30.620	31.704	32.808	33.928	35.064	36.228	37.406	38.603	39.820	41.054	42.319	43.579	44.870
4	31.408	32.688	33.968	35.296	36.640	38.012	39.408	40.824	42.272	43.744	45.238	46.752	48.304	49.875	51.471	53.093	54.739	56.426	58.106	59.827
50	392.68	408.56	424.72	441.20	458.04	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
55	431.96	449.40	467.20	485.32	503.84	522.68	541.48	561.36	581.24	601.44	—	—	—	—	—	—	—	—	—	—
60	471.24	490.24	509.68	529.48	549.64	570.16	591.12	612.40	634.08	656.12	678.57	701.28	724.56	748.13	772.06	—	—	—	—	—
65	510.50	531.11	552.16	573.59	595.45	617.71	640.38	663.44	686.92	710.81	735.12	759.72	784.94	810.47	836.40	862.76	889.51	916.92	944.22	972.19
70	549.77	571.96	594.64	617.71	641.26	665.22	689.64	714.48	739.76	765.49	791.67	818.16	845.32	872.82	900.74	929.12	957.94	987.45	1016.85	1046.98
75	589.04	612.82	637.11	661.83	687.06	712.74	738.90	765.51	792.60	820.17	848.22	876.60	905.70	935.16	965.08	995.49	1026.36	1057.98	1089.48	1121.76
80	628.31	653.67	679.58	705.95	732.86	760.26	788.16	816.54	845.44	874.85	904.77	935.04	966.08	997.50	1029.41	1061.86	1094.78	1128.51	1162.11	1196.54
85	667.58	694.53	722.06	750.07	778.67	807.77	837.42	867.58	898.28	929.53	961.32	993.48	1026.46	1059.85	1093.75	1128.22	1163.21	1199.04	1234.74	1271.33
90	706.84	735.38	764.53	794.20	824.47	855.29	886.68	918.61	951.12	984.20	1017.86	1051.92	1086.84	1122.19	1158.09	1194.59	1231.63	1269.58	1307.38	1346.11
95	746.11	776.24	807.01	838.32	870.28	902.80	935.94	969.65	1003.96	1038.88	1074.41	1110.36	1147.22	1184.54	1222.43	1260.95	1300.06	1340.11	1380.01	1420.90
100	785.38	817.09	849.48	882.44	916.08	950.32	985.20	1020.68	1056.80	1093.56	1130.96	1168.80	1207.60	1246.88	1286.77	1327.32	1368.48	1410.64	1452.64	1495.68
105	—	—	—	—	—	997.84	1034.46	1071.71	1109.64	1148.24	1187.51	1227.24	1267.98	1309.22	1351.11	1393.69	1436.90	1481.17	1525.27	1570.46
110	—	—	—	—	—	1045.35	1083.72	1122.75	1162.48	1202.92	1244.06	1285.68	1328.36	1371.57	1415.44	1460.05	1505.33	1551.70	1597.90	1645.25
115	—	—	—	—	—	—	—	—	—	—	1300.60	1344.12	1388.74	1433.91	1479.78	1526.42	1573.75	1622.24	1670.54	1720.03
120	—	—	—	—	—	—	—	—	—	—	1357.15	1402.56	1449.12	1496.26	1544.12	1592.78	1642.18	1692.77	1743.17	1794.82
125	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1659.15	1710.60	1763.30	1815.80	1869.60
130	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1725.52	1779.02	1833.83	1888.43	1944.38

VOLUMES IN C.C. OF FOUR CYLINDERS. From 70mm. × 70mm. to 89mm. × 170mm.

BORE IN MM.

STROKE IN MM.	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
1	15.394	15.836	16.286	16.742	17.203	17.671	18.146	18.626	19.113	19.607	20.108	20.612	21.124	21.642	22.167	22.698	23.235	23.778	24.329	24.885
2	30.788	31.672	32.571	33.483	34.407	35.343	36.292	37.253	38.227	39.213	40.216	41.224	42.248	43.285	44.334	45.396	46.471	47.558	48.657	49.769
3	46.181	47.508	48.858	50.225	51.610	53.014	54.437	55.879	57.340	58.820	60.324	61.836	63.372	64.927	66.500	68.094	69.706	71.336	72.986	74.654
4	61.575	63.344	65.144	66.966	68.813	70.686	72.583	74.505	76.454	78.426	80.432	82.447	84.496	86.569	88.668	90.792	92.941	95.115	97.314	99.538
70	1077.56	1108.56	1140.01	1171.91	1204.23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
75	1154.53	1187.76	1221.44	1255.62	1290.24	1325.36	1360.93	1396.98	1435.30	1470.50	—	—	—	—	—	—	—	—	—	—
80	1231.50	1266.92	1302.87	1339.33	1376.26	1413.71	1451.66	1490.11	1529.07	1568.53	1608.48	1648.95	1689.91	1731.39	1773.36	—	—	—	—	—
85	1308.47	1346.12	1384.30	1423.04	1462.28	1502.07	1542.39	1583.24	1624.64	1666.56	1709.00	1752.01	1795.53	1839.60	1884.19	1929.33	1975.00	2021.20	2067.93	2115.19
90	1385.44	1425.28	1465.73	1506.75	1548.29	1590.43	1633.12	1676.37	1720.20	1764.60	1809.56	1855.07	1901.15	1947.81	1995.03	2042.82	2091.17	2140.09	2189.57	2239.62
95	1462.41	1504.48	1547.16	1590.45	1634.31	1678.78	1723.85	1769.51	1815.77	1862.63	1910.08	1958.13	2006.77	2056.02	2105.86	2156.31	2207.35	2258.98	2311.21	2364.04
100	1539.38	1583.68	1628.59	1674.16	1720.33	1767.14	1814.58	1862.64	1911.34	1960.66	2010.60	2061.19	2112.39	2164.23	2216.70	2269.80	2323.53	2377.88	2432.86	2488.46
105	1616.35	1662.84	1710.02	1758.87	1806.34	1855.50	1905.31	1955.77	2006.90	2058.70	2111.12	2164.25	2218.01	2272.44	2327.53	2383.29	2439.70	2496.77	2554.50	2612.88
110	1693.31	1742.04	1791.45	1841.58	1892.36	1943.85	1996.04	2048.90	2102.47	2156.73	2211.68	2267.31	2323.63	2380.66	2438.37	2496.78	2555.88	2615.66	2676.14	2737.31
115	1770.28	1821.20	1872.88	1925.29	1978.37	2032.21	2086.76	2142.03	2198.04	2254.76	2312.20	2370.37	2429.25	2488.87	2549.20	2610.27	2672.06	2734.56	2797.78	2861.73
120	1847.25	1900.00	1954.31	2009.00	2064.39	2120.57	2177.49	2235.16	2293.61	2352.79	2412.72	2473.42	2534.86	2597.08	2660.04	2723.76	2788.23	2853.45	2919.43	2986.15
125	1924.22	1979.20	2035.74	2092.70	2150.41	2208.93	2268.22	2328.30	2389.17	2450.83	2513.28	2576.48	2640.48	2705.29	2770.87	2837.25	2904.41	2972.35	3041.07	3110.58
130	2001.19	2058.36	2117.17	2176.41	2236.42	2297.28	2358.95	2421.43	2484.74	2548.86	2613.80	2679.54	2746.10	2813.50	2881.71	2950.74	3020.59	3091.24	3162.71	3235.00
135	2078.16	2137.56	2198.60	2260.12	2322.44	2385.64	2449.68	2514.56	2580.31	2646.89	2714.32	2782.60	2851.72	2921.71	2992.54	3064.23	3136.76	3210.13	3284.35	3359.42
140	2155.13	2216.72	2280.03	2343.83	2408.46	2474.00	2540.41	2607.69	2675.87	2744.93	2814.84	2885.66	2957.34	3029.93	3103.38	3177.72	3252.94	3329.03	3406.00	3483.85
145	—	—	—	—	—	2562.35	2631.14	2700.82	2771.44	2842.96	2915.40	2988.72	3062.96	3138.14	3214.21	3291.21	3369.11	3447.92	3527.64	3608.27
150	—	—	—	—	—	2650.71	2721.87	2793.96	2867.01	2940.99	3015.92	3091.78	3168.58	3246.35	3325.05	3404.70	3485.29	3566.82	3649.28	3732.69
155	—	—	—	—	—	—	—	—	—	—	3116.44	3194.84	3274.20	3354.56	3435.88	3518.19	3601.47	3685.71	3770.93	3857.12
160	—	—	—	—	—	—	—	—	—	—	3216.96	3297.90	3379.82	3462.77	3546.71	3631.68	3717.64	3804.60	3892.57	3981.54
165	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3745.17	3833.82	3923.50	4014.21	4105.96
170	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3858.66	3950.00	4042.39	4135.85	4230.38

VOLUMES IN C.C. OF FOUR CYLINDERS From 90mm. × 90mm. to 109mm. × 200mm.

BORE IN MM.

STROKE IN MM.	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109
1	25.447	26.016	26.591	27.172	27.759	28.353	28.953	29.559	30.172	30.791	31.416	32.047	32.685	33.329	33.979	34.636	35.299	35.968	36.644	37.325
2	50.894	52.031	53.181	54.343	55.518	56.706	57.906	59.119	60.344	61.582	62.832	64.095	65.370	66.658	67.959	69.272	70.598	71.936	73.287	74.651
3	76.341	78.047	79.771	81.515	83.278	85.059	86.859	88.678	90.516	92.372	94.248	96.142	98.056	99.988	101.939	103.908	105.897	107.905	109.931	111.976
4	101.788	104.062	106.362	108.687	111.04	113.412	115.812	118.237	120.688	123.163	125.664	128.190	130.741	133.317	135.918	138.545	141.196	143.873	146.574	149.301
90	2290.23	2341.40	2393.15	2445.45	2498.33	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
95	2417.46	2471.48	2526.10	2581.31	2637.12	2693.53	2750.53	2808.13	2866.33	2925.13	—	—	—	—	—	—	—	—	—	—
100	2544.70	2601.56	2659.05	2717.17	2775.92	2835.29	2895.30	2955.93	3017.19	3079.08	3141.60	3204.75	3268.52	3332.92	3397.95	3463.61	3529.90	3596.82	3664.36	3732.53
105	2671.93	2731.64	2792.00	2853.03	2914.71	2977.06	3040.06	3103.73	3168.05	3233.04	3298.68	3364.98	3431.95	3499.57	3567.85	3636.79	3706.40	3776.66	3847.58	3919.16
110	2799.17	2861.71	2924.96	2988.89	3053.51	3118.82	3184.83	3251.52	3318.91	3386.99	3455.76	3525.22	3595.37	3666.22	3737.75	3809.97	3882.89	3956.50	4030.80	4105.79
115	2926.40	2991.79	3057.91	3124.75	3192.31	3260.59	3329.59	3399.32	3469.77	3540.94	3612.84	3685.46	3758.80	3832.86	3907.65	3983.16	4059.39	4136.34	4214.02	4292.42
120	3053.64	3121.87	3190.86	3260.60	3331.10	3402.35	3474.36	3547.12	3620.63	3694.90	3769.92	3845.70	3922.22	3999.51	4077.55	4156.34	4235.88	4316.18	4397.23	4479.04
125	3180.87	3251.95	3323.81	3396.46	3469.90	3544.12	3619.12	3694.91	3771.49	3848.85	3927.00	4005.93	4085.65	4166.15	4247.44	4329.52	4412.38	4496.02	4580.45	4665.67
130	3308.10	3382.02	3456.77	3532.32	3608.69	3685.88	3763.89	3842.71	3922.35	4002.81	4084.08	4166.17	4249.08	4332.80	4417.34	4502.70	4588.87	4675.86	4763.67	4852.30
135	3435.34	3512.10	3589.72	3668.18	3747.49	3827.65	3908.65	3990.51	4073.21	4156.76	4241.16	4326.41	4412.50	4499.45	4587.24	4675.88	4765.37	4855.70	4946.89	5038.92
140	3562.57	3642.18	3722.67	3804.04	3886.28	3969.41	4053.42	4138.31	4224.07	4310.72	4398.24	4486.64	4575.93	4666.09	4757.14	4849.06	4941.86	5035.54	5130.11	5225.55
145	3689.81	3772.26	3855.62	3939.90	4025.08	4111.18	4198.18	4286.10	4374.93	4464.67	4555.32	4646.88	4739.35	4832.74	4927.03	5022.24	5118.36	5215.39	5313.33	5412.18
150	3817.04	3902.34	3988.58	4075.75	4163.88	4252.94	4342.95	4433.90	4525.79	4618.62	4712.40	4807.12	4902.78	4999.39	5096.93	5195.42	5294.85	5395.23	5496.54	5598.80
155	3944.28	4032.42	4121.53	4211.61	4302.67	4394.71	4487.71	4581.69	4676.65	4772.58	4869.48	4967.36	5066.21	5166.03	5266.83	5368.60	5471.35	5575.07	5679.76	5785.43
160	4071.51	4162.49	4254.48	4347.47	4441.47	4536.47	4632.48	4729.49	4827.51	4926.53	5026.56	5127.59	5229.63	5332.68	5436.73	5541.78	5647.84	5754.91	5862.98	5972.06
165	4198.75	4292.57	4387.43	4483.33	4580.26	4678.24	4777.24	4877.29	4978.37	5080.49	5183.64	5287.83	5393.06	5499.32	5606.63	5714.96	5824.34	5934.75	6046.20	6158.68
170	4325.98	4422.65	4520.39	4619.19	4719.06	4820.00	4922.01	5025.08	5129.23	5234.44	5340.72	5448.07	5556.49	5665.97	5776.52	5888.14	6000.83	6114.59	6229.42	6345.31
175	4453.22	4552.73	4653.34	4755.05	4857.86	4961.76	5066.77	5172.88	5280.09	5388.39	5497.80	5608.31	5719.91	5832.62	5946.42	6061.32	6177.33	6294.43	6412.63	6531.94
180	4580.45	4682.80	4786.29	4890.91	4996.65	5103.53	5211.54	5320.68	5430.95	5542.35	5654.88	5768.54	5883.34	5999.26	6116.32	6234.51	6353.82	6474.27	6595.85	6718.56
185	—	—	—	—	—	5245.29	5356.30	5468.47	5581.81	5696.30	5811.96	5928.78	6046.76	6165.91	6286.22	6407.70	6530.32	6654.11	6779.07	6905.19
190	—	—	—	—	—	5387.06	5501.07	5616.27	5732.67	5850.26	5969.04	6089.02	6210.19	6332.55	6456.11	6580.87	6706.81	6833.95	6962.29	7191.82
195	—	—	—	—	—	—	—	—	—	—	6126.12	6249.26	6373.62	6499.20	6626.01	6754.05	6883.31	7013.79	7145.51	7278.44
200	—	—	—	—	—	—	—	—	—	—	6283.20	6409.49	6537.04	6665.85	6795.91	6927.23	7059.80	7193.64	7328.72	7465.07

VOLUMES IN C.C. OF FOUR CYLINDERS. From 110mm. × 110mm. to 129mm. × 200mm.

BORE IN MM.

STROKE IN MM.	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129
1	38.013	38.708	39.408	40.115	40.828	41.548	42.273	43.005	43.744	44.488	45.239	45.996	46.760	47.529	48.305	49.087	49.876	50.671	51.472	52.279
2	76.027	77.415	78.816	80.230	81.656	83.095	84.547	86.011	87.487	88.976	90.478	91.992	93.519	95.059	96.610	98.175	99.752	101.342	102.944	104.559
3	114.040	116.123	118.225	120.345	122.475	124.643	126.820	129.016	131.231	133.465	135.717	137.988	140.279	142.588	144.916	147.262	149.628	152.013	154.416	156.838
4	152.05	154.831	157.663	160.460	163.313	166.101	169.093	172.021	174.975	177.953	180.956	183.985	187.038	190.117	193.221	196.350	199.504	202.683	205.888	209.117
110	4181.47	4257.84	4334.91	4412.66	4491.11	4570.24	4650.07	4730.59	4811.80	4893.70	—	—	—	—	—	—	—	—	—	—
115	4371.54	4451.38	4531.95	4613.24	4695.25	4777.98	4861.44	4945.62	5030.52	5116.14	—	—	—	—	—	—	—	—	—	—
120	4561.60	4644.92	4728.99	4813.81	4899.39	4985.72	5072.81	5160.64	5249.24	5338.58	5428.68	5519.54	5611.15	5703.51	5796.63	5890.50	5985.12	6080.50	6176.64	6273.52
125	4751.67	4838.46	4926.03	5014.39	5103.53	5193.46	5284.17	5375.67	5467.95	5561.02	5654.88	5749.52	5844.95	5941.16	6038.16	6135.94	6234.51	6333.86	6434.00	6534.92
130	4941.74	5031.99	5123.07	5214.96	5307.67	5401.20	5495.54	5590.70	5686.67	5783.47	5881.07	5979.50	6078.74	6178.80	6279.68	6381.37	6483.89	6587.21	6691.36	6796.32
135	5131.80	5225.53	5320.11	5415.54	5511.81	5608.93	5706.90	5805.72	5905.39	6005.91	6107.27	6209.48	6312.54	6416.45	6521.21	6626.81	6733.27	6840.57	6948.72	7057.71
140	5321.87	5419.07	5517.15	5616.11	5715.95	5816.67	5918.27	6020.75	6124.11	6228.35	6333.47	6439.46	6546.34	6654.10	6762.73	6872.25	6982.65	7093.92	7206.08	7319.11
145	5511.94	5612.61	5714.19	5816.69	5920.09	6024.41	6129.64	6235.78	6342.83	6450.79	6559.66	6669.44	6780.14	6891.74	7004.26	7117.69	7232.03	7347.28	7463.44	7580.51
150	5702.00	5806.15	5911.23	6017.26	6124.24	6232.15	6341.01	6450.80	6561.55	6673.23	6785.86	6899.42	7013.94	7129.39	7245.79	7363.12	7481.41	7600.63	7720.80	7841.90
155	5892.07	5999.69	6108.28	6217.84	6328.38	6439.89	6552.37	6665.83	6780.26	6895.67	7012.05	7129.41	7247.73	7367.04	7487.31	7608.56	7730.79	7853.98	7978.16	8103.30
160	6082.14	6193.22	6305.32	6418.41	6532.52	6647.63	6763.74	6880.86	6998.98	7118.11	7238.25	7359.39	7481.53	7604.68	7728.84	7854.00	7980.17	8107.34	8235.52	8364.70
165	6272.20	6386.76	6502.36	6618.99	6736.66	6855.36	6975.11	7095.88	7217.70	7340.55	7464.44	7589.37	7715.33	7842.33	7970.36	8099.44	8229.55	8360.69	8492.88	8626.10
170	6462.27	6580.30	6699.40	6819.57	6940.80	7063.10	7186.47	7310.91	7436.42	7562.99	7690.64	7819.35	7949.13	8079.97	8211.89	8344.87	8478.93	8614.05	8750.24	8887.49
175	6652.34	6773.84	6896.44	7020.14	7144.94	7270.84	7397.84	7525.94	7655.14	7785.43	7916.83	8049.33	8182.93	8317.62	8453.42	8590.31	8728.31	8867.40	9007.60	9148.89
180	6842.40	6967.38	7093.48	7220.72	7349.08	7478.58	7609.21	7740.97	7873.85	8007.87	8143.03	8279.31	8416.72	8555.27	8694.94	8835.75	8977.69	9120.76	9264.96	9410.29
185	7032.47	7160.92	7290.52	7421.29	7553.22	7686.32	7820.57	7955.99	8092.57	8230.32	8369.22	8509.29	8650.52	8792.91	9836.47	9081.19	9227.07	9374.11	9522.32	9671.68
190	7222.54	7354.45	7487.56	7621.87	7757.36	7894.06	8031.94	8171.02	8311.29	8452.76	8595.42	8739.27	8884.32	9030.56	9178.00	9326.62	9476.45	9627.46	9779.67	9933.08
195	7412.61	7547.99	7684.60	7822.44	7961.51	8101.79	8243.31	8386.05	8530.01	8675.20	8821.61	8969.25	9118.12	9268.21	9419.52	9572.06	9725.83	9880.82	10037.03	10194.48
200	7602.67	7741.53	7881.65	8023.02	8165.65	8309.53	8454.67	8601.07	8748.73	8897.64	9047.81	9199.23	9351.91	9505.85	9661.05	9817.50	9975.21	10134.17	10294.39	10455.87

VOLUMES IN C.C. OF FOUR CYLINDERS.

From 130mm. × 130mm. to 150mm. × 200mm.

BORE IN MM.

STROKE IN MM.	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
1	53.093	53.913	54.739	55.572	56.411	57.256	58.107	58.965	59.829	60.699	61.575	62.458	63.347	64.243	65.144	66.052	66.966	67.887	68.814	69.747	70.686
2	106.186	107.826	109.478	111.144	112.821	114.511	116.214	117.929	119.657	121.398	123.151	124.916	126.694	128.485	130.288	132.104	133.933	135.774	137.627	139.493	141.372
3	159.279	161.739	164.218	166.715	169.232	171.767	174.321	176.894	179.486	182.097	184.726	187.374	190.042	192.727	195.433	198.156	200.899	203.661	206.441	209.240	212.058
4	212.372	215.652	218.957	222.287	225.642	229.023	232.428	235.859	239.315	242.795	246.301	249.833	253.389	256.970	260.577	264.209	267.865	271.547	275.254	278.987	282.744
130	6902.10	7008.69	7116.10	7224.33	7333.37	7443.24	7553.91	7665.41	7777.72	7890.85	—	—	—	—	—	—	—	—	—	—	—
135	7167.56	7278.25	7389.80	7502.19	7615.43	7729.51	7844.45	7960.23	8076.87	8194.35	—	—	—	—	—	—	—	—	—	—	—
140	7433.03	7547.82	7663.49	7780.05	7897.48	8015.79	8134.98	8255.06	8376.01	8497.84	8620.55	8744.14	8868.61	8993.96	9120.19	9247.30	9375.29	9504.16	9633.90	9764.53	9896.04
145	7698.44	7817.38	7937.19	8057.91	8179.53	8302.07	8425.52	8549.88	8675.15	8801.33	8928.43	9056.43	9185.35	9315.17	9445.91	9577.56	9710.12	9843.59	9977.97	10113.27	10249.47
150	7963.96	8086.95	8210.89	8335.76	8461.59	8588.35	8716.06	8844.70	8974.29	9104.83	9236.30	9368.72	9502.08	9636.39	9771.63	9907.82	10044.95	10183.83	10322.04	10462.00	10602.90
155	8229.42	8356.51	8484.58	8613.62	8743.64	8874.63	9006.59	9139.53	9274.44	9408.32	9544.18	9681.01	9818.82	9957.60	10097.35	10238.08	10379.78	10522.46	10666.11	10810.73	10956.33
160	8494.89	8626.08	8758.28	8891.48	9025.69	9160.91	9297.13	9434.35	9572.58	9711.82	9852.06	9993.30	10135.56	10278.81	10423.07	10568.34	10714.62	10861.89	11010.18	11159.47	11309.76
165	8760.35	8895.64	9031.97	9169.34	9307.74	9447.18	9587.66	9729.17	9871.72	10015.31	10159.93	10305.59	10452.29	10600.13	10748.79	10898.60	11049.45	11201.33	11354.25	11508.20	11663.19
170	9025.82	9165.21	9305.67	9447.20	9589.80	9733.46	9878.20	10024.00	10170.87	10318.81	10467.81	10617.89	10769.03	10921.24	11074.52	11228.86	11384.28	11540.76	11698.31	11856.93	12016.42
175	9291.28	9434.77	9579.37	9725.06	9871.85	10019.74	10168.73	10318.82	10470.01	10622.30	10775.69	10930.18	11085.76	11242.45	11400.24	11559.12	11719.11	11880.20	12042.38	12205.67	12370.05
180	9556.75	9704.34	9853.06	10002.92	10153.90	10306.02	10459.27	10613.64	10769.15	10925.79	11083.56	11242.47	11402.50	11563.66	11725.96	11889.39	12053.94	12219.63	12386.45	12554.40	12723.48
185	9822.21	9973.90	10126.76	10280.78	10435.96	10592.30	10749.80	10908.47	11068.30	11229.29	11391.44	11554.76	11719.24	11884.87	12051.68	12219.65	12388.77	12559.06	12730.52	12903.13	13076.91
190	10087.68	10243.47	10400.46	10558.63	10718.01	10878.57	11040.34	11203.29	11367.44	11532.78	11699.32	11867.05	12035.97	12206.09	12377.40	12549.91	12723.61	12898.50	13074.59	13251.87	13430.34
195	10353.14	10513.03	10674.15	10836.49	11000.06	11164.85	11330.87	11498.11	11666.58	11836.28	12007.20	12179.34	12352.71	12527.30	12703.12	12880.17	13058.44	13237.93	13418.65	13600.60	13783.77
200	10618.61	10782.60	10947.85	11114.35	11282.11	11451.13	11621.41	11792.94	11965.73	12139.77	12315.07	12491.63	12669.44	12848.52	13028.84	13210.43	13394.27	13577.37	13762.72	13949.33	14137.20

VOLUMES IN C.C. OF SIX CYLINDERS.

From 50mm. × 50mm. to 69mm. × 130mm.

STROKE IN MM.	BORE IN MM.																			
	50	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**
1	11.778	12.258	12.738	13.236	13.740	14.250	14.778	15.306	15.852	16.404	16.965	17.535	18.114	18.704	19.302	19.910	20.527	21.154	21.790	22.436
2	23.556	24.516	25.476	26.472	27.480	28.500	29.556	30.612	31.704	32.808	33.929	35.070	36.229	37.407	38.604	39.820	41.054	42.308	43.580	44.871
3	35.334	36.774	38.214	39.708	41.220	42.750	44.334	45.918	47.556	49.212	50.894	52.605	54.343	56.111	57.906	59.730	61.582	63.462	65.370	67.307
4	47.112	49.032	50.952	52.944	54.960	57.000	59.112	61.224	63.408	65.616	67.859	70.139	72.458	74.814	77.208	79.640	82.109	84.616	87.161	89.743
50	589.02	612.84	637.08	661.80	687.06	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
55	647.94	674.10	700.80	727.90	755.76	784.02	812.76	842.04	871.86	902.16	—	—	—	—	—	—	—	—	—	—
60	706.86	735.36	764.52	794.22	824.46	855.24	886.68	918.60	951.12	984.18	1017.88	1052.09	1086.87	1122.21	1158.12	—	—	—	—	—
65	765.72	796.68	828.24	860.40	893.16	926.52	960.54	995.16	1030.38	1066.20	1102.70	1139.76	1177.44	1215.73	1254.63	1294.14	1334.27	1375.01	1416.36	1458.32
70	824.64	857.94	891.96	926.58	961.86	997.80	1034.46	1071.72	1109.64	1148.22	1187.52	1227.44	1268.01	1309.25	1351.14	1393.69	1436.91	1480.78	1525.31	1570.50
75	883.56	919.26	955.62	992.76	1030.56	1069.08	1108.32	1148.28	1188.90	1230.24	1272.35	1315.11	1358.58	1402.76	1447.65	1473.24	1539.54	1586.55	1634.26	1682.68
80	942.48	980.52	1019.34	1058.94	1099.26	1140.36	1182.24	1224.84	1268.16	1312.26	1357.17	1402.79	1449.16	1496.28	1544.16	1592.79	1642.18	1692.32	1743.21	1794.86
85	1001.34	1041.78	1083.06	1125.12	1167.96	1211.64	1256.10	1301.34	1347.42	1394.28	1441.99	1490.46	1539.73	1589.80	1640.67	1692.34	1744.81	1798.09	1852.16	1907.04
90	1060.26	1103.10	1146.78	1191.30	1236.66	1282.92	1330.02	1377.90	1426.68	1476.30	1526.82	1578.14	1630.30	1683.32	1737.18	1791.89	1847.45	1903.86	1961.11	2019.22
95	1119.18	1164.36	1210.50	1257.48	1305.42	1354.20	1403.88	1454.46	1505.94	1558.32	1611.64	1665.81	1720.87	1776.83	1833.69	1891.44	1950.09	2009.63	2070.06	2131.39
100	1178.10	1225.68	1274.22	1323.66	1374.12	1425.48	1477.80	1531.02	1585.20	1640.34	1696.46	1753.48	1811.45	1870.35	1930.20	1990.99	2052.72	2115.40	2179.01	2243.57
105	—	—	—	—	—	1496.76	1551.66	1607.58	1664.46	1722.36	1781.29	1841.16	1902.02	1963.87	2026.71	2090.54	2155.36	2221.17	2287.96	2355.75
110	—	—	—	—	—	1568.04	1625.58	1684.14	1743.72	1804.38	1866.11	1928.83	1992.59	20.5739	2123.22	2190.09	2257.99	2326.94	2396.92	2467.93
115	—	—	—	—	—	—	—	—	—	—	1950.93	2016.51	2083.16	2150.90	2219.73	2289.64	2360.63	2432.71	2505.87	2580.11
120	—	—	—	—	—	—	—	—	—	—	2035.76	2104.18	2173.74	2244.42	2316.24	2389.19	2463.27	2538.48	2614.82	2692.29
125	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2488.74	2565.90	2644.25	2723.77	2804.47
130	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2588.29	2668.54	2750.12	2832.72	2916.65

VOLUMES IN C.C. OF SIX CYLINDERS. From 70mm. × 70mm. to 89mm. × 170mm.

BORE IN M.M.

STROKE IN MM.	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
1	23.091	23.755	24.429	25.112	25.805	26.507	27.219	27.940	28.670	29.410	30.159	30.918	31.686	32.464	33.251	34.047	34.853	35.668	36.493	37.327
2	46.182	47.510	48.858	50.225	51.610	53.015	54.438	55.880	57.340	58.820	60.319	61.836	63.372	64.927	66.501	68.094	69.706	71.336	72.986	74.654
3	69.273	71.266	73.287	75.337	77.415	79.522	81.656	83.819	86.011	88.230	90.478	92.754	95.059	97.391	99.752	102.141	104.559	107.004	109.478	111.980
4	92.363	95.021	97.706	100.450	103.220	106.429	108.875	111.759	114.681	117.640	120.637	123.670	126.740	129.855	133.003	136.188	139.412	142.673	145.971	149.310
70	1616.35	1662.86	1710.04	1757.87	1806.36	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
75	1731.81	1781.64	1832.18	1883.43	1935.38	1988.04	2041.41	2095.49	2150.27	2205.76	—	—	—	—	—	—	—	—	—	—
80	1847.26	1900.42	1954.33	2008.99	2064.41	2120.58	2177.51	2235.19	2293.62	2352.81	2412.75	2473.44	2534.89	2597.10	2660.06	—	—	—	—	—
85	1962.71	2019.19	2076.47	2134.55	2193.43	2253.12	2313.60	2374.88	2436.97	2499.86	2563.55	2628.03	2693.33	2759.42	2826.31	2894.00	2962.50	3031.79	3101.89	3172.79
90	2078.17	2137.97	2198.62	2260.11	2322.46	2385.65	2449.69	2514.58	2580.32	2646.91	2714.34	2782.63	2851.76	2921.74	2992.56	3064.24	3136.76	3210.13	3248.35	3359.42
95	2193.62	2256.74	2320.76	2385.68	2451.48	2518.19	2585.79	2654.28	2723.67	2793.96	2865.14	2937.22	3010.19	3084.85	3158.82	3234.47	3311.03	3388.47	3466.82	3546.06
100	2309.08	2375.52	2442.91	2511.24	2580.51	2650.73	2721.88	2793.98	2867.02	2941.01	3015.94	3091.81	3168.62	3246.37	3325.07	3404.71	3485.29	3566.82	3649.28	3732.69
105	2424.53	2494.30	2565.05	2636.80	2709.54	2783.26	2857.98	2933.68	3010.38	3088.06	3166.73	3246.40	3327.05	3408.69	3491.32	3574.94	3659.56	3745.16	3831.75	3919.33
110	2539.98	2613.07	2687.20	2762.36	2838.56	2915.80	2994.07	3073.38	3153.73	3235.11	3317.53	3400.99	3485.48	3571.01	3657.58	3745.18	3833.82	3923.50	4014.21	4105.96
115	2655.44	2731.85	2809.34	2887.92	2967.59	3048.33	3130.16	3213.08	3297.08	3382.16	3468.33	3555.58	3643.91	3733.33	3823.83	3915.42	4008.08	4101.84	4196.67	4292.60
120	2770.89	2850.63	2931.49	3013.49	3096.61	3180.87	3266.26	3352.78	3440.43	3529.21	3619.12	3710.17	3802.34	3895.65	3990.08	4085.65	4182.35	4280.18	4379.14	4479.23
125	2886.35	2969.40	3053.64	3139.05	3225.64	3313.41	3403.25	3492.48	3583.78	3376.26	3769.92	3864.76	3960.77	4057.97	4156.34	4255.89	4356.61	4458.52	4561.60	4665.87
130	3001.80	3088.18	3175.78	3264.61	3354.66	3445.94	3538.45	3632.18	3727.13	3823.31	3920.72	4019.35	4119.20	4220.28	4322.59	4426.12	4530.88	4636.86	4744.07	4852.50
135	3117.25	3206.95	297.93	3390.17	3483.69	3578.48	3674.54	3771.88	3870.48	3970.36	4071.51	4173.94	4277.63	4382.60	4488.84	4596.36	4705.14	4815.20	4926.53	5039.13
140	3232.71	3325.73	3420.07	3515.73	3612.71	3711.02	3810.64	3911.57	4013.83	4117.41	4222.31	4328.53	4436.06	4544.93	4655.10	4766.59	4879.41	4993.54	5109.00	5225.77
145	—	—	—	—	—	3843.55	3946.73	4051.28	4157.19	4264.46	4373.11	4483.12	4594.50	4707.24	4821.35	4936.82	5053.67	5171.88	5291.46	5412.40
150	—	—	—	—	—	3976.09	4082.82	4190.97	4300.54	4411.51	4523.90	4637.71	4750.93	4869.56	4987.60	5107.06	5227.94	5350.22	5473.92	5599.04
155	—	—	—	—	—	—	—	—	—	—	4674.70	4792.30	4911.36	5031.88	5153.86	5277.30	5402.20	5528.56	5656.39	5785.67
160	—	—	—	—	—	—	—	—	—	—	4825.50	4946.89	5069.79	5194.20	5320.11	5447.53	5576.47	5706.90	5838.85	5972.31
165	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5617.77	5750.73	5885.25	6021.32	6158.94
170	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5788.01	5924.99	6063.59	6203.78	6345.58

VOLUMES IN C.C. OF SIX CYLINDERS. From 90mm. × 90mm. to 109mm. × 200mm.

BORE IN MM.

STROKE IN MM.	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109
1	38.170	39.023	39.886	40.758	41.639	42.529	43.429	44.339	45.258	46.186	47.124	48.071	49.028	49.994	50.969	51.954	52 949	53.952	54.965	55.988
2	76.341	78.047	79.772	81.515	83.278	85.059	86.859	88.678	90.516	92.372	94.248	96.142	98.056	99.988	101.939	103.908	105 897	107.405	109.931	111.975
3	114.511	117.070	119.657	122.273	124.916	127.588	130.288	133.017	135.774	138.559	141.372	144.214	147.083	149.982	152,908	155.863	158.846	161.857	164.896	167.962
4	152.682	156.094	159.543	163.030	166.555	170.118	173.718	177.356	181.032	184.745	188.496	192.285	196.111	199.975	203.877	207.817	211.794	215.809	219.862	223.949
90	3435.34	3512.10	3589.72	3668.18	3747.49	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
95	3626.19	3707.22	3789.15	3871.97	3955.68	4040.29	4125.80	4212.20	4299.50	4387.69	—	—	—	—	—	—	—	—	—	—
100	3817.04	3902.34	3988.58	4075.75	4163.88	4252.94	4342.95	4433.90	4525.79	4618.62	4712.40	4807.12	4902.78	4999.39	5096.93	5195.42	5294.85	5395.23	5496.54	5598.70
105	4007.90	4097.46	4188.00	4279.54	4372.07	4465.59	4560.10	4655.59	4752.08	4849.55	4948.02	5047.48	5147.92	5249.35	5351.78	5455.19	5559.60	5664.99	5771.37	5878.64
110	4198.75	4292.57	4387.43	4483.33	4580.26	4678.24	4777.24	4877.29	4978.37	5080.50	5183.64	5287.83	5393.06	5499.32	5606.63	5714.96	5824.34	5934.75	6046.20	6158.57
115	4389.60	4487.69	4586.86	4687.12	4788.46	4890.88	4994.39	5098.98	5204.66	5311.42	5419.26	5528.19	5638.20	5749.29	5861.47	5974.73	6089.08	6204.51	6321.02	6438.51
120	4580.45	4682.81	4786.29	4890.91	4996.65	5103.53	5211.54	5320.68	5430.95	5542.35	5654.88	5768.54	5883.34	5999.26	6116.32	6234.51	6353.82	6474.27	6595.85	6718.44
125	4771.31	4877.92	4985.72	5094:69	5204.85	5316.18	5428.68	5542.37	5657.34	5773.28	5890.50	6008.90	6128.48	6249.23	6371.16	6494.25	6618.57	6744.03	6870.68	6998.38
130	4962.16	5073.04	5185.15	5298.48	5413.04	5528.82	5645.83	5764.07	5883.53	6004.21	6126.12	6249.26	6373.62	6499.20	6626.01	6754.05	6883.31	7013.79	7145.51	7278.31
135	5153.01	5268.16	5384.58	5502.27	5621.23	5741.47	5862.98	5985.76	6109.82	6235.14	6361.74	6489.61	6618.75	6749.17	6880.86	7013.82	7148.05	7283.56	7420.33	7558.25
140	5343.86	5463.27	5584.01	5706.06	5829.43	5954.12	6080.13	6207.46	6336.10	6466.07	6597.36	6729.97	6863.89	6999.14	7135.70	7273.59	7412.79	7553.32	7695.16	7838.18
145	5534.71	5658.39	5783.43	5909.84	6037.62	6166.76	6297.27	6429.15	6562.39	6697.00	6832.98	6970.32	7109.03	7249.11	7390.55	7533.36	7677.54	7823.08	7969.99	8118.12
150	5725.57	5853.51	5982.86	6113.63	6245.81	6379.41	6514.42	6650.85	6788.68	6927.93	7068.60	7210.68	7354.17	7499.08	7645.40	7793.13	7942.28	8092.84	8244.82	8398.05
155	5916.42	6048.62	6182.29	6317.42	6454.01	6592.06	6731.57	6872.54	7014.97	7158.87	7304.22	7451.03	7599.31	7749.05	7900.24	8052.90	8207.02	8362.60	8519.64	8677.99
160	6107.27	6243.74	6381.72	6552.12	6662.20	6804.71	6948.72	7094.24	7241.26	7389.80	7539.84	7691.39	7844.45	7999.12	8155.09	8312.67	8471.76	8632.36	8794.47	8957.92
165	6298.12	6438.86	6581.15	6725.00	6870.40	7017.35	7165.86	7315.93	7467.55	7620.72	7775.46	7931.75	8089.59	8248.99	8409.94	8572.44	8736.51	8902.12	9069.30	9237.86
170	6488.97	6633.98	6780.58	6928.78	7078.59	7230.00	7383.01	7537.63	7693.84	7851.66	8011.08	8172.10	8334.73	8498.95	8664.78	8832.22	9001.25	9171.89	9344.12	9517.79
175	6679.83	6829.09	6980.01	7132.57	7286.78	7442.65	7600.16	7759.32	7920.13	8082.59	8246.70	8412.46	8579.87	8748.92	8919.63	9091.99	9265.99	9441.65	9618.95	9797.73
180	6870.68	7024.21	7179.44	7336.36	7494.98	7655.29	7817.31	7981.01	8146.42	8313.52	8482.32	8652.81	8825.01	8998.89	9174.48	9351.76	9530.73	9711.41	9893.78	10077.66
185	—	—	—	—	—	7867.94	8034.45	8202.71	8372.71	8544.45	8717.94	8893.17	9070.14	9248.86	9429.32	9611.53	9795.48	9981.17	10168.61	10357.60
190	—	—	—	—	—	8080.59	8251.60	8424.40	8599.00	8775.38	8953.56	9133.53	9305.28	9498.83	9684.17	9871.30	10060.22	10250.93	10443.43	10637.53
195	—	—	—	—	—	—	—	—	—	—	9189.18	9373.88	9560.42	9748.80	9939.02	10131.07	10324.96	10520.69	10718.26	10947.17
200	—	—	—	—	—	—	—	—	—	—	9424.80	9614.24	9805.06	9998.77	10193.86	10390.84	10589.71	10790.45	10993.09	11197.40

VOLUMES IN C.C. OF SIX CYLINDERS. From 110mm. × 110mm. to 129mm. × 200mm.

BORE IN MM.

STROKE IN MM.	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129
1	57.020	58.061	59.112	60.173	61.242	62.321	63.410	64.508	65.615	66.732	67.859	68.994	70.139	71.294	72.458	73.631	74.814	76.006	77.208	78.419
2	114.040	116.123	118.225	120.345	122.485	124.643	126.820	129.016	131.231	133.465	135.717	137.988	140.279	142.588	144.916	147.263	149.628	152.013	154.416	156.838
3	170.060	174.184	177.337	180.518	183.727	186.964	190.230	193.524	196.846	200.197	203.576	206.983	210.418	213.882	217.374	220.894	224.442	228.019	231.624	235.257
4	228.080	232.246	236.449	240.691	244.969	249.286	253.640	258.032	262.462	266.929	271.434	275.977	280.557	285.176	289.831	294.525	299.256	304.025	308.832	313.676
110	6272.20	6383.76	6502.36	6618.99	6736.66	6855.36	6975.11	7095.88	7217.70	7340.55	—	—	—	—	—	—	—	—	—	—
115	6557.30	6677.07	6797.92	6919.85	7042.87	7166.97	7292.16	7418.43	7545.78	7674.21	—	—	—	—	—	—	—	—	—	—
120	6842.40	6967.38	7093.48	7220.72	7349.08	7478.58	7609.21	7740.97	7873.85	8007.88	8143.03	8279.31	8416.72	8555.27	8694.94	8835.75	8977.69	9120.76	9264.96	9410.29
125	7127.51	7257.69	7389.04	7521.58	7655.29	7790.19	7926.26	8063.51	8201.93	8341.54	8482.32	8624.28	8767.42	8911.74	9057.23	9203.91	9351.76	9500.79	9651.00	9862.38
130	7412.61	7547.99	7684.60	7822.44	7961.51	8101.79	8243.31	8386.05	8530.01	8675.20	8821.61	8969.25	9118.12	9268.21	9419.52	9572.06	9725.83	9880.82	10037.04	10194.48
135	7697.71	7838.30	7980.17	8123.21	8267.71	8413.40	8560.36	8708.59	8858.09	9008.86	9160.91	9314.22	9468.81	9624.68	9781.81	9940.22	10099.90	10260.85	10423.07	10586.57
140	7982.81	8128.61	8275.73	8424.17	8573.93	8725.01	8877.41	9031.13	9186.16	9342.52	9500.20	9659.19	9819.51	9981.15	10144.10	10308.38	10473.97	10640.88	10809.11	10978.67
145	8667.91	8418.91	8571.29	8725.03	8880.14	9036.62	9194.46	9353.67	9514.24	9676.18	9839.49	10004.17	10170.21	10337.62	10506.39	10676.53	10848.04	11020.91	11195.15	11370.76
150	8553.01	8709.22	8866.85	9025.90	9186.35	9348.22	9511.51	9676.21	9842.32	10009.84	10178.78	10349.14	10520.90	10694.08	10868.68	11044.69	11222.11	11400.94	11581.99	11762.86
155	8838.11	8999.53	9162.41	9326.76	9492.56	9659.83	9828.56	9998.75	10170.40	10343.51	10518.08	10694.11	10871.60	11050.55	11230.97	11412.84	11596.18	11709.88	11967.23	12154.95
160	9123.21	9289.84	9457.98	9627.62	9798.78	9971.44	10145.61	10321.29	10498.47	10677.17	10857.37	11039.08	11222.30	11407.02	11593.26	11781.00	11970.25	12161.01	12353.27	12547.05
165	9408.31	9580.14	9753.54	9928.48	10104.99	10283.05	10462.66	10643.83	10826.55	11010.83	11196.66	11384.05	11572.99	11763.49	11955.55	12149.16	12344.32	12541.04	12739.31	12939.14
170	9693.41	9870.45	10049.10	10229.35	10411.20	10594.65	10779.71	10966.37	11154.63	11344.49	11535.96	11729.02	11923.69	12119.96	12317.84	12517.31	12718.39	12921.07	13125.35	13331.24
175	9978.51	10160.76	10344.66	10530.21	10717.41	10906.26	11096.76	11288.91	11482.71	11678.15	11875.25	12073.99	12274.39	12476.43	12680.13	12885.47	13092.46	13301.10	13511.39	13723.33
180	10263.61	10451.07	10640.22	10831.07	11023.62	11217.87	11413.81	11611.45	11810.78	12011.81	12214.54	12418.96	12625.09	12832.90	13042.42	13253.63	13466.53	13681.13	13897.43	14115.43
185	10548.71	10741.37	10935.78	11131.94	11329.83	11529.48	11730.86	11933.99	12138.86	12345.47	12553.83	12763.94	12975.78	13189.37	13404.70	13621.78	13840.60	14061.17	14283.47	14507.52
190	10833.81	11031.68	11231.35	11432.80	11636.05	11841.08	12047.91	12256.53	12466.94	12679.14	12893.13	13108.91	13326.48	13545.84	13766.99	13989.94	14214.67	14441.20	14669.51	14899.62
195	11118.91	11321.99	11526.91	11733.66	11942.26	12152.69	12364.96	12579.01	12795.01	13012.80	13232.42	13453.88	13677.18	13902.31	14129.28	14358.09	14588.74	14821.23	15055.55	15291.71
200	11404.01	11612.30	11822.47	12034.53	12248.47	12464.30	12682.01	12901.61	13123.09	13346.46	13571.71	13798.85	14027.87	14258.78	14491.57	14726.25	14962.81	15201.26	15441.59	15683.81

VOLUMES IN C.C. OF SIX CYLINDERS.

From 130mm. × 130mm. to 150mm. × 200mm.

STROKE IN MM.	BORE IN MM.																					
	130	**131**	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**	**141**	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**	**15**
1	79.640	80.869	82.109	83.358	84.616	85.883	87.161	88.447	89.743	91.048	92.363	93.687	95.021	96.364	97.716	99.078	100.450	101.830	103.220	104.620	106.02
2	159.279	161.739	164.218	166.715	169.232	171.767	174.321	176.894	179.486	182.097	184.726	187.374	190.042	192.728	195.433	198.156	200.899	203.661	206.441	209.240	212.05
3	238.919	242.608	246.327	250.073	253.848	257.650	261.482	265.341	269.229	273.145	277.090	281.062	285.063	289.092	293.149	297.235	301.349	305.491	309.661	313.860	318.08
4	318.558	323.478	328.435	333.431	338.463	343.534	348.642	353.788	358.972	364.193	369.452	374.749	380.083	385.455	390.865	396.313	401.798	407.321	412.882	418.480	424.11
130	10353.14	10513.03	10674.15	10836.49	11000.06	11164.85	11330.87	11498.11	11666.58	11836.28	—	—	—	—	—	—	—	—	—	—	—
135	10751.34	10917.38	11084.70	11253.28	11423.14	11594.27	11766.67	11940.35	12115.30	12291.52	—	—	—	—	—	—	—	—	—	—	—
140	11149.54	11321.73	11495.24	11670.07	11846.22	12023.69	12202.48	12382.58	12564.01	12746.76	12930.83	13116.21	13302.92	13490.94	13680.29	13870.95	14062.93	14256.24	14450.86	14646.80	14844.06
145	11547.74	11726.08	11905.78	12086.86	12269.30	12453.11	12638.28	12824.82	13012.73	13202.00	13392.64	13584.65	13778.02	13972.76	14168.87	14366.34	14565.18	14765.39	14966.96	15169.90	15374.20
150	11945.94	12130.42	12316.33	12503.65	12692.38	12882.52	13074.08	13267.06	13461.44	13657.24	13854.46	14053.08	14253.13	14454.58	14657.45	14861.73	15067.43	15274.54	15483.06	15693.00	15904.35
155	12344.13	12534.77	12726.87	12920.43	13115.46	13311.94	13509.89	13709.29	13910.16	14112.48	14316.27	14521.52	14728.23	14936.40	15146.03	15357.12	15569.68	15783.69	15999.16	16216.10	16434.49
160	12742.33	12939.12	13137.42	13337.22	13538.54	13741.36	13945.69	14151.53	14358.87	14567.72	14778.09	14989.96	15203.33	15418.22	15634.61	15852.51	16071.92	16292.84	16515.27	16739.20	16964.64
165	13140.53	13343.47	13547.96	13754.01	13961.62	14170.78	14381.49	14593.76	14807.59	15022.97	15239.90	15458.39	15678.44	15900.04	16123.19	16347.90	16574.17	16801.99	17031.37	17262.30	17494.78
170	13538.73	13747.81	13958.51	14170.80	14384.70	14600.19	14817.29	15036.00	15256.30	15478.21	15701.72	15926.83	16153.54	16381.86	16611.78	16843.30	17076.42	17311.14	17547.47	17785.40	18024.93
175	13936.92	14152.16	14369.05	14587.59	14807.77	15029.61	15253.10	15478.23	15705.02	15933.45	16163.53	16395.26	16628.65	16863.68	17101.36	17338.69	17578.67	17820.29	18063.57	18308.50	18555.07
180	14335.12	14556.51	14779.59	15004.38	15230.85	15459.03	15688.90	15920.47	16153.73	16388.69	16625.35	16863.70	17103.75	17345.50	17588.94	17834.08	18080.91	18329.45	18579.67	18831.60	19085.22
185	14733.32	15960.86	15190.14	15421.16	15653.93	15888.45	16124.70	16362.71	16602.44	16843.93	17087.16	17332.14	17578.55	17827.32	18077.52	18329.47	18583.16	18838.60	19095.78	19354.70	19615.36
190	15131.52	15365.20	15600.68	15837.95	16077.01	16317.86	16560.50	16804.94	17051.16	17299.17	17548.98	17800.57	18053.96	18309.13	18566.10	18824.86	19085.41	19347.75	19611.88	19877.80	20145.51
195	15529.71	15769.55	16011.23	16254.74	16500.09	16747.28	16996.31	17247.17	17499.87	17754.41	18010.79	18269.01	18529.06	18790.95	19054.68	19320.25	19587.66	19856.90	20127.98	20400.90	20675.65
200	15927.91	16173.90	16421.77	16671.48	16923.17	17176.70	17432.11	17689.41	17948.59	18209.66	18472.61	18737.44	19004.17	19272.77	19543.27	19815.64	20089.90	20366.05	20644.08	20924.00	21205.80

SUPERCHARGING.

BY H. R. RICARDO.

There has arisen during the last few years a sudden outburst of popular interest in supercharging, which gives rise to the question as to why so ancient and so well-known a means of increasing the power output of an engine has not been employed before.

The power output obtainable from an engine depends upon two factors, and upon two factors alone :—

(1) The weight of air it can consume per minute.
(2) The efficiency at which that air is utilized.

For reasons which will be explained later, we can only afford to supercharge an "efficient" engine; therefore, we must first define carefully just what we mean by an "efficient" engine.

The term "efficiency" is very widely abused. In the best circles it is taken to mean the proportion of the available heat of the fuel which is turned into actual power. Even this definition is not strictly correct, for it presupposes that the fuel is given sufficient air to burn it completely, which is seldom, if ever, the case. Efficiency should be reckoned, not on the fuel, but rather on the air consumed, for every pound of air when carburetted and burnt, will liberate a definite quantity of heat, in round figures about 1,300 B.Th.Us., almost regardless of whether it is saturated or super-saturated with fuel. At first sight, this may appear a subtle distinction, but from many points of view it is a most important one, and when considering supercharging it becomes a vital one.

An engine which will give out one brake horse-power for every $7\frac{1}{2}$ lb. of air it consumes per hour, corresponding to a thermal efficiency of 26 per cent, may be classed as a fairly efficient engine regardless of its fuel consumption. The correct ratio of air to fuel is approximately as 15 to 1, so that if there is no waste of fuel, such an engine should consume $\frac{1}{2}$ lb. of petrol per horse-power per hour. Supposing, however, that the carburettor were badly adjusted, or the distribution at fault, the same engine might easily consume $\frac{3}{4}$ lb. instead of $\frac{1}{2}$ lb. per horse-power per hour, but its true efficiency would still be unaltered; it would mean only that the additional fuel was being wasted through some fault in the carburettor or distribution system, not that the engine was any less efficient in the true sense of the word. Modern requirements in the way of flexibility and acceleration put such severe demands upon the carburettor and distribution system that it is necessary to employ a somewhat rich mixture setting, and therefore under most conditions we waste a certain amount of fuel, added to which the volatility of the fuel has steadily depreciated; hence the improvement in fuel consumption is by no means commensurate with the improvement in efficiency which has been realized in recent years.

The limit of power we can get from any engine is reached when either :—

(1) The speed of revolution becomes so high as to prove mechanically destructive.
(2) The flow of waste heat becomes greater than that with which we can cope.

For any given efficiency, the power of an engine is directly proportional to the weight of air we can make it consume per hour. Obviously, we can double the power output of any engine either by doubling the speed or by doubling the pressure at the carburettor. In either case, the engine will take in twice as much air per hour, but in either case we shall bump heavily against one or other of the two limits just mentioned. Increasing the pressure, i.e., supercharging, puts up the heat-flow very rapidly but does not greatly increase the dynamic stresses. Increasing the speed increases the heat-flow somewhat less rapidly but intensifies the dynamic stresses excessively.

In our search for greater power output, we may attempt an increase in speed or in pressure, and the choice will depend upon that one of the two limitations to which we are already nearest.

Broadly speaking, we shall find that in an engine of large cylinder capacity our nearest limit to-day is set by heat-flow, and our best chance of improvement lies in increase of speed, while in an engine of small capacity the reverse is usually the case and supercharging gives the greater scope.

Let us next consider the relationship between heat-flow and efficiency. In the first place it cannot be emphasized too strongly that it is the flow of waste heat, and waste heat alone, which does all the damage in the way of burning out exhaust valves, carbonization, gummed rings and all the other kindred evils to which the inefficient engine is heir.

Let us take the case of two engines, each of the same cylinder capacity, of which the efficiencies, defined in the manner explained above, are 20 per cent. and 30 per cent. respectively. Let us assume that, at the same speed, each engine consumes the same weight

of air, and that the potential heat equivalent of this quantity of air when fully carburetted amounts to 100 horse-power in either case. Now the first engine will clearly develop 20 b.h.p. and let loose 80 horse-power worth of waste heat, while the second will develop 30 b.h.p. and turn loose 70 horse-power worth of waste heat. In an engine of this size and of good average design, with reasonably well cooled exhaust-valve seats, etc., 80 horse-power is just about the utmost limit of waste heat it can digest for any length of time without getting into serious trouble. In the case, therefore, of the 20 per cent. efficient engine, 20 b.h.p. is the utmost we can hope to get out of it without running up against our second limit, and we certainly could not afford to supercharge. In the case of the 30 per cent. efficient engine we can get 30 b.h.p. and still have only 70 horse-power worth of waste heat to cope with, and, moreover, it is heat at lower temperature and therefore much less damaging. We have said that we can cope with 80 horse-power worth of waste heat, so that in this case we are not up to our limit and could afford to supercharge the engine up to well over 35 b.h.p. and still be in exactly the same position as regards heat limitations as in the case of the less efficient engine when developing 20 b.h.p.

Actually, we could go very considerably higher, because, in a car, the occasions when we should want 35 b.h.p. are obviously much less frequent than our demands for 20 b.h.p., so that we should really be quite safe in supercharging the more efficient engine up to 40 b.h.p.

The effect, therefore, of increasing the true thermal efficiency from 20 per cent. to 30 per cent. is that we have increased the limiting power at the same speed from 20 to 40 b.h.p., still keeping the same degree of reliability and maintenance of tune, and have made supercharging possible, which it certainly would not have been in the previous case.

When both engines are running along on the level at the same speed and developing, say, 10 b.h.p., the low-efficiency engine is pouring out a steady 40 horse-power worth of waste heat, while the more efficient engine, when running at the same power, will be turning out only 70/3 or 23.3 h.p., and will therefore last far longer without overhaul or decarbonizing, so that on the comparatively rare occasions on which full power is required, we could afford to increase the waste-heat flow to considerably over 80 h.p. and still retain at least as good reliability and maintenance of tune. Taking everything into consideration, we should probably be perfectly safe in boosting the more efficient engine up to at least 50 b.h.p.

The improvement in thermal efficiency, due to the better knowledge now available, has resulted in quite an extraordinary increase in power output with the result that even without supercharging, the 2-litre engine of to-day gives very nearly, if not quite, as much power as the 4-litre engine of ten years ago, or the 6-litre engine of fifteen years ago, although the external design does not appear to have undergone any conspicuous change.

Little or nothing is known about supercharging to-day which was not common knowledge twenty or thirty years ago. Then, as to-day, it was perfectly well known that the power output of an engine was directly proportional to the pressure at the carburettor and could be increased *pro rata* with that pressure by supercharging. Then, as to-day, blowers of the Roots or vane type were well known and in regular commercial use. The only new factor which has emerged is that it is only within the last few years that engines have been produced of which the thermal efficiency is high enough to permit of supercharging.

The car engine of ten years ago would hardly stand the full normal atmospheric pressure, and was either deliberately or inadvertently throttled at the valves, carburettor, or both. As the efficiency improved, so the breathing capacity of engines was increased, until to-day it is so high that we can afford even to add to the normal atmospheric pressure, in other words, to supercharge, but it must not be supposed that because one engine of good modern design will stand supercharging, another of inferior design will do likewise. To tack a supercharger on to an inefficient engine is merely to court disaster.

Broadly speaking, the position to-day is that the best designed engines have very nearly reached the limit of speed attainable in the present state of the art, but are well within the limit of heat-flow; hence the obvious step is to supercharge them if we are striving to get the utmost out of a given cylinder capacity. Who can say what the future will bring? It may quite well be that the trend of improvement will be in the direction of further increase in speed and that we shall again reach the limit set by heat-flow without supercharging. This will be a more healthy development, for the supercharger is an added complication, and as such, is always undesirable. Moreover, supercharging greatly increases the tendency to detonate, and therefore tends to lower the efficiency, while a corresponding increase in speed tends to reduce detonation, and so permits us to increase the efficiency. The author's view is therefore that supercharging for motor cars is somewhat of a passing phase made possible at the moment because, in the race for improvement, the thermodynamic side has moved more rapidly than the mechanical; moreover, it has been stimulated by artificial conditions, such as racing rules and taxation. These notes are an extract from a paper presented to the Institute of Automobile Engineers and published in *The Automobile Engineer*, April, 1927.

Compression Pressure in Pounds per Square Inch for Various Percentages of Compression Space Volume.

Combustion Chamber, Percentage of Piston Displacement.	Compression Pressures in Lb. per Square Inch Gauge Pressure.		
	High Value.	Average Value.	Low Value.
18	190	170	147
19	179	160	138
20	168	151	130
21	158	142	122
22	149	133	115
23	140	125	108
24	132	118	102
25	125	112	97
26	118	107	92
27	113	102	88
28	108	97	84
29	103	93	80
30	99	89	77
31	95	86	74
32	92	83	71
33	89	80	68
34	86	77	66
35	83	74	64
36	80	72	62
37	77	70	60
38	74	68	58
39	72	66	56
40	70	64	55

B.Th.U. DATA.

A British thermal unit (B.Th.U.) represents the amount of heat required to raise the temperature of 1 lb. of water at or near 39°F. 1°F.

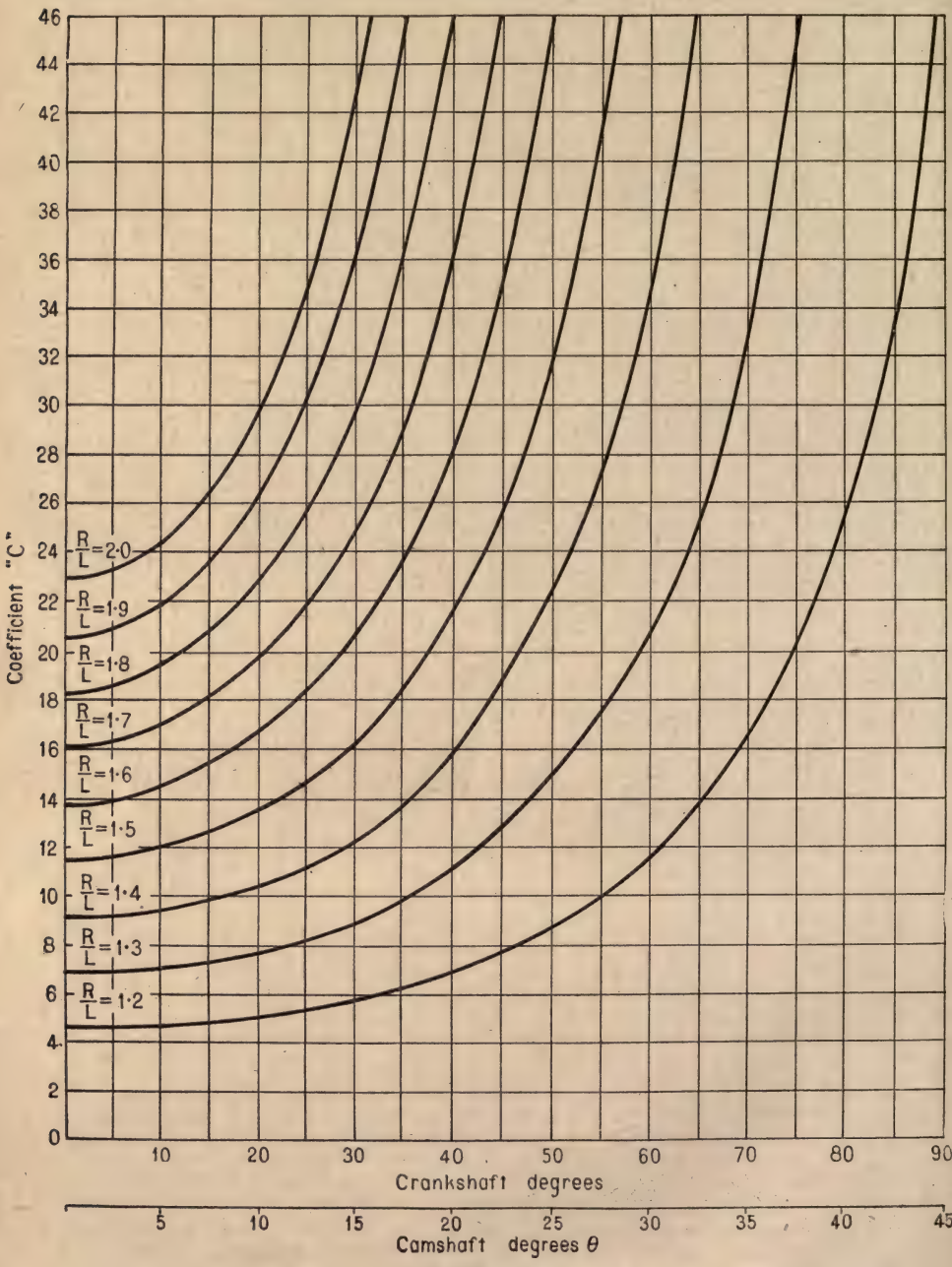
A British thermal unit represents 778 foot-lbs.; 1 lb. of fuel per horse-power hour equals 1,980,000 foot-lbs. per lb. of fuel, or 2,545 B.Th.U. per lb. of fuel.

1 h.p. expressed in B.Th.U. = 33,000 ÷ 778 = 42.416 heat units per minute.

ANALYSIS OF CAMS.

BY R. J. COUSINS.

Graphs Nos. 1, 2, and 3, cover all ordinary proportions of cams in which the noses are composed of circular arcs, the flanks of tangents or circular arcs (concave or convex), and having flat or circular followers. Cases involving other curves such as constant acceleration or constantly increasing acceleration are not treated here.



GRAPH No. 1.

The method of using the graphs is obvious from the small diagrams, etc., and will be found extremely simple.

Every cam necessarily consists of four parts:—

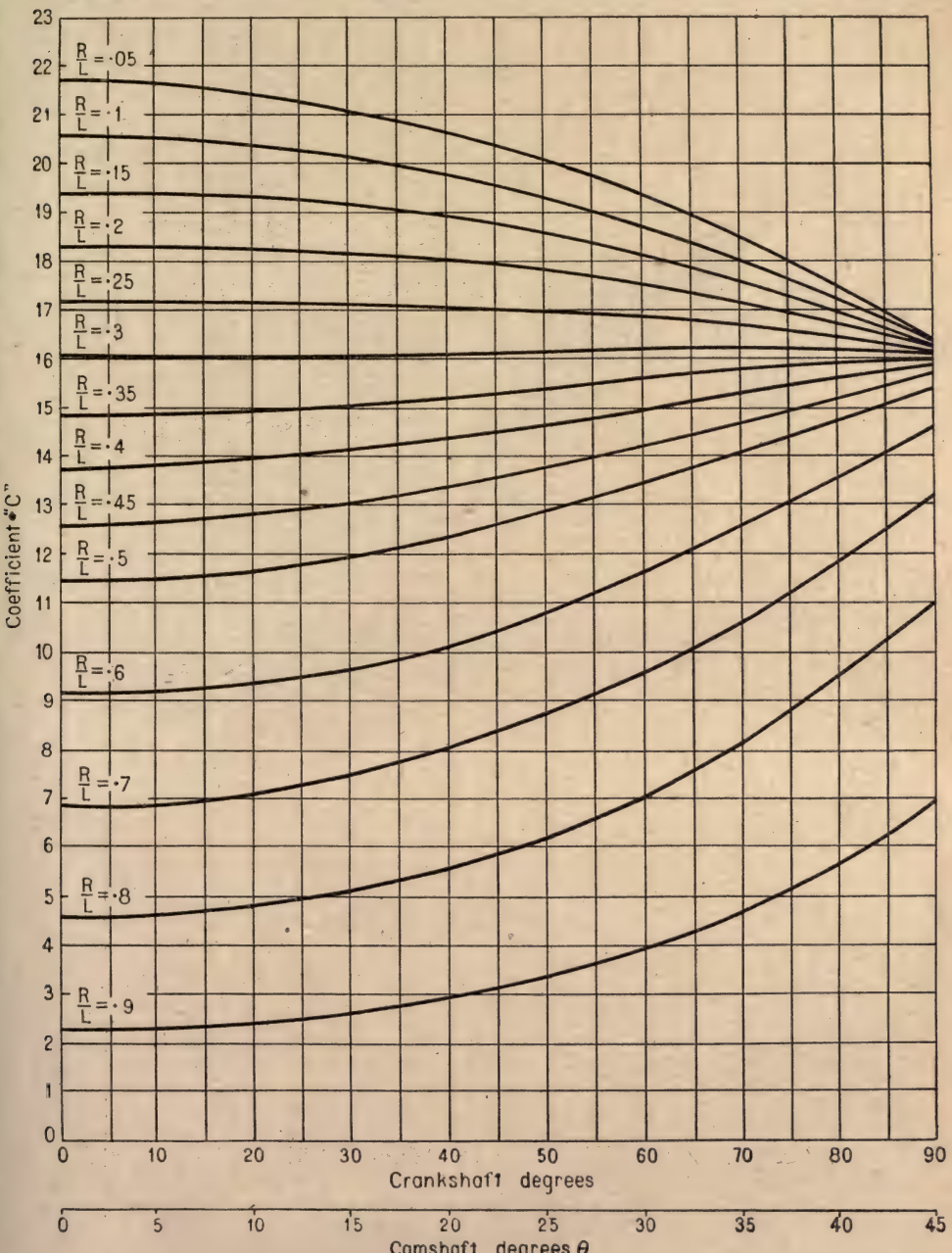
(I) The leading flank commencing at the point where the profile begins to rise from the base circle and extending to the point of maximum radial velocity.

(II) The leading side of the nose from the point of maximum velocity to the apex.

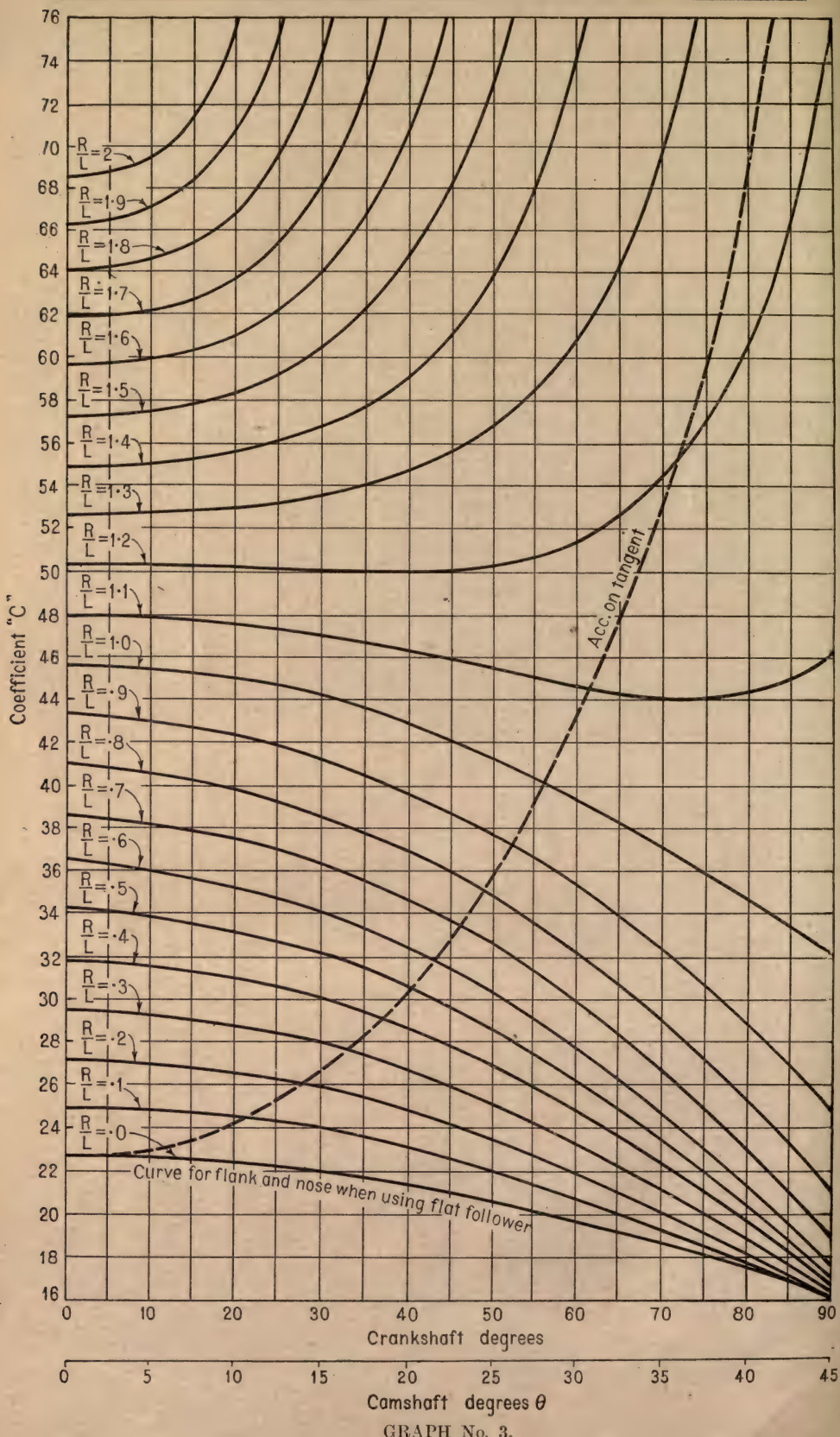
(III) The trailing side of the nose.

(IV) The trailing flank.

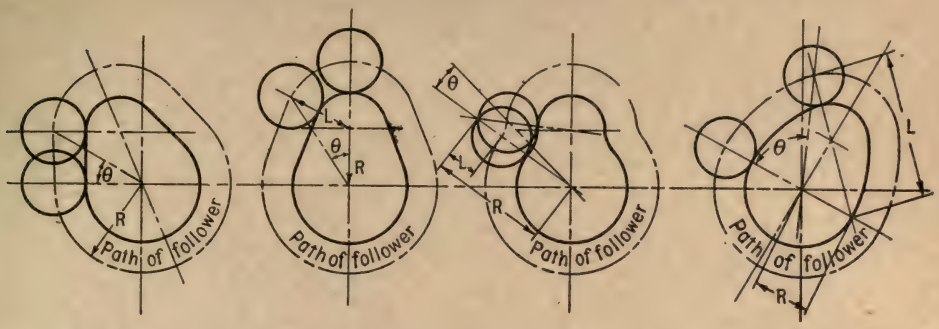
Usually (I) and (IV) are similar, as are also (II) and (III), but this is not necessarily so. The point of maximum velocity is referred to as the point of reversal because the acceleration



GRAPH No. 2.


Coefficient "C"
R/L=2
R/L=1·9
R/L=1·8
R/L=1·7
R/L=1·6
R/L=1·5
R/L=1·4
R/L=1·3
R/L=1·2
R/L=1·1
R/L=1·0
R/L=·9
R/L=·8
R/L=·7
R/L=·6
R/L=·5
R/L=·4
R/L=·3
R/L=·2
R/L=·1
R/L=·0
Acc. on tangent
Curve for flank and nose when using flat follower
Crankshaft degrees
Camshaft degrees θ

GRAPH No. 3.



A. Tangent Flank. Use Graph No. 3 (dotted line).

B. Round Nose. Use Graph No. 3.

C. Concave Flank. Use Graph No. 1.

D. Convex Flank. Use Graph No. 2.

FIG. 1.—External Cams.

changes from positive (radially outwards) to negative (radially inwards) at this point, which is the junction of the curves easily determined by drawing the common normal. The angle θ in the diagrams, in the case of the flank, is measured from the beginning of the flank to the point at which it is desired to measure the acceleration, and in the case of the nose, from the apex to the desired point.

In most cases it is only necessary to take four points, viz., the beginning and end of positive acceleration on flank of cam and the beginning and end of negative acceleration on the nose (from which the force required to be given by the springs is ascertained). The curves can then be put in by inspection, as they naturally have the same characteristics as the particular graphs used in fixing the terminal points. In extreme cases, involving high speeds and lifts, intermediate points should be taken on the nose so as to determine the most suitable spring with greater accuracy.

To ensure that the spring pressure is adequate at all points, it is advisable to draw a force/lift diagram, *i.e.*, a graph of the negative acceleration on a basis of valve travel. As the corresponding graph for a helical spring is a straight line, it is but a simple matter to draw in the straight line which most nearly corresponds to the required curve and so determine the maximum load and the total and initial deflections. The method is shown in fig. 4.

Horizontal lines are drawn through a number of points on the displacement curve from the point of reversal of force to the apex, and on them are marked the vertical heights of the corresponding points on the acceleration graph. The resulting curve gives the force at each point in the lift, and a straight line lying outside but approximating to this curve represents the correct spring. The deflections are read off to the same scale as the valve lift and the force at any point is equal to $\frac{W(\text{lbs.}) \times A(\text{ft.-sec.}^2)}{32.2}$, where W is the weight of the moving parts and A is the acceleration at that point.

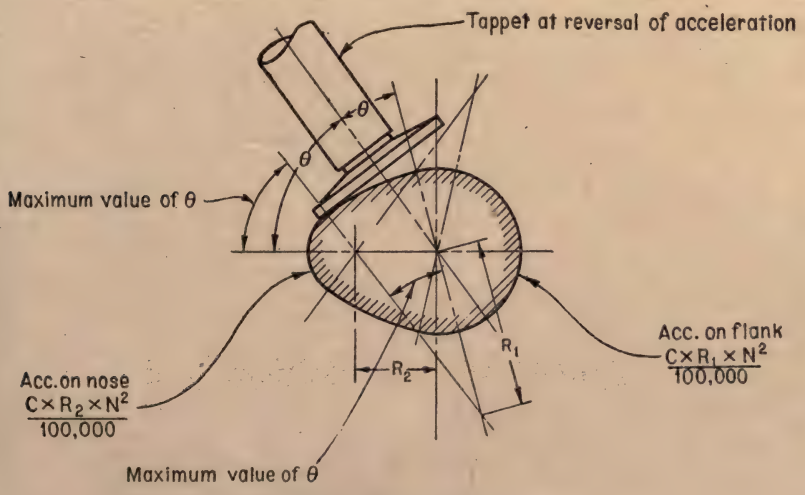


FIG. 2.—Flat Follower Cam.

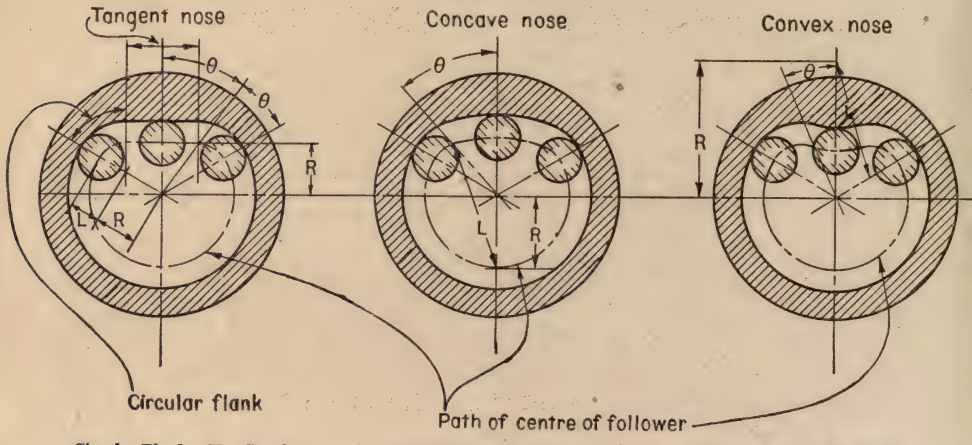
In some cases, where the initial force (valve seated) is very small, it is advisable to increase the loading at this point to seat the valves firmly and prevent the exhaust from being sucked open when running throttled.

In discussing the matter, the following symbols will be used:—

$$\text{Acc.} = \frac{C \times R \times N^2}{100{,}000}.$$

C=Coefficient from table according to angle and proportions of cam.
R=Distance in inches between centre of camshaft and centre of curvature of cam face, except for the case of a straight-line flank, where it is the sum of the radii of base circle and cam follower. (See Figs. 1, 2 and 3.)
L=Distance from centre of curvature of cam face to centre of follower.
N=R.p.m. of crankshaft assuming camshaft runs half engine speed. The dotted curve gives acceleration on tangent. (See Graph No. 1.)
θ=True Angle in camshaft degrees.

Note.—When $\frac{R}{L}=0$ then L=infinity. This is equivalent to the case of a flat follower. (See Graph No. 3.)



Circular Flank. Use Graph No. 3.
Tangent Nose. Use Graph No. 3 (dotted line).

Concave Nose. Use Graph No. 2.

Convex Nose. Use Graph No. 1.

FIG. 3.—Internal Cams.

A glance at the graphs will show that a large $\frac{R}{L}$ ratio on the nose results in a force/lift diagram which has a diminishing value from reversal to apex, *i.e.*, the reverse of a normal spring, so that the spring which is sufficient to deal with the force at the point of reversal is far too strong at the apex and puts unnecessary stress on the parts. Whenever possible, therefore, a ratio of $\frac{R}{L}$ should be chosen which is less than unity.

It is generally found that the follower wears more rapidly than the cam. In fig. 5 are shown two designs in which the displacement and acceleration are identical, but there is no doubt as to which would have the longer life. In this connection it should be borne in mind that the pressure on the nose of the cam is at most the spring pressure and decreases as the speed rises towards the designed figure, the force of the spring being neutralised by the inertia of the valve parts, and therefore the cam nose may safely be made of very small radius; but, on the other hand, the pressure between the flank and the follower consists of the spring pressure, the positive acceleration (rising as the square of the speed), and, in the exhaust cam, the force necessary to overcome the gas pressure, and it is therefore essential that the radius of curvature of the follower should be as large as can conveniently be arranged, and the peripheral velocity reduced to the minimum. In all cases, the base circle should be reduced as much as possible consistent with stiffness and strength of shaft and angle of attack on the tappet or follower. (The last consideration only applies with any force in the case of round-ended sliding tappets, where a heavy lateral component causes considerable friction and wear and soon develops rattle.)

It should be noted that it is assumed that there is no clearance. This is a condition which does not obtain in practice, but it should be approximated to as nearly as possible

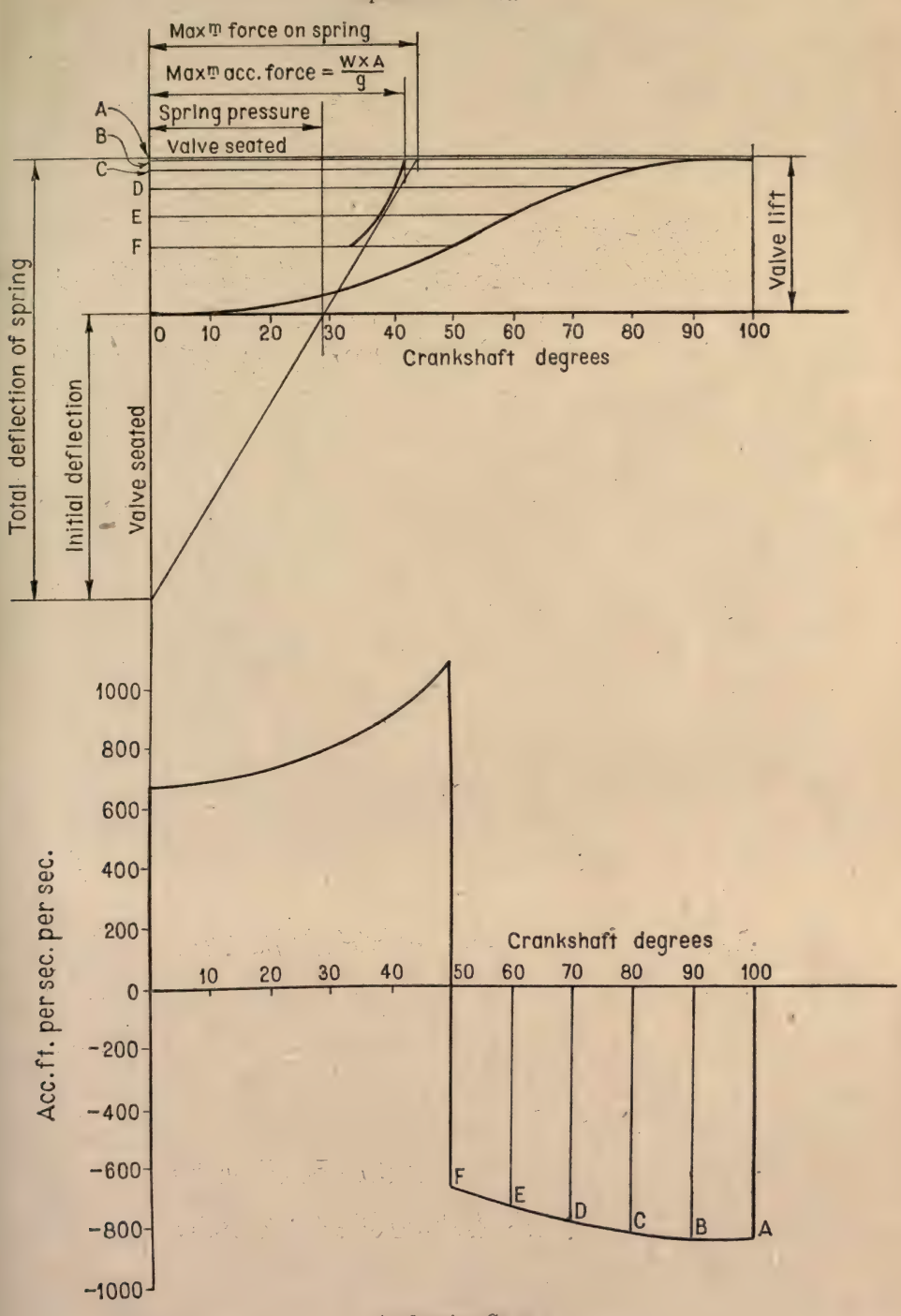


FIG. 4.—Graphic Determination of Valve Springs.

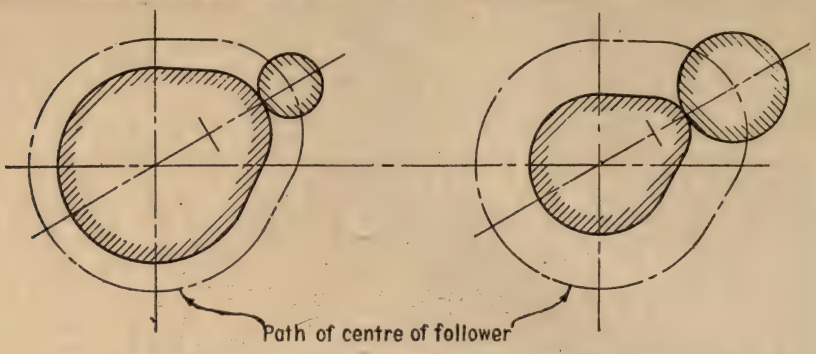


FIG. 5.—Cams identical in Displacement and Acceleration, but showing the advantages of a small base circle and larger radius roller or follower.

because the energy of the impact is roughly proportionate to the clearance and has to be taken up by the deflection of the surfaces.

A point which is often neglected is the correct mounting of the follower when this takes the form of a lever with a roller or rounded end. The follower should, of course, be so placed that the arc, through which the centre of the roller moves, approximates to a radial line from the camshaft centre.

The graphs are also applicable to internal cams of a type which used to be popular on motor-cycle engines. In fig. 3 is shown the table that should be used in each case, and it should be noted that the curves corresponding to the nose in external cams apply to flanks in internal and vice versa, and that the springs have to be suitable for the portion of the cam which approaches the shaft centre, this part being either a tangent or a concave or convex arc.

This type of cam is not recommended if the general design permits the use of an external follower, as the peripheral speeds are high and the grinding difficult by comparison.

VALVE-SPRINGS.

From Automotive Industries.

Pressure Required with Tangential Cams.

INSTRUCTIONS FOR USE OF CHART. (FIG. 1.)

To determine the minimum pressure which the spring must exert when the valve is lifted, start from that point on the bottom scale which denotes the distance D between the centres of the base circle and the rounding circle of the cam; proceed upward to the inclined line representing the value R + *r* (see sketch), then to the right to the Datum Line, then

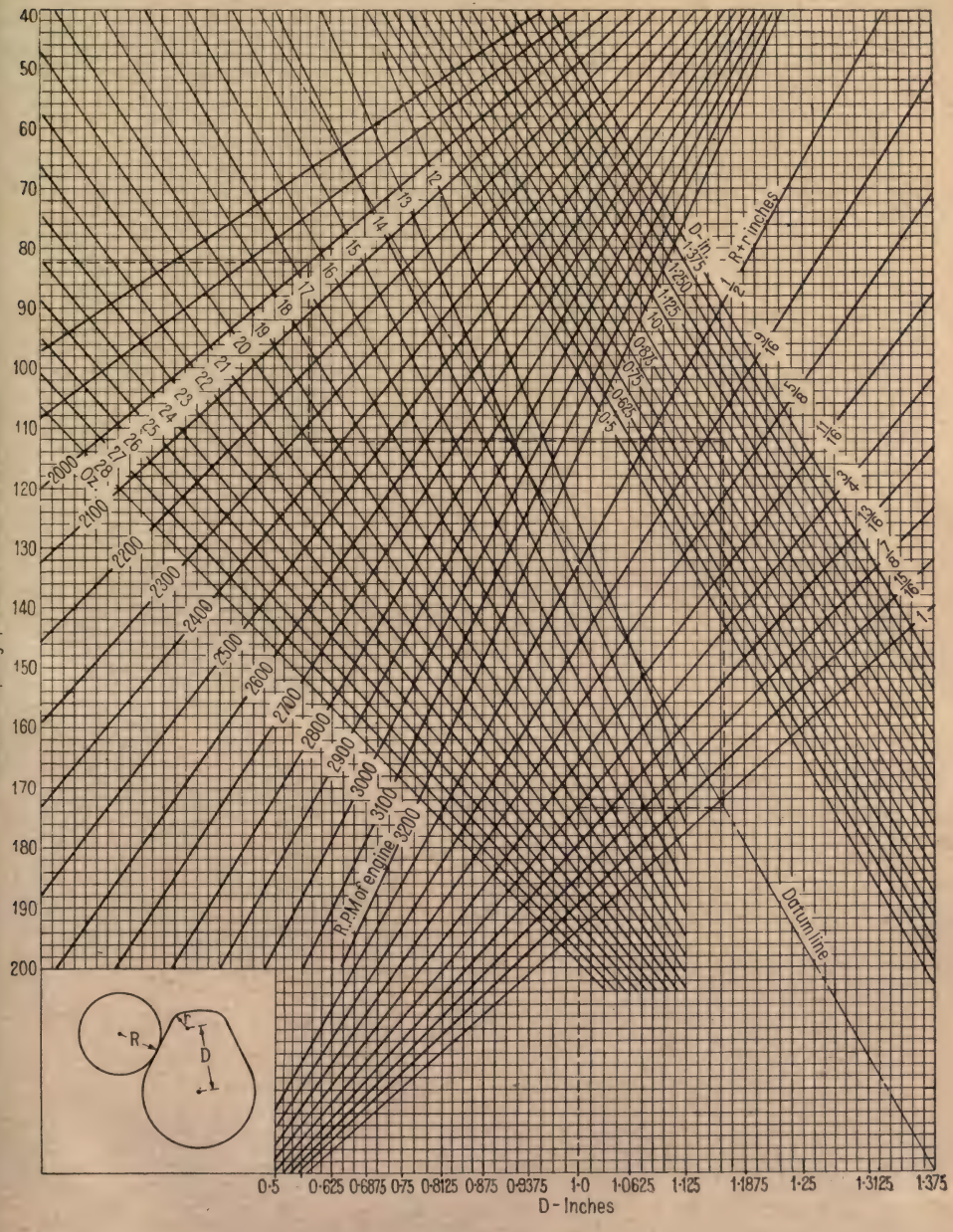


FIG. 1.

upward to one of the parallels representing the distance D, then to the left to one of the inclined lines representing the weight of the valve reciprocating parts, then up or down to one of the inclined lines representing the maximum engine speed, and then to the left to the scale giving the spring pressure required.

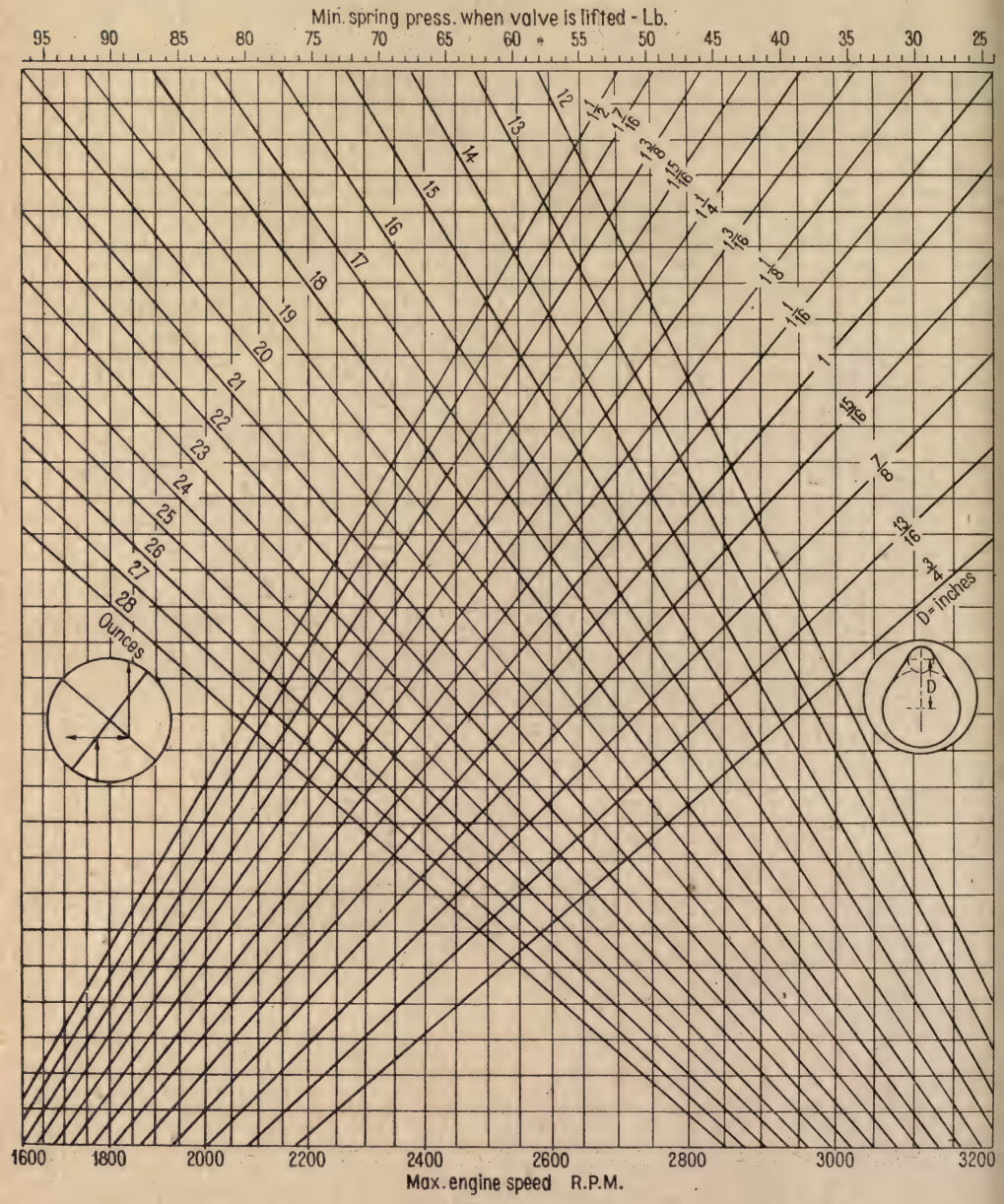


FIG. 2.

FORMULA FOR CALCULATION PURPOSES.

For round-nosed cams with roller-footed tappets as dealt with in the chart :—

$$\text{Minimum Valve-Spring Force} = \frac{W \times N^2 \times D}{2.256 \times 10^6} \left\{ 1 + \frac{D}{R + r} \right\} \text{lb.}$$

where :—

W = equivalent weight of the valve system in ounces.

N = revs. per minute of the engine.
D = distance between the centres of the cam-base circle and the cam-nose circle in in.
R = radius of the roller on the foot of the tappet in in.
r = radius of the cam-nose circle in in.

Pressure Required with Mushroom Follower Cams.

INSTRUCTIONS FOR USE OF CHART. (FIG. 2.)

To determine the minimum pressure required in valve springs for use in connection with the ordinary mushroom type of cam follower and the corresponding cam, locate the maximum engine speed on the bottom scale; proceed upwards to the incline representing the centre distance D of the base and top circles of the cam; thence horizontally to the incline representing the weight of the valve reciprocating parts, and thence vertically to the scale at the top.

PISTON CLEARANCE.

BY DR. R. J. ANDERSON AND M. A. BECKMAN.

An aluminium piston does not necessarily need a larger clearance than cast iron to avoid piston slap, modern split skirt light alloy pistons being run with the same clearance. In recent practice the average skirt clearance for aluminium pistons is 0.0005 to 0.001 in. per inch of diameter, namely 0.002 to 0.004 in. on a 4-in. piston. Different sections of piston should have different clearances, the most important being the skirt clearance or that across the thrust faces. The more important factors affecting clearance are: (1) The design of the piston; (2) the fitting of the piston from the mechanical point of view; (3) the machining, accuracy and finish of the cylinder bores; (4) the machining, accuracy and finish of the pistons themselves. Other factors are the thermal expansion and conductivity of both aluminium alloy and the cast-iron cylinder wall, lubricating system, cooling system, and type of engine.

On starting from cold, with force feed lubrication, time elapses before the oil is circulated, and clearance must be adjusted to compensate for increase in piston diameter due to initial heating. This does not arise with splash lubrication, oil being immediately thrown into the bores. The cooling system determines the engine operating temperature, and consequently that of the cylinder walls and pistons.

Assuming perfect machining, accuracy, alignment, and finish of both pistons and cylinder bores, clearance required on aluminium pistons depends on (1) the thermal expansion and conductivity of the alloys used for both pistons and cylinder; (2) design of piston as regards sections, slots, etc.; (3) engine operating temperature; (4) maximum and minimum temperature attained by piston head on the cylinder block.

Calculations can be simplified by assuming maxima and minima temperatures for both piston head and cylinder, using coefficients of thermal expansion for aluminium and cast iron, and calculating what enlargement of piston due to temperature will cause seizing. In slotted skirt pistons, the expansion is a matter of experiment. Slotted skirt pistons with cast-in relief have been run with a skirt clearance of 0.001 in. per inch of diameter, though some makers have halved this amount.

Referring to slotted skirt pistons, the average skirt clearance for aluminium pistons used in water-cooled touring car engines, is 0.0005 to 0.001 in. per inch of diameter; for air-cooled engines 0.001 to 0.00125 in. The usual clearance for heavy duty lorry and 'bus water-cooled engines is 0.001 to 0.0015 in., determined by r.p.m. of engine, load and operating conditions. The usual recommended skirt clearance for cast-iron pistons is 0.0008 to 0.001 in. per inch of diameter.

Referring now to the calculation of the theoretical clearance for the head of an aluminium piston, a simple example will show the method. A few assumptions will be made. Thus, the average temperature of the cold engine may be taken as 20 deg. C. (68 deg. F.), *i.e.*, the temperature of the cylinder wall and piston head at the time of starting the engine; actually in operation this may be 0 deg. C. (32 deg. F.) or lower. The maximum temperature of the cast-iron cylinder adjacent to the piston head may be taken as 100 deg. C. (212 deg. F.), *i.e.*, the boiling-point of water. The average maximum temperature attained by the piston head may be taken as 200 deg. C. (392 deg. F.). Taking a typical piston alloy having an average coefficient of thermal expansion of 26.9×10^{-6} per deg. C. (0.0000269), for 20-250 deg. C., and using 12.2×10^{-6} (0.0000122) for that of cast-iron, calculation can be made for the amount that the piston head will expand so as to just touch the cylinder wall. It may be assumed that the cylinder bore is 3.500 in. in diameter. The problem is to determine the proper diameter of the piston head (top land) so as to prevent seizing at a temperature of 200 deg. C. for the piston head and 100 deg. C. for the cylinder wall.

Let X = the total clearance, *i.e.*, the amount of expansion of the head, so that the top land just touches the cylinder wall.

The expansion of the cast-iron cylinder will be $3.5 \times 0.0000122 \times (100 \text{ deg.} - 20 \text{ deg.}) = 0.003416$in., or, roughly, 0.0034in.

Then at 100 deg. C. cylinder wall temperature (at the top) the bore will be 3.5034in. in diameter.

To touch the cylinder wall the expansion of the piston head would have to be

$$(3.5034 - X) \times 0.0000269 \times (200 \text{ deg.} - 20 \text{ deg.})$$

or

$$(3.5034 - X) \times 0.004842.$$

But to touch the wall the head expansion would have to be

$$X + 0.0034.$$

Hence,

$$(3.5034 - X) \times (0.004842) = X + 0.0034.$$

And, solving for X, we obtain

$$X = 0.0135\text{in.}$$

Or, for a 3.5in. piston, the head clearance would be about 0.0039in. per inch of diameter. In practice the usual clearance allowed for the top land is 0.108in. total for this size of piston for the purpose of guarding against seizing due to abnormal overheating of the piston for any reason.

In the same way, taking a 4.000in. cylinder bore, and assuming a head clearance for the piston of 0.016in. total, calculation can be made for the head temperature at which seizing will occur. In this case, let X = the average temperature of the piston head, *i.e.*, the temperature at which seizing would just occur.

The expansion of the cast-iron cylinder wall will be

$$4.0 \times 0.0000122 \times (100 \text{ deg.} - 20 \text{ deg.}) = 0.003904\text{in.},$$

or, roughly, 0.0039in.

Then at 100 deg. C. cylinder wall temperature (at the top) the bore will be 4.0039in. in diameter.

The expansion of the piston head will be $(4.0039 - 0.016) \times 0.0000269 \times (X \text{ deg.} - 20 \text{ deg.})$.

Since the expansion of the cast-iron cylinder wall is 0.0039in., the piston head must expand $0.016 + 0.0039 = 0.0199$in. in order to seize the cylinder wall.

Hence,

$$(4.0039 - 0.016) \times 0.0000269 \times (X - 20) = 0.0199.$$

Solving for X, we have

$$X = 206 \text{ deg. C. } (402.8 \text{ deg. F.}).$$

In practice a usual allowance for total clearance on the top land for a 4in. piston is 0.025in., indicating that the temperature as calculated is not out of line, allowing for abnormal operation.

Considerable work has been done on the head operating temperatures of aluminium-alloy pistons, among others by Jardine and Jehle.* These investigators found that the maximum head temperature (for the centre of the head) was 367.8 deg. C. (694 deg. F.) in the case of an aluminium piston operating in a single-cylinder Liberty engine (5.000in. bore). The temperature at the end of the skirt was 75 deg. C. (167 deg. F.). The inlet water temperature was 52.2 deg. C. (126 deg. F.), and the outlet water temperature 62.8 deg. C. (145 deg. F.). Gibson† found in the case of a single-cylinder air-cooled aircraft engine (100 mm. bore) that the hottest point of an aluminium piston was 200-240 deg. C. (392-464 deg. F.), while the maximum temperature of a cast-iron piston run under the same conditions was 440 deg. C. (824 deg. F.). He also found in the case of an Hispano-Suiza aircraft engine a mean edge temperature of 265 deg. C. (509 deg. F.), for aluminium pistons when running under full load. Grimes reports the head temperature of aluminium-alloy pistons in the Franklin air-cooled engine as 162.8 deg. C. (325 deg. F.), as against 246.1 deg. C. (475 deg. F.), for cast-iron pistons. Rosenhain states that the head of an aluminium piston of good design never rises much above 250 deg. C. (482 deg. F.), while that of a cast-iron piston in the same engine may exceed 450 deg. C. (842 deg. F.), referring to aircraft engines. In any case, it is well established that cast-iron pistons operate at much higher head temperatures than aluminium pistons under the same conditions, and that the maximum temperature attained by aluminium pistons in the conventional type of water-cooled automobile engine is comparatively low—doubtless not over 200 deg. C. (392 deg. F.) under normal conditions. The head temperature attained by pistons in automobile engines is considerably less than in aviation engines. The low temperature reached by the aluminium piston is owing to the rapid heat conduction of the aluminium alloys.

While cylinder block temperatures are variable depending upon conditions, the lower end of the wall (representing the lowest point of piston travel) may be taken as about 54.4 deg. C. (130 deg. F.), *i.e.*, the inlet water temperature, while the top may be taken as 100 deg. C. (212 deg. F.), representing the temperature of the wall at the top of the bore and closest to combustion. The outlet water temperature may be taken as about 82.2 deg. C. (180 deg. F.).

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* F. Jardine and F. Jehle, Aluminium Pistons, *Journ. Soc. Autom. Engnrs.*, vol. 8, 1921, pp. 397-403.

† Reports of the light alloys sub-committee, Advisory Committee for Aeronautics, H.M. Stationery Office, London, 1921.

This refers to summer conditions. Block temperatures in an air-cooled engine run up to about 193.3 deg. C. (380 deg. F.).

During the war, in tests on aluminium pistons in the Liberty 12-cylinder aviation engine, C. Harold Wills, then with the Ford Motor Co., plated the heads of such pistons with nickel, with iron, and with copper, running each for ten hours on the test block. This was in connection with erosion tests. The iron-plated pistons showed temper colours indicating the distribution of temperature. The centre of the pistons had been above the highest temper colour, *i.e.*, 316 deg. C. (600.8 deg. F.). The bright line temper colour, 288 deg. C. (550.4 deg. F.), appeared a short distance from the centre of the piston head, with a gradual passage through the range of colours to straw and pale yellow, 220 deg. C. (428 deg. F.), near the edge of the head. The temper colours appeared in concentric rings, indicating that there were no hot spots. Thus the temperature of the piston head edge at the skirt must have been about 220 deg. C. The head clearance allowed for the 5in. aluminium piston in the 12-cylinder Liberty engine at the time was 0.035in., or about 0.007in. per inch of diameter. Calculations for the temperature at which this piston head would seize give about 315 deg. C. (599 deg. F.). Since the clearance of 0.035 in. was used to prevent seizing under any operating condition, the average temperature of the piston head could not have exceeded 315 deg. C., and the calculation shows that the temper colour results of Wills indicated actual temperatures of the correct range.

A simple method for calculating clearance which gives an approximate value for the total clearance of the largest land is to multiply the approximate diameter of the piston by the coefficient of thermal expansion of the aluminium alloy by the temperature of the head. Thus, for a 3.5in. piston, assuming a head temperature of 200 deg. C., and taking the coefficient of thermal expansion as 0.0000269, the approximate clearance required to prevent seizing is

$$3.5 \times 0.0000269 \times (200\,\text{deg.} - 20\,\text{deg.}) = 0.0169\text{in.}$$

The actual top land clearance recommended for this size piston is 0.018in.

EFFECT OF DESIGN ON CLEARANCE.

As regards clearance, factors for consideration in designing aluminium pistons include (1) the rigidity (flexibility) of the skirt; (2) method of slotting; (3) thickness and cross-section of the head; (4) thickness and cross-section of the skirt; (5) amount of metal in the bosses; (6) length of the piston; (7) diameter of the piston; (8) skirt (reinforcement) rib; and (9) relief around piston-pin holes. While the total clearance, at any given diametral section of a piston, is the difference in diameter between the cylinder bore and the piston at that particular section, clearance may be specified in thousandths of an inch per inch of diameter of piston. Thus, in the case of a 3.5 in. piston having a skirt clearance of 0.0021in. total, the clearance is about 0.0006in. per inch of diameter. The piston must be designed so as to be sufficiently rigid to support the vertical and lateral thrust of the connecting rod and in addition be sufficiently flexible, as to the skirt, to take care of any increase in diameter through expansion due to increase in temperature. The design must be such that a close initial fit will be permitted (thus preventing slap in a cold engine), and this initial clearance must be maintained for various speeds and temperatures. As indicated above, with the present type of designs, aluminium-alloy pistons are being run with the same skirt clearance as cast-iron pistons. Piston seizing in all cases is due to too small clearance for a given design, engine and operating conditions, while piston slap is due to too large clearance.

Aluminium pistons are fitted with rather large clearance in the head so that the lands may be of the proper size when the engine is running at the working temperature and at the same time prevent seizing. Although various schemes, such as steel bands, have been tried, it has been impossible so far successfully to control expansion of the head.

In the usual slotted-skirt piston, the fourth land has the most clearance, next comes the first land, and the second and third have the least. The clearance of the head should always be made large enough to prevent seizing due to expansion. Land clearance is closely related to the cross-section of the piston head. In the case of the skirt, minimum initial fitting clearance (in a properly machined bore) ensures against the accumulation of excessive clearance due either to wear or permanent setting (collapse) because of excessive friction encountered. It has been found experimentally that the bulk of the heat which enters the piston head leaves through the rings (depending upon the design of the piston and other factors), and that the actual temperature of the skirt is not high enough to warrant the large clearances which were formerly thought necessary. Jardine and Jehle report skirt temperatures no higher than 144.4 deg. C. (292 deg. F.) for the top of the skirt (hottest portion) when the head temperature (hottest portion at the centre of the head) was 350 deg. C. (622 deg. F.); in this case the temperature at the bottom of the skirt was 86.1 deg. C. (187 deg. F.). This refers to tests on a single-cylinder Liberty aviation engine. The change in size of the skirt on heating up in an engine is due to three factors, viz., (1) the normal expansion caused by the increase in temperature of the skirt; (2) the distortion of the skirt caused by the expansion of the much hotter head and the sections around the piston-pin holes in the path of the relatively high head heat; and (3) permanent growth. Both the normal expansion of the skirt and its distortion or warping, which latter is slight, are taken care of by the skirt slot or slots which compensate for these changes in dimension. The actual amount of permanent growth on a 4in. piston casting, due to heating, is virtually negligible.

MODULUS OF FLYWHEEL.

BY JAMES WATT.*

The dimensions of the flywheel for a new engine can be determined very satisfactorily in an empirical manner by obtaining as many data as possible regarding those fitted to other engines of the same class and approximately the same cylinder dimensions, and proportioning the new flywheel to be in line with this current practice. In order to obtain a true idea of the kinetic effect of the many differently shaped flywheels which may have to be dealt with, the following formula will be found useful.

Referring to fig. 1, let:

I = Flywheel effect of hollow cylinder.
L = Length of cylinder in in.
R = Outer radius of cylinder in in.
r = Inner radius of cylinder in in.
C = A constant—0.4085 for cast-iron and 0.4477 for steel.

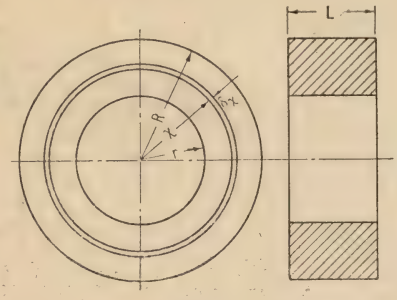


Fig. 1.

Formula.—

$$I = CL\,(R^4 - r^4)$$

Notes.—

(1) To find the total effect of a flywheel (and other rotating parts attached thereto), for purposes of calculation divide the whole system into convenient hollow cylinders, and find the value of I for each part. The sum of these values gives the complete flywheel effect.

(2) It will be noted that I is in somewhat unusual units, as the effect of the acceleration due to gravity has been omitted. This is permissible since the calculation is purely comparative.

CLUTCH.

BY JAMES WATT.

The clutch affords very little work of an unusual nature, although the calculation of the torque transmitted by a clutch of the disc type occasionally causes a little uncertainty. A very easily applied formula dealing with this is therefore shown.

DISC CLUTCH—INTENSITY OF PRESSURE AND TORQUE TRANSMITTED.

Referring to fig. 2, let:

P = Intensity of pressure on friction surfaces in lb. per sq. in.
L = Total axial load in lb. (*i.e.*, sum of spring loads if more than one spring is fitted).
R = Outer radius of friction surfaces in in.
r = Inner radius of friction surfaces in in.
T = Torque transmitted by clutch in lb.-in.
μ = Coefficient of friction.
N = Total number of *mated pairs* of friction surfaces.
A = Area of each friction surface in sq. in.

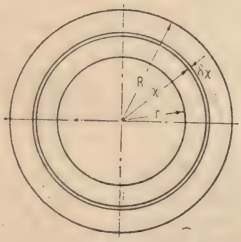


Fig. 2.

Formulæ.—

$$P = \frac{L}{\pi\,(R^2 - r^2)} \quad \ldots \quad (17)$$

$$T = 2\,\frac{\mu NL\,(R^3 - r^3)}{3\,(R^2 - r^2)} \quad \ldots \quad (18)$$

Note.—

In calculating the torque transmitted by a clutch, or, what amounts to the same thing, the spring load necessary to transmit a certain torque, allowance should be made for a reasonable amount of wear on the fabric liners. That is, with new liners a certain excess of spring-load should be provided, so that the postulated value of μ is not exceeded when the liners are worn.

* The sections by James Watt are extracted from a paper presented to the Inst. Automobile Engineers.

GEARBOX.

BY JAMES WATT.

Calculations in connection with gearboxes are of considerable bulk, but again quite a number, although important, are comparatively simple when looked at from a mathematical standpoint. It is consequently not intended to touch upon such matters as the torques on the shafts or the loads on the gear teeth arising from these torques. Neither will the duties of the ball bearings be considered, as, knowing the linear dimensions of the shafts and having found the loads on the teeth, the loads on the bearings are determined in quite a simple manner by taking moments in each plane and constructing a force polygon at each bearing. The speeds of revolution cause no trouble at all; nor, of course, do the diameters and the centres of the various gears. The effect on the shafts of the castellations cut thereon, however, deserves mention, as does the analysis of the bending stress and deflection in these shafts.

STRENGTH AND STIFFNESS OF CASTELLATED SHAFTS.

The calculation of the strength and stiffness of castellated shafts would afford sufficient matter for a complete paper; on the other hand, the subject can be dismissed in a few words. Writing on *Practical* Calculations the author prefers the latter course.

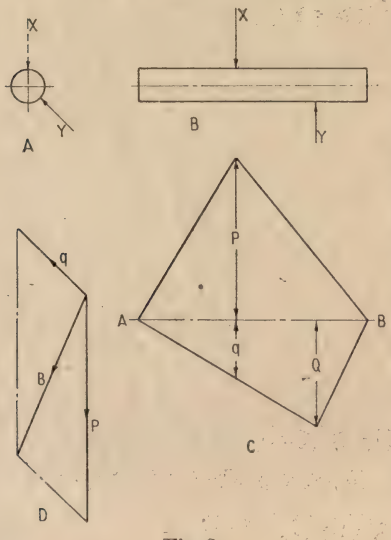


Fig. 3.

Method.—

Although they offer a slight resistance to bending, the projecting castellations have practically no effect in torque. Owing to this fact, the author's practice is to base all calculations for section modulus and moment of inertia on the root diameter of the castellation, treating the case simply as a plain shaft of this dimension. While this method may not be perfectly correct, it is quite near enough for all practical purposes, particularly as the stresses and deflections shown are, after all, more or less comparative, and since in any case authorities differ in opinion as to whether the equivalent shaft is actually a little larger or a little smaller than the root diameter.

BENDING MOMENT ON GEARBOX SHAFTS.

The shafts in the gearbox when running under such conditions as subject them to any appreciable bending are usually acted on by two forces simultaneously, which forces correspond in magnitude and direction to the respective loads on the teeth of two gear wheels. These forces almost always lie in different planes, and for purposes of demonstration might be as in figs. 3A and 3B, which show respectively the end and side elevations of a circular beam or shaft supporting the concentrated loads X and Y. The combined bending moment due to these loads may be determined in the following manner.

Method.—

(1) Calculate the bending moment due to load X and let this bending moment be represented by P.

(2) Then calculate that due to load Y and call this Q.

(3) Now above and below any convenient datum line, say AB in fig. 3C, set out the respective bending moment diagrams. The maximum heights will correspond to P and Q, and these points will lie respectively in the planes of X and Y.

(4) By inspection find whether the greatest depth of the combined diagrams lies in the line of P or in that of Q. For purposes of explanation, assume that it is in the line of P.

(5) Now in the line of the greater bending moment, P in the case assumed, scale the effect of the lesser. In fig. 3C let this be represented by q.

(6) Now set off to a convenient scale, not necessarily that adopted in fig. 3C, the magnitudes of the bending moments P and q in the direction of their respective causal forces X and Y, as shown in fig. 3D. Completing the parallelogram, B then represents to the same scale the magnitude and direction of the resultant bending moment.

(7) This resultant bending moment B can be combined with the twisting moment T to find the equivalent twisting moment T, by means of the usual formula.

$$T_e = B + \sqrt{B^2 + T^2}$$

The stress on the shaft then equals T_e/X_p where Z_p is the polar modulus of the cross section.

Notes.—

(1) Analytical methods may be applied to the solution of this problem, but in the author's opinion the more practical method of attack is that outlined above.

(2) Great care must be taken to ensure that the causal forces X and Y above are taken in the correct directions, namely, for each pair of gears in the direction of the load *acting on* the teeth of that wheel which is carried on the shaft under consideration.

DEFLECTION OF GEARBOX SHAFTS.

The deflection resulting from the combined action of two loads applied as in figs. 3A and 3B can be found in a manner very similar to that adopted to determine the resultant bending moment, In this case the respective deflection curves require to be calculated and embodied in a diagram somewhat similar to that in fig. 3C. This method, however, entails a considerable expenditure of time, as the deflections must be worked out at a number of points and the curves plotted. Since the calculation of deflection is admittedly comparative when applied to a component of such complex mechanism as a gearbox the following approximate method may meet all requirements. At any rate, it saves a considerable amount of work when the initial design is being laid out, and if so desired the result may be checked in a manner more in accordance with pure theory once the design is fixed up and definite data are available.

Method.—

(1) Having determined the resultant combined bending moment in the manner already explained, next find the evenly distributed load which would produce at the middle of the shaft a bending moment of the same magnitude.

(2) By means of the usual formula, calculate the deflection due to this distributed load and assume this to be equal to that due to the forces X and Y.

WHIRLING OR CRITICAL SPEED OF CARDAN-SHAFT.

BY JAMES WATT.

In designing a cardan-shaft, besides taking account of the torsional stress, it is necessary to see that the sectional moment of inertia is sufficiently great in relation to the weight to prevent whirling. The rise and fall of the axle as a car moves over a rough road give to the shaft a forced mechanical vibration in a vertical plane which, acting in conjunction with the mass of the shaft itself, sets up an appreciable deflection. A very complicated system of internal forces is thus induced when the speed of rotation, the period of this forced vibration and the frequency of the harmonic vibration of the shaft as a spring are such that they bear a certain relation, and a disturbing factor is that the friction in its socket of the sliding member of the universal joint imposes a certain end load, which end load has the effect of reducing quite appreciably the frequency of the natural harmonic vibration. At certain speeds of rotation the shaft may actually fail by bending, and the calculation of these critical or whirling speeds is at once seen to be a very difficult proposition. The author regrets that he cannot suggest any formula of a more definite nature than that noted below. However, duly recognized as giving purely comparative results, this formula is certainly of considerable service in practice.

Let N = Permissible maximum speed of rotation in revs. per minute.
D = Diameter of cardan-shaft in in.
L = Effective length of cardan-shaft in in.
(f) = Some unknown function.

Formulæ.—

$$N = (f)\frac{D}{L^2} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (19)$$

From this it will be seen that,

$$D \text{ varies as } N \text{ and as } L^2 \quad .. \quad .. \quad .. \quad .. \quad .. \quad (20)$$

Notes.—

(1) Knowing the above relations between D, N, and L, some very helpful calculations of a directly comparative nature can be made, For example, given the diameter and effective length of a certain satisfactory cardan-shaft and knowing the maximum speed of rotation, for different adaptations of the *same* chassis the diameter can very easily be fixed up to suit:

(a) The same speed but a different wheelbase.
(b) The same wheelbase but a different speed.
(c) A different speed and a different wheelbase.

(2) Further, provided that the springing arrangements and the method of tyring do not vary to any great extent, and that there is the same number of universal joints in both

cases, it is quite reasonable to assume that the relations are fairly true for different chassis of the same class, pleasure or commercial. It would not, however, be permissible to make a direct comparison between, say, a pleasure car with pneumatic tyres and a 3-ton lorry shod with solid tyres, nor should one chassis having two universal joints be compared directly with another having only one joint.

(3) L, the effective length of the shaft, can quite reasonably be assumed to be the distance between the respective fulcrum-pins of the front and rear universal joints when two joints are fitted. In the case of a shaft having only one joint, it is suggested that L be taken as three-fourths of the distance between the front fulcrum-pin and the centre of the supporting bearings at the rear.

To facilitate calculations connected with the critical speed of cardan-shafts, Nomograms A and B have been constructed, these being based on Professor Morley's formula.

$$n = \frac{\pi}{2L^2}\sqrt{\frac{g.\ E.\ I}{w}},$$

where n = No. of revolutions per second,
L = length between supports in inches,
g = acceleration due to gravity in inches per second per second,
E = modulus of elasticity—30,000,000,
I = moment of inertia of the section,
and w = weight of shaft per inch of length.

Now if N be the revolutions per minute, and d be the diameter of the shaft in inches, this formula (for steel shafts) will become

$$N = 60n = \frac{60\pi}{2L^2}\sqrt{\left\{\frac{32 \times 12 \times 30 \times 10^6 \times \frac{\pi d^4}{64}}{0.28 \times \frac{\pi d^2}{4}}\right\}}$$

which, after simplification, equals $N = 4{,}800{,}000\ \frac{d}{L^2}$, and Nomogram A shows the relations between N, d, and L, that is to say, any two of these being known, the third may be read off by laying a straight edge across the diagram.

In the case of a hollow shaft, if D_1 and D_0 be the internal and external diameters, the formula becomes:

$$N = \frac{60\pi}{2L^2}\sqrt{\left\{\frac{32 \times 12 \times 30 \times 10^6 \times \frac{\pi}{64}(D_0^4 - D_1^4)}{0.28 \times \frac{\pi}{4}(D_0^2 - D_1^2)}\right\}}$$

which, after simplification, equals $N = 4{,}800{,}000\sqrt{\frac{D_0^2 + D_1^2}{L^2}}$,

that is to say, the speed at which whirling will take place in a tubular shaft of external and internal diameters D_0 and D_1 will be the same as that of a solid shaft of diameter d provided,

$$\sqrt{D_0^2 + D_1^2} = d,$$

Nomogram B being provided to give these relations.

In this Nomogram it should be noted that as the quantity under the root sign is the sum of two squares it is immaterial which of the two outer lines we treat as external diameter, and which as internal.

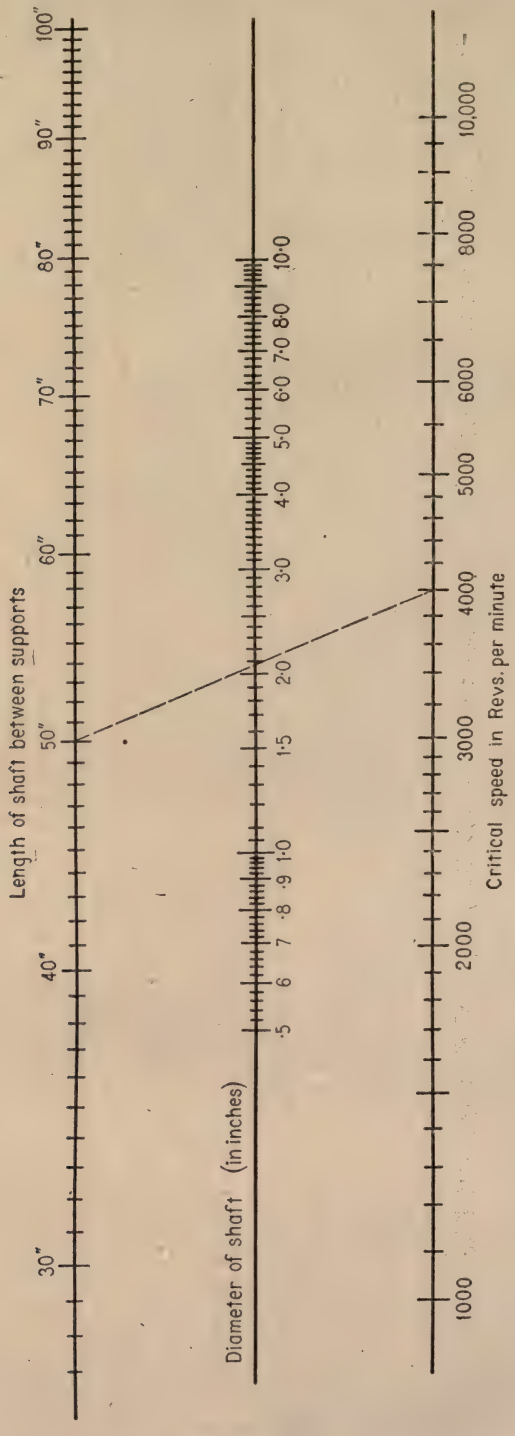
There are so many disturbing factors which enter into the question of automobile propeller shaft design, not the least of which is road vibration, that it is impossible to say what margin of calculated speed over attainable speed should be allowed. It would appear that 30 per cent. is not excessive, as when travelling at a speed well below the calculated speed a severe bump may momentarily deflect the propeller shaft, owing to its own inertia, and so commence a whirl which will continue until the speed is reduced. It should also be borne in mind that a shaft, having once reached the stage of whirling, is liable to take a permanent set, after which, being out of truth, the critical whirling speed is very much lower. These facts demonstrate the obvious necessity for a factor of safety.

EXAMPLE:—

A propeller shaft is 50 inches long between universal joints, and the maximum engine speed is 3,000 revs. per minute; the speed at which whirl will commence should therefore not be less than 4,000.

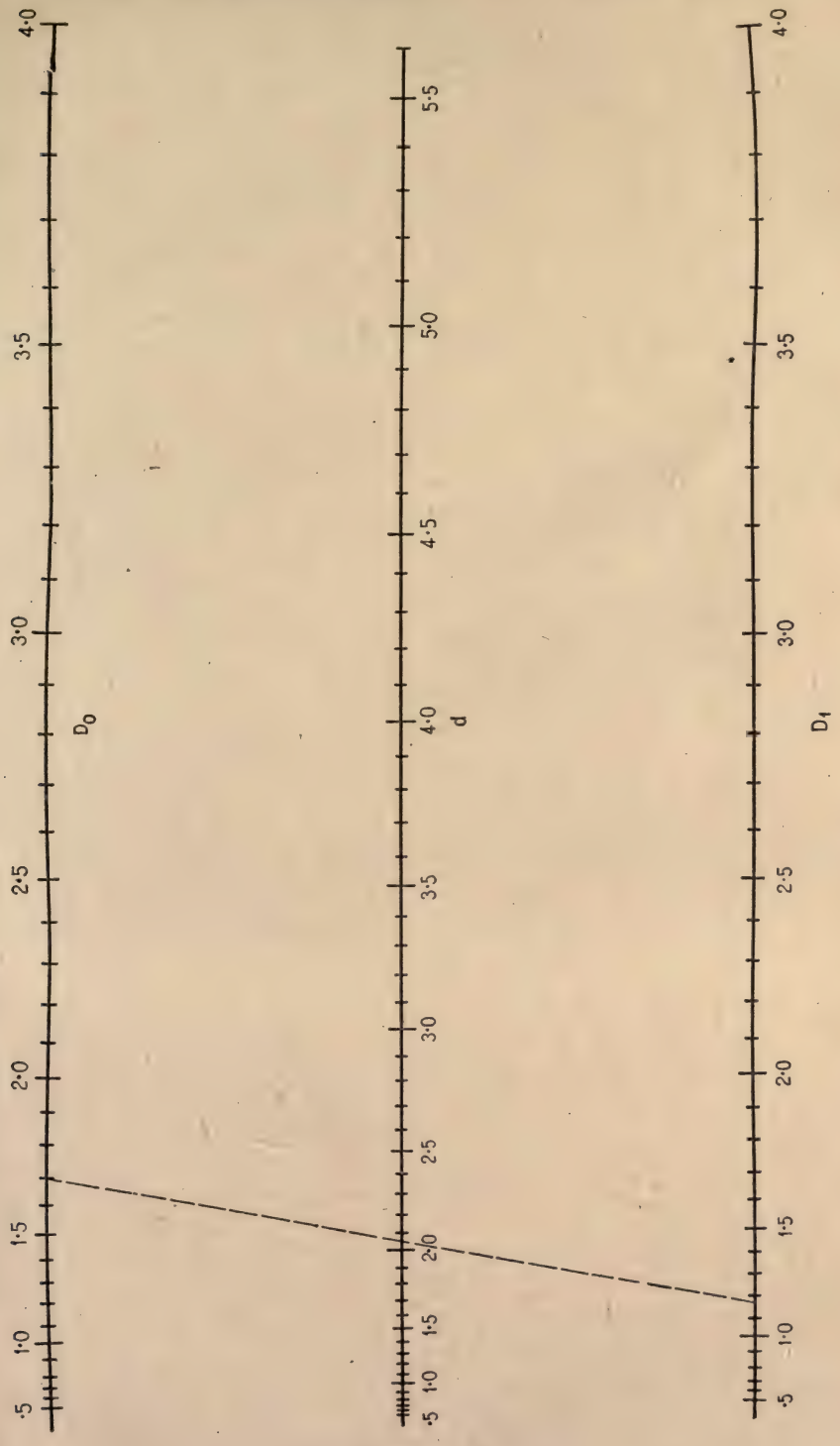
From Nomogram A, $d = 2.06$ where $L = 50$ and $N = 4{,}000$, and from Nomogram B the following values of D_0 and D_1 are obtained, corresponding to the above value of d. The actual values adopted must, of course, depend on the power to be transmitted.

$D_0 =$	1.9	1.8	1.7	1.6	1.55
$D_1 =$	0.8	1.0	1.18	1.30	1.36



NOMOGRAM A.

Note.—For tubular shafts, where D_0 and D_1 are external and internal diameters respectively, $\sqrt{D_0^2 + D_1^2} \doteq d$, where d is the value given above for a solid shaft.



NOMOGRAM B.

$$d = \sqrt{D_0^2 + D_1^2}.$$

BACK AXLE.

By James Watt.

Assuming this to be of the "live" type, the back axle provides some most interesting mathematical work. The estimating of the dynamic stress induced in the carrying member when the vehicle is running over a rough road is a case in point, and both the worm and the bevel gear incorporated as the driving medium afford a field for a considerable amount of investigation.

Stress in Live Axle Body taking account of Dynamic Loading.

In estimating the bending stress induced in the carrying member of a live axle, the shock-effect in driving over a rough road is of much greater import than the dead load applied by the springs. The making of any computation to give a result in the absolute category is at once seen to be practically impossible. On the other hand, an estimate of some sort ought to be made, and provided that the limitations of its application are fully recognized the following method will be of considerable assistance.

This calculation is comparative in the fullest sense of the word; the data are in all cases so meagre, and so many assumptions have been made, that it is doubtful if the stress shown even approximates to the actual. Nevertheless, knowing that a certain axle is satisfactory, if the stress thereon be calculated in this manner and a later similar axle be made to show a stress of the same order of magnitude, there will result a fair assurance that the new axle will also be satisfactory.

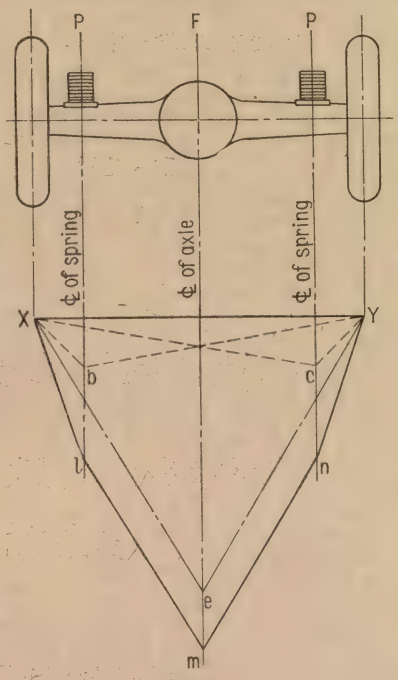


Fig. 4.

Referring to fig. 4, let:

W = Weight of complete axle, two road wheels and one spring in lb.

w = Weight of centre portion of axle in lb.

L = Maximum *static* load on *both* springs in lb.

D = Deflection of springs in ft. at load L.

d = Allowable extra deflection of springs in ft. (fixed by clearance between axle and frame or other limiting stop).

H = Assumed height in ft. of obstacle in the path of the car, say a railway sleeper coming in contact with both rear tyres, or road conditions of a more usual nature giving a similar effect.

v = Vertical velocity at which tyres come in contact with road after surmounting obstacle in ft. per sec.

s = Amount in ft. by which tyres deflect in bringing axle to rest (see Note 2).

F = Maximum force in lb. necessary to bring centre portion of mass w to rest from an initial velocity of v.

g = 32ft. per sec. per sec.

P = Residual load on *each* spring in lb.

Formulæ.—

First find the value of v^2 as below (see Note 1).

$$v^2 = \frac{gH}{DW}\left\{ 2D\,(L + W) + L\,(2d - H) \right\} \quad .. \quad .. \quad (21)$$

Next calculate the dynamic load F by means of the following formula (see Note 2).

$$F = \frac{wv^2}{gs} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (22)$$

It is also necessary to determine the residual spring load P.

$$P = \frac{L\,(D + d - H)}{2D} \quad .. \quad .. \quad .. \quad .. \quad (23)$$

The axle body is assumed to be loaded as per fig. 4, and, knowing F and P, the bending moment and stress are calculated in the usual way .. .. (24)

Notes.—

(1) L is the combined load on both springs, and D, *d* and H are in ft. not in.

(2) The value of *s* varies in accordance with the following factors :

(*a*) Tyres. (1) Pneumatic or solid. (2) Single or twin. (3) Size. (4) Air pressure in pneumatics. Wear on solids.

(*b*) Springiness of axle itself and of spokes and rim of road wheel.

(*c*) Resiliency of road surface.

Now the dynamic force F varies roughly with the size and type of car, and consequently to a certain degree it also varies with factor (*a*) above. Advantage has been taken of this fact in compiling Table III., which gives approximate values for *s* to suit pneumatic or solid tyres, single or twin. Using this table, a rough balance between the magnitudes F and *s* for any particular case can be determined by trial and error, since formula (22) is fairly simple. The conditions are so complex that this table cannot be expected to meet all cases with great accuracy. It will, however, be found of much assistance as a guide, and if thought necessary the relation between F and *s* for any particular case can be checked experimentally as soon as an axle is built and available for testing purposes.

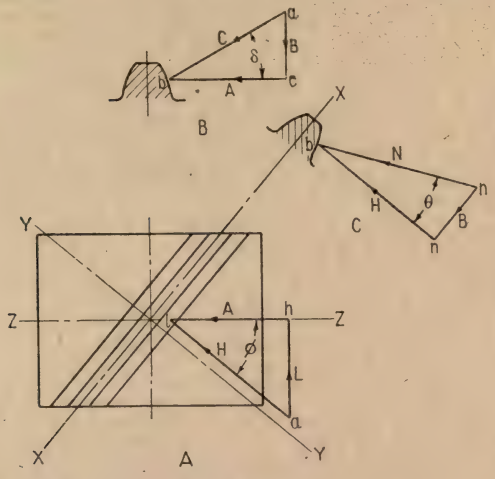


Fig. 5.

(3) In the lower portion of fig. 4, X*b*Y and X*c*Y respectively indicate the bending moments due to the two residual springloads P, while X*e*Y shows that arising from the dynamic load F. X*lmn*Y is the curve of total bending moment, and is the combination of these three triangles.

EFFICIENCY OF WORM GEAR.

The calculation of the mechanical efficiency of worm gearing is a matter which has frequently been treated by others. Nevertheless, the author feels that the following formulæ are worthy of inclusion, as they are particularly simple to apply and are mathematically more nearly absolute than many others in common use. In practice, the use of these formulæ is more to determine the *minimum* permissible lead angle for any particular worm gear than to arrive at an absolute value for the mechanical efficiency.

Referring to figs 5A, B, and C, let :

ϕ = Helix or lead angle.
δ = Nominal tooth pressure-angle (measured in plane of worm axis).
θ = Pressure-angle measured normal to tooth surface.
μ = Coefficient of friction between worm and wheel.
n = Mechanical efficiency.

Formulæ.—

$$\text{Tan } \theta = \tan \delta \cos \phi \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad (25)^*$$

Having found tan θ, obtain value of θ from trigonometrical tables .. (26)

The mechanical efficiency then equals

$$n = 1 - \frac{\mu}{\cos \theta \cos \phi \sin \phi} \quad .. \quad .. \quad .. \quad (27)^*$$

Note.—

Fig. 6 is a curve worked out by the above formulæ, taking μ as 0.025 and assuming a nominal tooth pressure-angle of 30 degrees. This the author understands to be the virtual pressure-angle of F.J. worm gear manufactured by Messrs. David Brown & Sons, and it will be seen that the maximum efficiency calculated under these conditions is 94.6 per cent. In the published results of a series of tests by the National Physical Laboratory the efficiencies of an F.J. worm gear, presumably of the best possible lead angle, vary between 93.4 per cent. and 97.3 per cent. as extremes. Twenty-five out of a total of thirty results, however, are over 95 per cent., so that 0.025 is seen to be a very safe value of μ to apply in practice.

AXIAL THRUST OF WORM.

The following formula is so simple that it may seem ridiculous to include it. Nevertheless, the author has repeatedly found in engineers a tendency to make an elaborate calculation taking into account such factors as the lead angle, coefficient of friction, etc. This is quite unnecessary.

Let A = Axial thrust of worm in lb.
R = Pitch radius of worm wheel in in.
T = Torque on worm wheel in lb.-in.

Formula.—

$$A = \frac{T}{R} \quad .. \quad .. \quad .. \quad .. \quad (28)$$

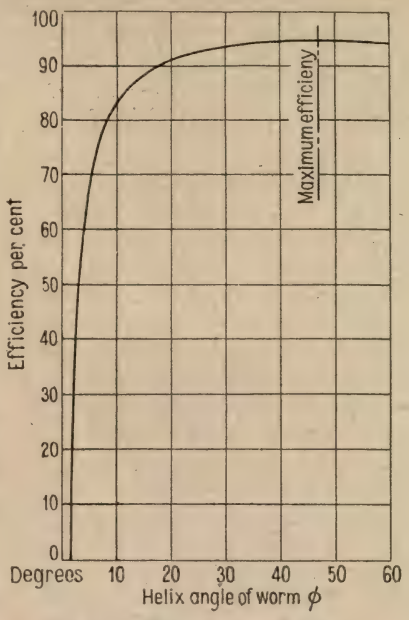


Fig. 6. Efficiency of worm gear.
μ taken as 0.025. δ taken as 30 deg.

STRENGTH OF BEVEL-WHEEL TEETH.

Should a bevel gear be adopted as the final drive, or should a bevel type of differential gear be used, in fixing up the tooth dimensions the convenient method of "trial and error" may be followed. A reasonable nominal pitch should be assumed and that at the small end of the tooth obtained, graphically if so desired. The arithmetical mean of the values of M for the nominal and small-end pitches respectively should then be determined, and also the velocity factor V, using "Autolew" curves as for an ordinary spur gear,† but in the case of a bevel gear the tangential load on the tooth and the velocity in ft. per minute should be calculated as at the *mean diameter*, and not at the pitch circle. The following describes the process in detail, and has the merit that it eliminates any graphical work.

TABLE III.

DYNAMIC LOADING OF AXLE.

Relative values of F and s.

Values of F in lb.	Values of s.							
	Pneumatic.				Solid.			
	Single.		Twin.		Single.		Twin.	
	In.	Feet.	In.	Feet.	In.	Feet.	In.	Feet.
Up to 3,000 ..	$\frac{3}{4}$	0.063	—	—	—	—	—	—
3,000 to 4,000 ..	1	0.083	—	—	—	—	—	—
4,000 to 5,000 ..	$1\frac{1}{4}$	0.104	—	—	—	—	—	—
5,000 to 6,500 ..	$1\frac{1}{2}$	0.125	—	—	$\frac{5}{16}$	0.026	—	—
6,500 to 8,000 ..	$1\frac{3}{4}$	0.146	1	0.083	$\frac{5}{16}$			
8,000 to 10,000 ..	2	0.167	$1\frac{1}{4}$	0.104	$\frac{3}{8}$	0.031	$\frac{1}{4}$	0.021
10,000 to 12,500 ..	—	—	$1\frac{1}{2}$	0.125	$\frac{3}{8}$			
12,500 to 15,000 ..	—	—	$1\frac{3}{4}$	0.146	$\frac{7}{16}$	0.036	$\frac{5}{16}$	0.026
15,000 to 20,000 ..	—	—	2	0.16	$\frac{7}{16}$			
20,000 to 35,000 ..	—	—	—	—	$\frac{1}{2}$	0.042	$\frac{3}{8}$	0.031
35,000 to 55,000 ..	—	—	—	—	—	—	$\frac{7}{16}$	0.036
Over 55,000 ..	—	—	—	—	—	—	Not more than $\frac{1}{2}$	0.042

Referring to fig. 7, let:

θ = Pitch angle of pinion.
N_p = No. of teeth in pinion.
N_w = No. of teeth in wheel.
P_l = Diametral pitch at large end of tooth (*i.e.*, the nominal "D. P.").
P_s = Diametral pitch at small end of tooth.
B = Length of tooth (or breadth of face) in in.
R = Mean effective radius of (larger) wheel in in.
T = Torque on wheel in lb.-in.
L = Tangential load on teeth in lb.
M_l, M_s = "Autolew" strength-factors (from curves).
M_m = Mean of M_l and M_s.
V = Velocity factor from "Autolew" curves.

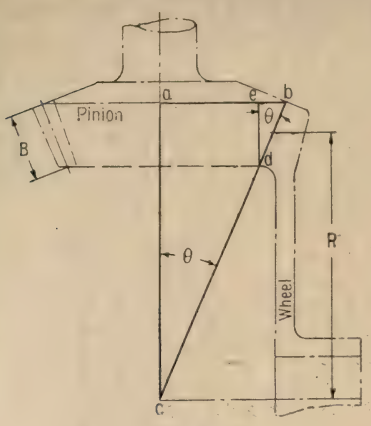


Fig. 7.

Formulæ.—

$$\text{Tan } \theta = N_p/N_w \quad .. \quad .. \quad .. \quad .. \quad (29)$$

From trigonometrical tables write down values of sin θ and cos θ .. .. .. (30)

$$P_s = \frac{N_p}{\frac{N_p}{P_l} - 2\,B \sin\theta} \quad .. \quad .. \quad .. \quad (31)$$

From curve find "Autolew" strength-factor corresponding to

(*a*) P_l and $N_p = M_l$

(*b*) P_s and $N_p = M_s$

Then mean effective strength-factor for pinion (*i.e.*, smaller wheel) is

$$M_m = \frac{M_l + M_s}{2} \quad .. \quad .. \quad .. \quad .. \quad (32)$$

$$R = \tfrac{1}{2}\left\{\frac{N_w}{P_l} - B\cos\theta\right\} \quad .. \quad .. \quad (33)$$

$$L = \frac{T}{R} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (34)$$

Next calculate the peripheral speed in ft. per minute of a disc of which R is the radius in in., and from "Autolew" curve find corresponding velocity factor V.. .. .. (35)

Then stress in lb. per sq. in. equals $S = L/(BM_m V)$ .. .. (36)

Note.—

Assuming that an axle driving-bevel is under consideration, it is usually convenient to find the load and velocity from the wheel and not from the pinion, owing to the tractive effort being part of the fundamental data and to the torque on the wheel being easily determined from this: nevertheless, the actual stress calculation must be made for the weaker member (the pinion). The formulæ have been drawn out in accordance with these requirements.

AXIAL THRUST OF BEVEL GEARS.

The following is a very convenient method by which the loads imposed on the thrust bearings may be determined.

Referring to figs. 8A and B, let:

L = Tangential load on teeth in lb. (see formula 34 for *Strength of Teeth*).
F = Force tending to separate pinion and wheel in lb.
W = Axial thrust of wheel in lb.
P = Axial thrust of pinion in lb.
N_p = No. of teeth in pinion.
N_w = No. of teeth in wheel.
δ = Pressure angle of tooth.

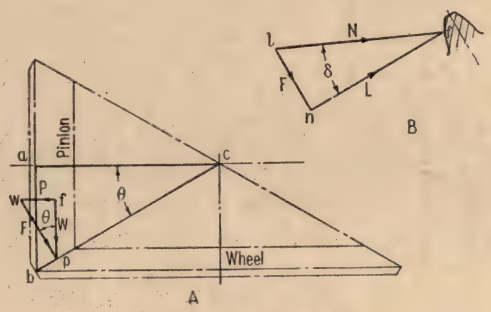


Fig. 8.

Formulæ.—

$$F = L \tan \delta \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad (37)$$

$$W = \frac{FN_w}{\sqrt{N_p^2 + N_w^2}} \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad (38)$$

$$P = \frac{FN_p}{\sqrt{N_p^2 + N_w^2}} \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad (39)$$

Notes.—

(1) These formulæ are approximate in that the effect of the wedge action of the tapering of the tooth is omitted. The results are, however, sufficiently accurate for all practical purposes.

(2) θ is the pitch angle of the pinion, and this does not enter directly into the consideration of the case.

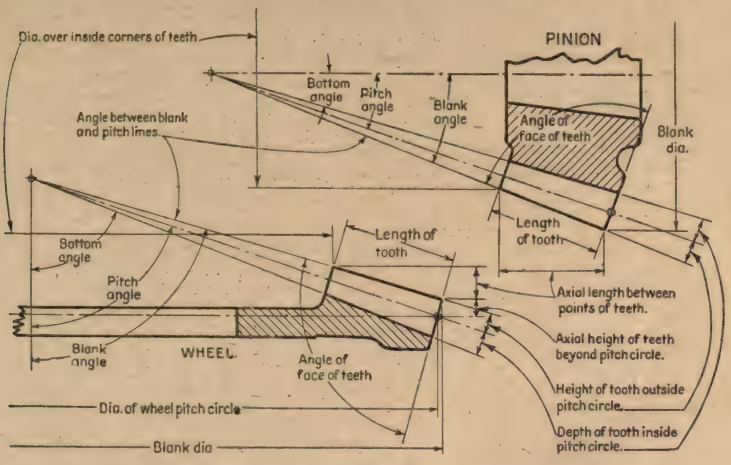
† Proc. I.A.E., Vol. XIV., pp. 439 to 442.

BEVEL WHEELS AND PINIONS AT 90°.

Pitch angle of wheel	The tangent of the pitch angle of wheel $= \frac{\text{No. of teeth on wheel}}{\text{No. of teeth on pinion}}$
Pitch angle of pinion	=90° less the pitch angle of wheel.
Blank angle of wheel or pinion	Add to either pitch angle, this small angle; the tangent being given by this ratio: $\frac{\text{Height of tooth outside P.C.} \times \text{sin wheel pitch angle}}{\text{Radius of wheel pitch circle}}$
Bottom angle of wheel or pinion	Subtract from either pitch angle, this small angle; the tangent being given by this ratio: $\frac{\text{Depth of tooth inside P.C.} \times \text{sin wheel pitch angle}}{\text{Radius of wheel pitch circle}}$
Wheel blank diameter	=Pitch diameter of wheel + (twice height of tooth outside P.C. × cos wheel pitch angle).
Pinion blank diameter	=Pitch diameter of pinion + (twice height of tooth outside P.C. × cos pinion pitch angle).
Angle of face of teeth with edge of wheel and pinion	=90° less the angle between blank and pitch line.
Diameter over inside corners of teeth	=Blank diameter less (twice length of teeth × sine of blank angle).
Axial height of teeth beyond pitch circle	=Height of tooth outside pitch line × sine of pitch angle.
Axial length between points of teeth	=Length of tooth × cos of blank angle.

For checking purposes it is advisable to make a layout of half the wheel and pinion, four times full size, scaling to within plus and minus .005 in. All angles should be drawn with a Brown and Sharpe draughtsman's protractor, and should correspond with the calculations to within plus and minus five minutes.

BEVEL WHEELS AND PINIONS AT 90°.



CORRECTING BEVELS FOR UNDERCUTTING.

Unless there are facilities for cutting teeth with a special angle of pressure, bevel driving gears require a certain amount of correction to eliminate the undercutting which so weakens the pinion teeth.

Incidentally correction, to a certain extent, prevents interference, and consequently reduces the noise which this fault invariably causes.

In some cases where a driving pinion has split across from the keyway to the root of a tooth the gears can be corrected, and an appreciable amount of metal can be gained in the weak place without altering pitch, teeth, or ratio.

Fig. 1 shows teeth on a standard pinion. The roots are weakened by undercut.

Fig. 2 shows teeth on a corrected pinion for the same drive. This gives increased root strength.

Fig. 3 shows corrected gear in full and standard gear dotted. The angle θ is found in the tables, and is the difference between standard and corrected gears.

In the wheel, face angle and base angle are increased and the outside diameter is decreased.
In the pinion, face angle and base angle are decreased and the outside diameter is increased.
Pitch line diameters are not altered.
The addenda are altered, but the module remains unchanged.
The effect of correction on the tooth form is similar to the effect obtained when gears are cut with an increased angle of pressure.

Fig. 1.

Fig. 2.

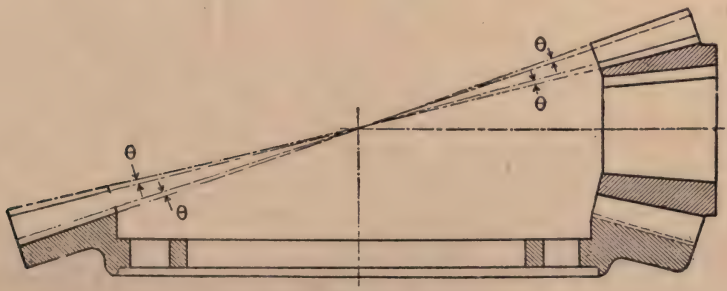


Fig. 3.

CORRECTING ANGLES FOR BEVEL GEARS.

Teeth in Wheel.	No. of Teeth in Pinion.															
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
20	2° 0′	1° 45′	1° 30′	1° 15′	—	—	—	—	—	—	—	—	—	—	—	—
21	2° 0′	1° 45′	1° 30′	1° 16′	1° 1′	—	—	—	—	—	—	—	—	—	—	—
22	1° 59′	1° 44′	1° 29′	1° 16′	1° 2′	0° 47′	—	—	—	—	—	—	—	—	—	—
23	1° 57′	1° 42′	1° 28′	1° 15′	1° 2′	0° 49′	0° 35′	—	—	—	—	—	—	—	—	—
24	1° 55′	1° 40′	1° 27′	1° 15′	1° 3′	0° 51′	0° 36′	0° 24′	—	—	—	—	—	—	—	—
25	1° 54′	1° 39′	1° 26′	1° 14′	1° 3′	0° 52′	0° 38′	0° 26′	0° 16′	—	—	—	—	—	—	—
26	1° 52′	1° 37′	1° 25′	1° 13′	1° 4′	0° 53′	0° 40′	0° 28′	0° 17′	0° 7′	—	—	—	—	—	—
27	1° 50′	1° 35′	1° 23′	1° 12′	1° 4′	0° 53′	0° 43′	0° 30′	0° 18′	0° 9′	0° 4′	—	—	—	—	—
28	1° 48′	1° 33′	1° 22′	1° 11′	1° 3′	0° 54′	0° 43′	0° 32′	0° 20′	0° 11′	0° 5′	—	—	—	—	—
29	1° 46′	1° 31′	1° 21′	1° 10′	1° 3′	0° 54′	0° 43′	0° 33′	0° 22′	0° 12′	0° 5′	—	—	—	—	—
30	1° 43′	1° 29′	1° 19′	1° 9′	1° 3′	0° 54′	0° 44′	0° 34′	0° 24′	0° 14′	0° 6′	—	—	—	—	—
31	1° 40′	1° 27′	1° 17′	1° 8′	1° 2′	0° 53′	0° 44′	0° 35′	0° 26′	0° 16′	0° 7′	—	—	—	—	—
32	1° 38′	1° 25′	1° 16′	1° 7′	1° 0′	0° 53′	0° 44′	0° 36′	0° 27′	0° 18′	0° 9′	0° 2′	—	—	—	—
33	1° 36′	1° 23′	1° 15′	1° 6′	1° 0′	0° 52′	0° 43′	0° 37′	0° 28′	0° 19′	0° 10′	0° 3′	—	—	—	—
34	1° 33′	1° 21′	1° 13′	1° 5′	0° 59′	0° 52′	0° 43′	0° 38′	0° 28′	0° 20′	0° 12′	0° 4′	—	—	—	—
35	1° 30′	1° 19′	1° 11′	1° 4′	0° 58′	0° 51′	0° 42′	0° 37′	0° 29′	0° 21′	0° 14′	0° 6′	—	—	—	—
36	1° 26′	1° 17′	1° 10′	1° 3′	0° 57′	0° 51′	0° 42′	0° 37′	0° 29′	0° 22′	0° 15′	0° 7′	0° 1′	—	—	—
37	1° 22′	1° 15′	1° 8′	1° 2′	0° 56′	0° 50′	0° 42′	0° 37′	0° 29′	0° 23′	0° 16′	0° 9′	0° 2′	—	—	—
38	1° 20′	1° 13′	1° 6′	1° 1′	0° 55′	0° 50′	0° 41′	0° 37′	0° 30′	0° 23′	0° 17′	0° 10′	0° 3′	—	—	—
39	1° 18′	1° 11′	1° 5′	1° 0′	0° 54′	0° 49′	0° 41′	0° 36′	0° 30′	0° 24′	0° 18′	0° 11′	0° 4′	—	—	—
40	1° 16′	1° 10′	1° 4′	0° 59′	0° 53′	0° 49′	0° 41′	0° 36′	0° 30′	0° 25′	0° 19′	0° 12′	0° 5′	—	—	—
41	1° 15′	1° 9′	1° 3′	0° 58′	0° 53′	0° 49′	0° 41′	0° 36′	0° 30′	0° 25′	0° 19′	0° 12′	0° 6′	—	—	—
42	1° 14′	1° 8′	1° 2′	0° 57′	0° 52′	0° 48′	0° 40′	0° 36′	0° 30′	0° 25′	0° 20′	0° 13′	0° 7′	0° 1′	—	—
43	1° 13′	1° 7′	1° 1′	0° 56′	0° 52′	0° 47′	0° 40′	0° 35′	0° 31′	0° 25′	0° 20′	0° 14′	0° 8′	0° 2′	—	—
44	1° 12′	1° 6′	1° 0′	0° 55′	0° 51′	0° 46′	0° 40′	0° 35′	0° 31′	0° 25′	0° 20′	0° 14′	0° 9′	0° 3′	—	—
45	1° 11′	1° 5′	0° 59′	0° 54′	0° 51′	0° 45′	0° 39′	0° 35′	0° 31′	0° 26′	0° 21′	0° 15′	0° 10′	0° 4′	—	—
46	1° 10′	1° 4′	0° 58′	0° 53′	0° 50′	0° 45′	0° 39′	0° 35′	0° 31′	0° 26′	0° 21′	0° 15′	0° 11′	0° 5′	—	—
47	1° 9′	1° 3′	0° 57′	0° 52′	0° 49′	0° 44′	0° 38′	0° 34′	0° 31′	0° 25′	0° 21′	0° 16′	0° 11′	0° 6′	0° 1′	—

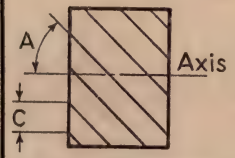
CORRECTING ANGLES FOR BEVEL GEARS (*Continued*).

Teeth in Wheel.	No. of Teeth in Pinion.															
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
48	1° 8′	1° 2′	0° 56′	0° 52′	0° 49′	0° 43′	0° 38′	0° 34′	0° 30′	0° 25′	0° 22′	0° 16′	0° 12′	0° 7′	0° 2′	—
49	1° 7′	1° 1′	0° 55′	0° 51′	0° 48′	0° 43′	0° 37′	0° 34′	0° 30′	0° 25′	0° 22′	0° 16′	0° 12′	0° 8′	0° 2′	—
50	1° 6′	1° 0′	0° 54′	0° 50′	0° 48′	0° 42′	0° 37′	0° 33′	0° 30′	0° 25′	0° 22′	0° 17′	0° 12′	0° 8′	0° 3′	—
51	1° 5′	1° 0′	0° 52′	0° 49′	0° 47′	0° 42′	0° 36′	0° 33′	0° 30′	0° 24′	0° 22′	0° 17′	0° 12′	0° 8′	0° 3′	—
52	1° 5′	0° 59′	0° 52′	0° 48′	0° 46′	0° 41′	0° 36′	0° 32′	0° 29′	0° 24′	0° 21′	0° 17′	0° 13′	0° 9′	0° 3′	—
53	1° 4′	0° 58′	0° 52′	0° 48′	0° 45′	0° 40′	0° 35′	0° 32′	0° 29′	0° 24′	0° 21′	0° 17′	0° 13′	0° 9′	0° 4′	—
54	1° 3′	0° 57′	0° 51′	0° 47′	0° 45′	0° 39′	0° 35′	0° 32′	0° 29′	0° 24′	0° 21′	0° 18′	0° 13′	0° 9′	0° 4′	—
55	1° 2′	0° 56′	0° 51′	0° 46′	0° 44′	0° 39′	0° 34′	0° 32′	0° 28′	0° 24′	0° 20′	0° 18′	0° 13′	0° 10′	0° 4′	—
56	1° 2′	0° 56′	0° 50′	0° 46′	0° 44′	0° 38′	0° 34′	0° 31′	0° 28′	0° 24′	0° 20′	0° 18′	0° 14′	0° 10′	0° 4′	—
57	1° 2′	0° 55′	0° 50′	0° 45′	0° 43′	0° 38′	0° 34′	0° 31′	0° 28′	0° 23′	0° 20′	0° 18′	0° 14′	0° 10′	0° 4′	—
58	1° 1′	0° 54′	0° 49′	0° 44′	0° 42′	0° 37′	0° 33′	0° 31′	0° 27′	0° 23′	0° 20′	0° 19′	0° 14′	0° 10′	0° 5′	—
59	—	0° 53′	0° 48′	0° 44′	0° 42′	0° 37′	0° 33′	0° 31′	0° 27′	0° 23′	0° 20′	0° 19′	0° 14′	0° 11′	0° 5′	—
60	—	0° 52′	0° 47′	0° 44′	0° 41′	0° 37′	0° 33′	0° 30′	0° 27′	0° 23′	0° 20′	0° 18′	0° 14′	0° 11′	0° 5′	—
61	—	0° 52′	0° 46′	0° 43′	0° 40′	0° 36′	0° 32′	0° 30′	0° 26′	0° 23′	0° 19′	0° 18′	0° 14′	0° 11′	0° 5′	0° 1′
62	—	—	0° 46′	0° 43′	0° 40′	0° 36′	0° 32′	0° 30′	0° 26′	0° 23′	0° 19′	0° 18′	0° 14′	0° 11′	0° 6′	0° 1′
63	—	—	0° 45′	0° 42′	0° 39′	0° 36′	0° 32′	0° 29′	0° 26′	0° 22′	0° 19′	0° 18′	0° 14′	0° 11′	0° 6′	0° 1′
64	—	—	0° 44′	0° 41′	0° 38′	0° 35′	0° 31′	0° 28′	0° 25′	0° 22′	0° 19′	0° 18′	0° 14′	0° 11′	0° 6′	0° 2′
65	—	—	0° 43′	0° 41′	0° 38′	0° 34′	0° 31′	0° 28′	0° 25′	0° 22′	0° 19′	0° 17′	0° 15′	0° 12′	0° 6′	0° 2′
66	—	—	—	0° 40′	0° 37′	0° 34′	0° 31′	0° 27′	0° 24′	0° 22′	0° 19′	0° 17′	0° 15′	0° 12′	0° 6′	0° 2′
67	—	—	—	0° 40′	0° 36′	0° 33′	0° 30′	0° 27′	0° 24′	0° 22′	0° 18′	0° 17′	0° 15′	0° 12′	0° 7′	0° 2′
68	—	—	—	0° 39′	0° 36′	0° 33′	0° 30′	0° 27′	0° 24′	0° 21′	0° 18′	0° 17′	0° 15′	0° 12′	0° 7′	0° 2′
69	—	—	—	—	0° 35′	0° 32′	0° 30′	0° 26′	0° 23′	0° 21′	0° 18′	0° 17′	0° 15′	0° 12′	0° 7′	0° 3′
70	—	—	—	—	0° 34′	0° 31′	0° 30′	0° 26′	0° 23′	0° 21′	0° 18′	0° 16′	0° 15′	0° 12′	0° 8′	0° 3′
71	—	—	—	—	0° 34′	0° 31′	0° 29′	0° 26′	0° 22′	0° 21′	0° 18′	0° 16′	0° 15′	0° 13′	0° 8′	0° 3′
72	—	—	—	—	0° 33′	0° 31′	0° 29′	0° 25′	0° 21′	0° 20′	0° 17′	0° 16′	0° 15′	0° 13′	0° 8′	0° 3′
73	—	—	—	—	—	0° 30′	0° 29′	0° 25′	0° 21′	0° 20′	0° 17′	0° 15′	0° 15′	0° 13′	0° 8′	0° 3′
74	—	—	—	—	—	0° 30′	0° 29′	0° 25′	0° 21′	0° 20′	0° 17′	0° 15′	0° 15′	0° 13′	0° 8′	0° 3′
75	—	—	—	—	—	0° 30′	0° 28′	0° 25′	0° 20′	0° 20′	0° 17′	0° 15′	0° 15′	0° 14′	0° 8′	0° 3′

HELICAL AND SPIRAL GEAR DATA.

HELICAL GEARS { Axes are parallel.
Gears are either right and left or left and right.
Directions of rotation are opposite.

SPIRAL GEARS { Axes at 90°. Gears both rights or both lefts. Imagine the driven gear stationary, and revolve the driving gear in its required direction; the direction of its advance will indicate side on which to place thrust bearing. Now keep driver from turning, and draw it back to position. This will turn the driven gear in the direction of its revolution. (See "American Machinist Gear Book," page 221, for "Gears with Axes not at Right Angles.")



A = Angle of teeth with axis.
P = Diametral pitch of cutter or hob.

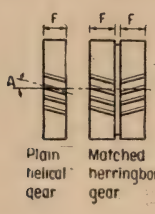
$$C = \frac{3.1416}{\text{Diametral pitch} \times \text{cosine A}} = \text{Circular pitch per tooth.}$$

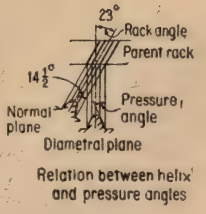
Note.—C must not be confused with the equivalent circular pitch normal to tooth, which equals $\frac{3.1416}{\text{Diametral pitch}}$

Pitch diameter	=	$\frac{\text{Number of teeth}}{\text{Diametral pitch} \times \text{cosine A}}$	or	Circular pitch × number of teeth × .3183
Lead of spiral	=	$\frac{\text{Number of teeth} \times 3.1416}{\text{Sine A} \times \text{diametral pitch}}$	or	Pitch diameter × 3.1416 × cotangent A
Cosine A	=	$\frac{\text{Number of teeth}}{\text{Pitch diameter} \times \text{diametral pitch}}$	or	$\frac{3.1416}{\text{Diametral pitch} \times \text{circular pitch}}$
Sine A	=	$\frac{\text{Number of teeth} \times 3.1416}{\text{Lead of spiral} \times \text{diametral pitch}}$	or	$\frac{\text{Pitch diameter} \times 3.1416 \times \text{cosine A}}{\text{Lead of spiral}}$

HELICAL GEAR DATA.

STANDARD PITCHES AND CUT ON FELLOWS GEAR SHAPERS.





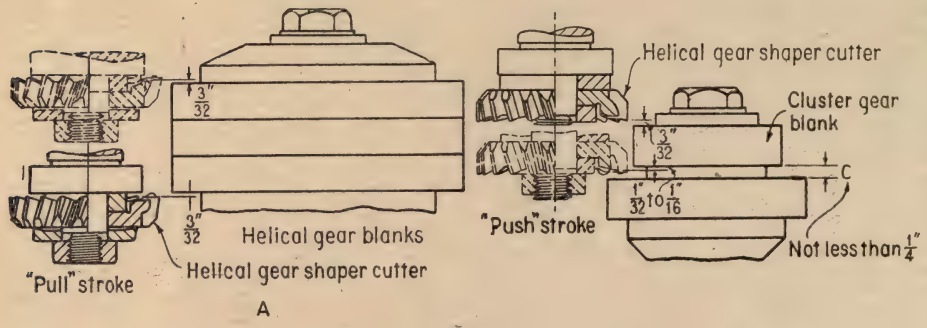
Diametral Pitch.	Normal Pitch.	Helix Angle "A."	Lead of Helix in Inches.	Minimum Width of Face "F" in Inches.
5/7	5.184	15°—20′	41.270	$2\frac{19}{64}$
5/7	5.456	23°—35′	25.904	$1\frac{7}{16}$
6/8	6.209	14°—55′	41.270	$1\frac{31}{32}$
6/8	6.518	23°	25.904	$1\frac{15}{64}$
7/9	7.254	15°—12′	41.270	$1\frac{21}{32}$
7/9	7.629	23°—25′	25.904	$1\frac{3}{64}$
8/10	8.279	14°—55′	41.270	$1\frac{31}{64}$
8/10	8.691	23°	25.904	$\frac{15}{16}$
9/11	9.324	15°—9′	41.270	$1\frac{19}{64}$
9/11	9.801	23°—20′	25.904	$\frac{13}{16}$
10/12	10.349	14°—55′	41.270	$1\frac{3}{16}$
10/12	10.863	23°	25.904	$\frac{3}{4}$
12/14	12.418	14°—55′	41.270	$\frac{63}{64}$
12/14	13.036	23°	25.904	$\frac{5}{8}$

The Fellows Gear Shaper Co. have standardized a range of cutters to produce helical gears of even diametrical pitch. Thus both the pitch and outside diameters of a 5/7 pitch helical gear may be calculated as though of straight spur type, the normal pitch (which is given for information only) not having to be employed.

The slight variations in the helix angle are due to all the cutters having the same nominal pitch diameter, which has to be corrected in some cases (altering thereby the helix angle) to obtain a whole number of teeth in the cutter.

HELICAL GEAR DATA.

EXCESS AMOUNT OF OVERTRAVEL NECESSARY WHEN CUTTING HELICAL GEARS, AND MINIMUM WIDTH OF CLEARANCE GROOVE.



Pitch.	Helix Angle.	Plain Helical Gears A.	Helical Shoulder and Internal Gears B.	
		Excess Amount of Overtravel—Inches.	Excess Amount of Overtravel—Inches.	Minimum Width of Groove C—Inches.
5/7	15°—20′	7/64	5/64	5/16
5/7	23°—35′	5/32	1/8	23/64
6/8	14°—55′	3/32	1/16	19/64
6/8	23°	1/8	3/32	21/64
7/9	15°—12′	5/64	1/16	9/32
7/9	23°—25′	7/64	3/32	5/16
8/10	14°—55′	3/32	1/16	17/64
8/10	23°	3/32	1/16	19/64
9/11	15°—9′	1/16	1/32	17/64
9/11	23°—20′	5/64	1/16	9/32
10/12	14°—55′	1/16	1/32	1/4
10/12	23°	5/64	1/16	17/64
12/14	14°—55′	3/64	1/64	1/4
12/14	23°	1/16	1/32	17/64

HELICAL BEVEL GEAR BEARING LOADS.

The following notes, taken from a paper by Mr. A. L. Nelson, will be found of value to automobile engineers in studying the radial and thrust loads produced by helical bevel gear, including those of the spiral type, particularly under the severe and exacting conditions of rear axle drives. Such gears, made of alloy steels, have, for the sake of lightness, to work under very high stresses, which means relatively small pitch diameters and correspondingly heavy bearing loads. The bearing loads are still further increased and high thrust loads added by cutting the gear teeth at an angle of from 15 deg. to 35 deg. with the pitch cone element. This type of gear is now almost universally used to obtain the degree of quietness imperative in acceptable automobile design.

The equations to be derived in this discussion, for the sake of simplicity, will be based primarily on the type of helical bevel gears cut on generating gear planers. However, gears of the Gleason "Spiral Type," which have teeth that are curved lengthwise on the arc of a circle, may be treated as though the teeth were straight and the angle of the tooth with the pitch cone element taken as the tangent of the tooth at the centre of the resultant tooth pressure. This type of gear is of greatest importance, for the method of manufacture is such as to permit quantity production at a cost low enough so that they are used extensively even for machine-tool machinery. For the latter class of work the gears are often run with shaft angles other than 90° ; hence the formulas will be derived for the general case of shafts at any angle.

CONDITION OF THE PROBLEM.

Fig. 1 shows the resultant tooth load diagram for a forward drive right hand (R.H.) helical gear, and fig. 2 shows the mating left hand (L.H.) pinion. The dimensions of the gears as required are shown on the figures.

Let T = the pinion torque in pound-inches.

$P = \frac{T}{r_1}$ = the vertical component of the resultant tooth pressure in pounds.

ϕ = the tooth angle with the pitch cone element.

θ = the tooth pressure angle.

$A = \frac{\tan \theta}{\cos \phi}$,

and

S = tan ϕ which are constants for given values of θ and ϕ.

D_1 = ½ pitch dia. of the pinion in inches.

D_2 = ½ pitch dia. of the gear in inches.

R_2 = the pitch cone radius.

f = the tooth length.

$R_1 = R_2 - f$.

Kf = the distance from the large end of the tooth to the centre of the resultant normal tooth pressure.

β = the centre angle of the gear.

$a = 90° - \beta$.

ψ = the centre angle of the pinion (= a with shafts at 90°).

r_4 and r_1 of the pinion are X and Y coordinates of the point of application of P, having the apex of the pitch cone as the origin, while r_2 and r_3 are the coordinates of P for the gear.

THE POINT OF APPLICATION OF THE NORMAL RESULTANT TOOTH PRESSURE (Kf).

For the purpose of determining Kf, fig. 3 shows a bevel gear tooth whose apex is at O. Fig. 4 shows an end view of the tooth with the normal tooth load at the outer edge of the tooth intersecting the tooth centre line at B at a distance h_2 (at large end of the tooth) above the weakest section, whose thickness is t_2 (as determined by Lewis's parabola method).

In fig. 3 is shown any elementary slice of the tooth of dx thickness and at a distance x from O, loaded with an elementary force dp. It follows from the figure that its height $h = \frac{h_2}{R_2} x$ and its width $t = \frac{t_2}{R_2} x$. Since the elementary section is a very short cantilever beam, it is necessary to take into account the deflection due to shear as well as that due to ordinary flexure in what is to follow. Each case will be treated separately, taking up the case of flexure alone first.

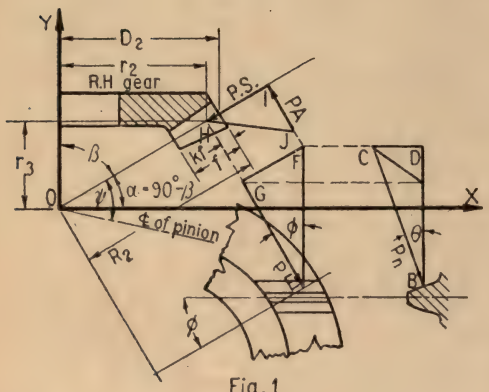


Fig. 1

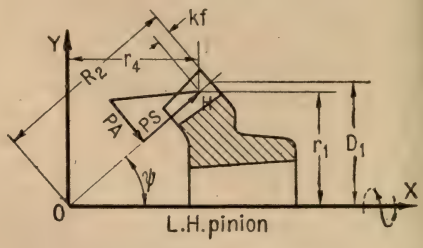


Fig 2

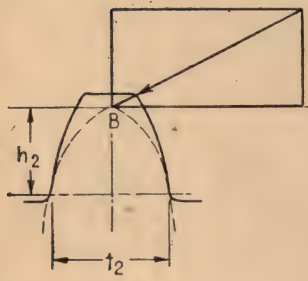


Fig. 4

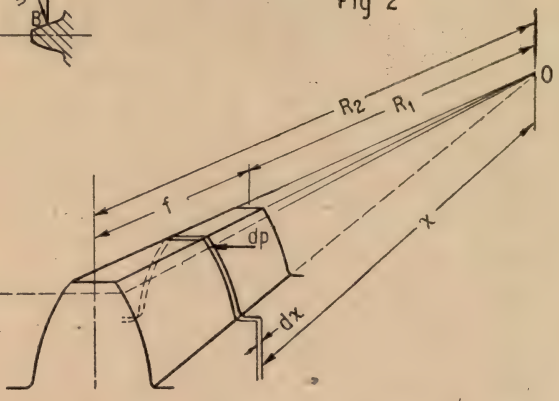


Fig. 3

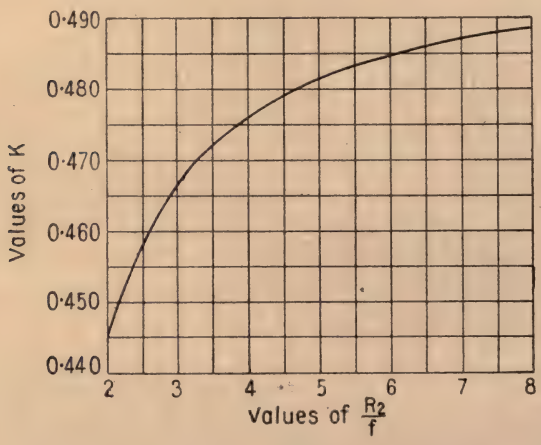


Fig 5

Let S be the flexure unit stress at the weakest section (width t and thickness dx) and $\triangle$ the deflection at the point where the line of action of dp intersects the centre line of the tooth. Since all the elements of the tooth form intersect at the pitch cone apex it is assumed that this is also the case when the tooth is loaded. This assumption will obtain very closely if the gear and pinion shafts are designed properly, that is, so that the deflection of the shafts will have a tendency to keep the gear and pinion in their theoretical alignment. The latter is a point in design well worth striving for in order to obtain quiet and uniformly wearing gear sets. From the above assumption it follows $\triangle$ is proportional to x, or

$$\triangle = C_1 x \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (1)$$

(C's will be used with subscripts to indicate various constants required.) For a cantilever beam of uniform section of constant width t the deflection

$$\triangle' = \frac{\left(\frac{h_2 x}{R_2}\right)^3 dp}{3EI} = \frac{\left(\frac{h_2}{R_2}\right)^3 x^3 dp}{3E\,\frac{1}{12}\left(\frac{t_2}{R_2}\right)^3 x^3 dx} = C_2 \frac{dp}{dx},$$

where E = the modulus of elasticity of the material and I = the moment of inertia of the elementary section.

From the fact that all of the elementary sections of the tooth are similar, it follows that the actual tooth deflection is proportional to $\triangle'$, therefore

$$\triangle = C_3 \triangle' = C_3 C_2 \frac{dp}{dx} \qquad \ldots \qquad \ldots \qquad \ldots \quad (2)$$

From (1) and (2)

$$\frac{dp}{dx} = \frac{C_1}{C_2 C_3}\, x = C_4 x \qquad \ldots \qquad \ldots \qquad \ldots \quad (3)$$

Equating the bending moment to the moment of resistance

$$\frac{h_2}{R_2}\, x\,dp = S\tfrac{1}{6}\left(\frac{t_2}{R_2}\right)^2 x^2 dx$$

whence

$$\frac{dp}{dx} = \frac{S t_2^2 x}{6 R_2 h_2} = C_5 S x \qquad \ldots \qquad \ldots \qquad \ldots \quad (4)$$

From (3) and (4)

$$S = \frac{C_4}{C_5} = \text{constant.}$$

Now let P be the resultant of the Σdp at a distance x_0 from O. Taking moments about O by the aid of (4) and from the fact that S=constant, it may be taken outside of the integral sign, then it follows that

$$P x_0 = \int_{R_1}^{R_2} x\,dp = C_5 S \int_{R_1}^{R_2} x^2 dx = C_5 S . \tfrac{1}{3} . (R_2^3 - R_1^3) \qquad \ldots \qquad \ldots \quad (5)$$

Also from (4)

$$P = C_5 S \int_{R_1}^{R_2} x\,dx = C_5 S . \tfrac{1}{2} . (R_2^2 - R_1^2) \qquad \ldots \qquad \ldots \qquad \ldots \quad (6)$$

Substituting P of (6) in (5)

$$x_0 = \tfrac{2}{3}\,\frac{(R_2^3 - R_1^3)}{(R_2^2 - R_1^2)} \qquad \ldots \qquad \ldots \qquad \ldots \quad (7)$$

The next step is to determine the location of P, considering the shear deflection alone. Let G be the shearing modulus of elasticity. Then for a cantilever beam of length l, unit shearing stress S_s, and unit detrusion e

$$G = \frac{S_s}{e} = \frac{S_s dl}{d\triangle'}.$$

$$\therefore \qquad \triangle' = \int_0^l \frac{S_s dl}{G} = \frac{S_s l}{G}.$$

As before for an elementary tooth section

$$\triangle = C_6 \triangle' = \frac{C_6 S_s h_2}{G\ R_2} X \qquad \ldots \qquad \ldots \qquad \ldots \quad (8)$$

where S_s is the unit shearing stress at the root of the tooth.
It follows from (1) and (8)

$$S_s = \frac{C_1 G R_2}{C_6 h_2} = \text{const.}$$

Equating the shear to the shearing resistance

$$dp = \frac{t_2}{R_2} X s_{sdx}$$

$$\therefore \quad \frac{dp}{dx} = C_7 x \quad .. \quad .. \quad .. \quad .. \quad (9)$$

Now since equation (9) is of the same form as (4) and since S_s = a constant it follows that x_o for shear is the same as x_o for flexure. From fig. 1

$$x_o = R_2 - Kf.$$

$$\therefore \quad K = \frac{R_2 - x_o}{f} = \frac{R_2 - \frac{2}{3}\left(\frac{R_2^3 - R_1^3}{R_2^2 - R_1^2}\right)}{R_2 - R_1} \quad .. \quad .. \quad (10)$$

To simplify the work of finding the value of K for any given case, fig. 5 is drawn with K as ordinates and $\frac{R_2}{f}$ as abscissa. The values of K were calculated corresponding to the ratio $\frac{R_2}{f}$ by taking $f = 1$, then $R_2 - R_1 = 1$ and

$$K = R_2 - \tfrac{2}{3} \cdot \frac{R_2^3 - (R_2 - 1)^3}{(2R_2 - 1)} \text{ (for } f = 1) \quad .. \quad .. \quad (11)$$

Now that the location of P is determined the force analysis will be considered.

FORCE ANALYSIS OF THE RESULTANT TOOTH PRESSURE.

For the force analysis of the resultant tooth pressure friction will be neglected since it is small due to the rolling nature of the tooth contact. In fig. 1 is shown the force diagram for forward drive R.H. helical type bevel gear with the pinion driving. BC is the normal resultant tooth pressure. This pressure is resolved into three components. EG is the vertical component, HI the component acting along the element of the pitch cone, and JI the component acting perpendicular to the pitch cone element. From the figure it follows that the normal resultant tooth pressure

$$P_n = \frac{P}{\cos\theta \cos\phi} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (12)$$

Also from the figure $HI = P \tan\phi = PS$, where $S = \tan\phi$ and

$$JI = CD = P_n \sin\theta = \frac{P \sin}{\cos\theta \cos\phi} = P \frac{\tan\theta}{\cos\phi} = PA, \text{ where } A = \frac{\tan\theta}{\cos\phi}.$$

There are four cases of conditions to be considered. In each case the pinion will be considered as the driver. Clockwise rotation viewing the pinion from the positive end of the X axis will be called the forward drive. The two components of forces in the plane of the gear axes will be broken up into F_x and F_y, that is the summation of the forces along the X and Y axes respectively.

Case I. Forward Drive R.H. Helical Gear or Reverse Drive L.H.

$$F_x = -P(A \sin\alpha + S \cos\alpha) \quad .. \quad .. \quad (I_{gx})$$
$$F_y = \quad P(A \cos\alpha - S \sin\alpha) \quad .. \quad .. \quad (I_{gy})$$

(The subscripts of the equation numbers may be interpreted as follows: g refers to the gear and x to the X axis, while y refers to the Y axis. Later p will be used to denote the equations for the pinion.)

Reversing the helix to L.H. and also reversing the drive does not change the equations. However, if only the drive is reversed, the component along the element of the cone reverses while that perpendicular to the element does not reverse. Hence the equations for this case are as follows:

Case II. For Forward Drive L.H. Helical Gear or Reverse Drive R.H.

$$F_x = P(-A \sin\alpha + S \cos\alpha) \quad .. \quad .. \quad (II_{gx})$$
$$F_y = P(A \cos\alpha + S \sin\alpha) \quad .. \quad .. \quad .. \quad (II_{gy})$$

In like manner the equations for the pinion become as follows:

Case III. For Forward Drive L.H. Helical Pinion or Reverse Drive R.H. (See fig. 2.)

$$F_x = \quad P(A \sin\psi + S \cos\psi) \quad .. \quad .. \quad (III_{px})$$
$$F_y = -P(A \cos\psi - S \sin\psi) \quad .. \quad .. \quad (III_{py})$$

Case IV. For Forward Drive R.H. Helical Pinion or Reverse Drive L.H.

$$F_x = -P(-A \sin\psi + S \cos\psi) \quad .. \quad .. \quad (IV_{px})$$
$$F_y = -P(A \cos\psi + S \sin\psi) \quad .. \quad .. \quad (IV_{py})$$

When the axes of the gear and pinion make an angle of 90°,

$\psi = \alpha$ and the equations of Cases III and IV become the same as for Cases I and II except opposite in sign.

GRAPHICAL SOLUTION FOR F_x AND F_y.

It will be observed from the above equations that they are all written so that the second factor is a coefficient of P. Furthermore, A and S depend only on the angles θ and ϕ, while α and ψ depend on the ratios $\frac{r_3}{r_2}$ and $\frac{r_1}{r_4}$ respectively. General graphical solutions for the equations may then be obtained by plotting two sets of curves as given in figs. 6 and 7 with the coefficients of P as ordinates and the cot α of the gear or cot ψ of the pinion as abscissa. Fig. 6 gives the coefficients of P for the gear and pinion having a tooth pressure angle (θ) of $14\frac{1}{2}°$, while fig. 7 gives those for 20°. Since the tooth angle with the pitch cone element (ϕ) generally varies from 15° to 35°, three sets of curves in each figure are given with the values of ϕ taken 20°, 25°, and 30°. For intermediate values of ϕ interpolate between the curves. For gears with values of θ between $14\frac{1}{2}°$ and 20° interpolate between the values given by figs. 6 and 7.

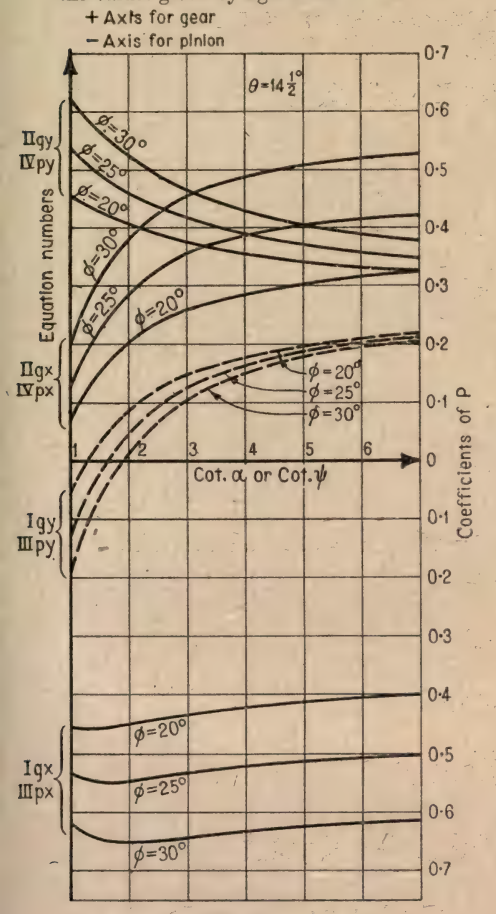


FIG. 6.

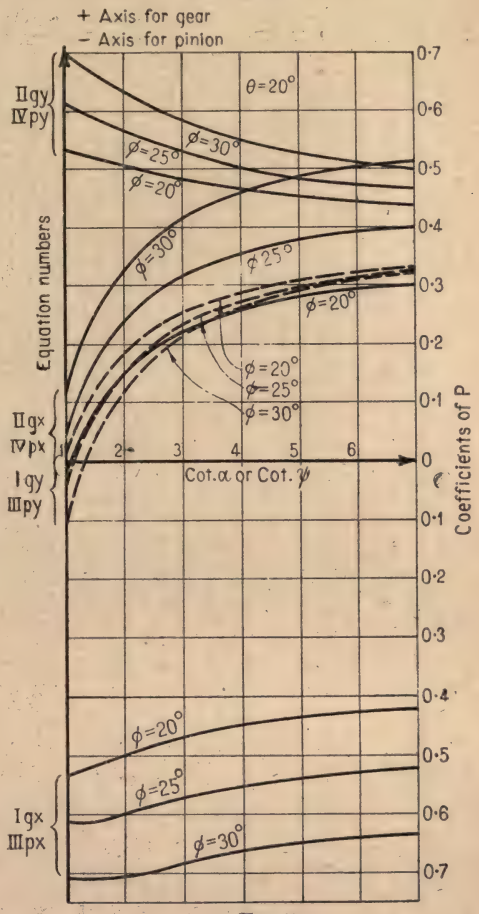


FIG. 7.

Since the equations for the pinion are opposite in sign to those of the gear, the positive ordinate is taken as negative for the pinion as indicated in figs. 6 and 7 in the upper left-hand corner, that is, the sign of the coefficient of P as given in the chart is the sign of F_x and F_y.

DETERMINING THE MAGNITUDE OF P.

Having determined the coefficients of P, the next step is to determine the magnitude of P. First find r_1 and dividing the torque of the pinion by r_1 gives P. From figs. 2 and 3 it follows that

$$R_2 = \frac{D_1}{\sin \psi} = \frac{D_2}{\cos \alpha} \quad .. \quad .. \quad .. \quad (13)$$

$$r_1 = (R_2 - Kf) \sin \psi \quad .. \quad .. \quad .. \quad (14)$$

$$r_4 = (R_2 - Kf) \cos \psi \quad .. \quad .. \quad .. \quad (15)$$

In like manner from fig. 1

$$r_2 = (R_2 - Kf) \cos \alpha \quad .. \quad .. \quad .. \quad (16)$$

$$r_3 = (R_2 - Kf) \sin \alpha \quad .. \quad .. \quad .. \quad (17)$$

In case of shafts making 90° with each other $\alpha = \psi$ and then $r_1 = r_3$ and $r_4 = r_2$.

SOME VERIFICATION OF CALCULATED RESULTS.

The following table is given as a comparison of average test and calculated coefficients of P. These pinion thrust tests were made by Gleason Gear Works and published by "Machinery," April, 1914.

Test Number.	Gear Type.	Number of Teeth in Gear and Pinion.	Tooth Angle with Pitch Cone Element ϕ.	Tooth Pressure Angle θ.	Per cent. of Tooth load $\left(P = \frac{T}{r_1}\right)$			
					Thrust on Pinion Forward Drive.		Thrust on Pinion Reverse Drive.	
					Observed.	Calculated.	Observed.	Calculated
1	Plain Bevel	53—15	0°	14½°	7.34	7.06	7.62	7.06
2	"Spiral Bevel"	53—15	31° 21′	14½°	—49.5	—50.3	73.8	66.9
3	"Spiral Bevel"	53—14	19° 45′	14½°	—28.7	—28.7	45.0	45.6
4	"Skew Bevel"	57—18	23° 46′	14½°	—30.5	—33.5	50.8	50.5

The above pinions are all R.H. In each case the observed average thrust in per cent. of the tooth load was taken from a large number of trials. The calculated values agree quite closely with the test values. This fact gives an added assurance to the dependability of the formulæ as derived in this paper.

SHAFT BEARING LOADS.

The bearing reactions may be found after having determined the resultant tooth pressure P, F_x, and F_y. The bearing reactions will depend on how the bearings are located in reference to the gears. The method of finding the bearing reactions will be illustrated by a numerical problem for forward and reverse drive. The following data are taken from a set of Gleason "Spiral type" automobile differential drive gears:

Pitch of teeth = 5.
Number of teeth in gear = 58, in pinion = 13.

$\beta = 77° 22'$.
$\alpha = \psi = 12° 38'$.
$\theta = 14\frac{1}{2}°$.
$\phi = 30°$ Gear R.H.
$f = 1.25$ inches.

$$D_1 = \frac{13}{2 \times 5} = 1.30 \text{ inches.}$$

$$D_2 = \frac{58}{2 \times 5} = 5.80 \text{ inches.}$$

$\cot \alpha = 4.461$ = (speed ratio since $\alpha = \psi$).

$$R_2 = \frac{D_2}{\cos \alpha} = \frac{5.80}{0.9758} = 5.94 \text{ inches.}$$

$$\frac{R_2}{f} = \frac{5.94}{1.25} = 4.75,$$ referring this ratio to figure 5 it follows that K = 0.48 and $Kf = 0.48 \times 1.25 = 0.60$ inches.

$r_1 = (R_2 - Kf) \sin \alpha = (5.94 - 0.60)\, 0.2187 = 1.167$ inches.
T = 1640 lb.-in. max. motor torque (from test).

$$P = \frac{T}{r_1} = \frac{1640}{1.167} = 1405 \text{ lb. on direct drive.}$$

$r_2 = (R_2 - Kf) \cos \alpha = (5.94 - 0.60)\, 0.9758 = 5.21$ inches.

Since the gear is R.H. the forward drive comes under Case I and the reverse drive under Case II. Referring $\cot \alpha = 4.46$ to fig. 6, it follows for:

Case I, $F_x = 1405\ (-0.629) = -884$ lb.
$F_y = 1405\ (0.165) = 232$ lb.

Case II, $F_x = 1405\ (0.498) = 700$ lb.
$F_y = 1405\ (0.418) = 587$ lb.

The gear is mounted on two Timken roller bearings 3½ inches each side of the pitch cone apex, as shown in fig. 8. Fig: 8 also shows the free body diagram for forward drive. P, F_x and F_y are shown acting on the gear tooth engaging the pinion. The forces for reverse

drive are placed in parentheses to avoid redrawing the figure. Each normal bearing reaction is resolved into two components F_1 and F_2 for the left bearing reaction and F_3 and F_4 for the right. The next step is to find the value of these components.

Taking moments about H

$$7F_1 - 884 \times 4.67 - 232 \times 5.21 = 0.$$
$$\therefore \quad F_1 = 763 \text{ lb.}$$
$$7F_2 - 1405 \times 4.67 = 0.$$
$$\therefore \quad F_2 = 937 \text{ lb.}$$

Then the total left bearing reaction is

$$R_l = \sqrt{763^2 + 937^2} = 1208 \text{ lb.}$$

The left bearing also takes the thrust of 232 lb.

In like manner, taking moments about G, it follows $F_3 = 121.4$ lb., $F_4 = 467.7$ lb., and the total right bearing reaction $R_r = 483$ lb.

The first speed transmission gear ratio is 2.56 : 1, hence the above reactions become 2.56 times as great for first speed, 3092 and 1236 lb., respectively ; while the thrust becomes 594 lb.

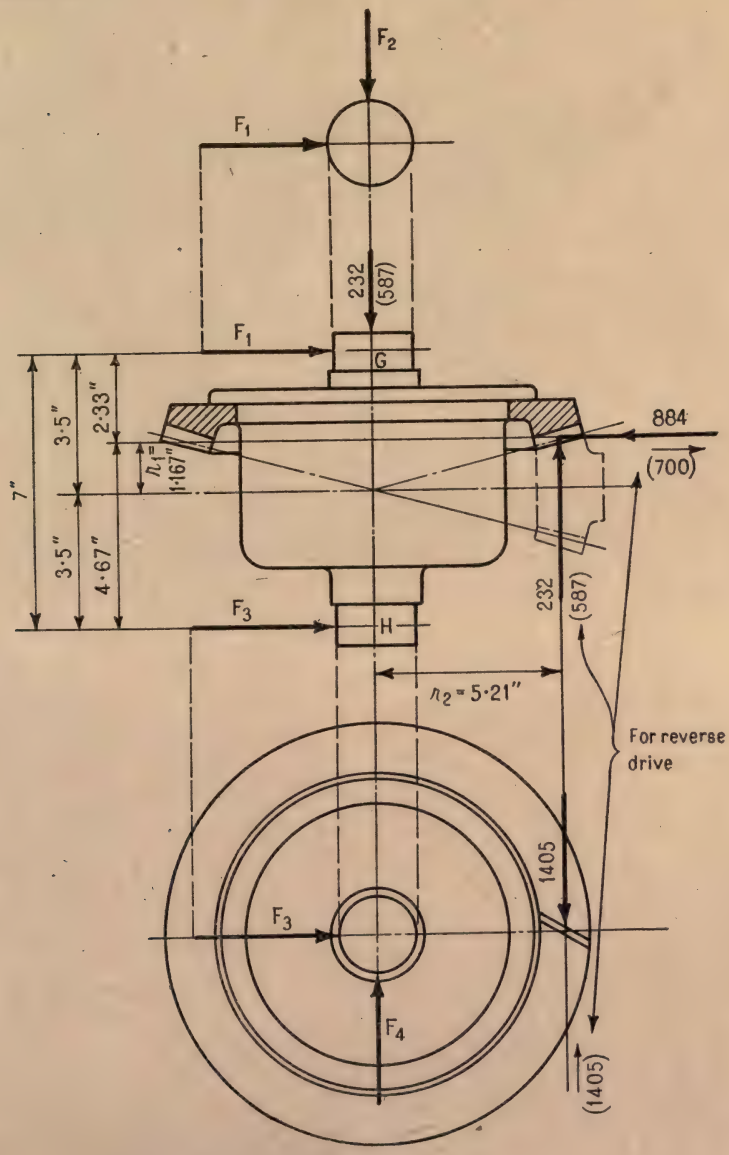


Fig. 8.

For reverse drive, taking moments as before :

$$7F_1 - 587 \times 5.21 + 700 \times 4.67 = 0.$$

$\therefore$ $F_1 = -30.3$ lb. The negative sign indicates that F_1 acts opposite to the direction shown in fig. 8.

$$7F_2 + 4.67 \times 1405 = 0.$$

$$\therefore \quad F_2 = -937 \text{ lb.}$$

In the same manner $F_3 = -670$ lb., and $F_4 = -468$ lb. Then $R_l = 938$ lb. and $R_r = 817$ lb. It should be observed that the magnitude and direction of these reactions are entirely different from those of the forward drive. In case of the pinion bearing reactions it is generally necessary to determine their direction and magnitude for both forward and reverse drive in order to design properly rigid bearing supports.

The reverse transmission gear reduction is generally so low that the rear wheels will slip before the full torque of the motor is applied. In this case the weight on the rear wheels is 2200 lb. The radius of the wheels is 17 inches. Assuming the coefficient of friction is 0.6, then

$$P = \frac{17 \times 2200 \times 0.6}{5.21} = 4308 \text{ lb.}$$

This force corresponds to a gear reduction of $\frac{4308}{1405} = 3.066$. (The actual reduction is 3.42). For slipping the wheels

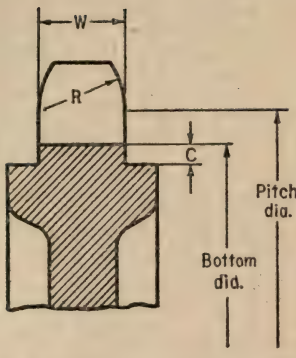
$R_l = 938 \times 3.066 = 2876$ lb.
$R_r = 817 \times 3.066 = 2505$ lb.
The thrust $= 587 \times 3.066 = 1800$ lb.

It is interesting to note that although the torque is not great enough to slip the wheels for forward drive under the conditions as assumed for the reverse, nevertheless the maximum radial bearing pressure obtains on forward drive, namely 3092 lb. Incidentally this pressure is slightly greater than the weight of the entire car precluding the passengers. However, on reverse drive the thrust on the gear is three times as great as for forward drive.

ROLLER CHAINS.

Proportions Standardized by the Association of British Driving Chain Manufacturers.

Association Chain No.		Pitch.	Maximum Roller Diam.	Minimum Width between Plates.		Min. Depth of Shroud below Roller Seating.	Maximum Tooth Width.	
Narrow.	Wide.			Narrow.	Wide.		Narrow.	Wide.
3 N	3 W	$\frac{3}{8}$″	.250″	.155″	.230″	.070″	.145″	.220″
Cycle Sizes		$\frac{1}{2}$″	.305″	.130″	.192″	.050″	.120″	.182″
4 N	4 W	$\frac{1}{2}$″	.335″	.205″	.305″	.094″	.195″	.295″
5 N	5 W	$\frac{5}{8}$″	.400″	.255″	.380″	.117″	.245″	.370″
6 N	6 W	$\frac{3}{4}$″	.475″	.310″	.460″	.140″	.295″	.445″
8 N	8 W	1″	.625″	.410″	.625″	.19″	.390″	.600″
10 N	10 W	$1\frac{1}{4}$″	.780″	.510″	.780″	.23″	.490″	.750″
12 N	12 W	$1\frac{1}{2}$″	.940″	.615″	.940″	.28″	.585″	.900″
14 N	14 W	$1\frac{3}{4}$″	1.100″	.715″	1.100″	.33″	.685″	1.050″
16 N	16 W	2″	1.250″	.820″	1.250″	.375″	.780″	1.200″
20 N	20 W	$2\frac{1}{2}$″	1.550″	—	1.560″	.47″	—	1.500″
24 N	24 W	3″	1.900″	—	1.875″	.56″	—	1.800″



ROLLER CHAIN WHEELS.

Section Profile of Teeth for Roller Chains.—Chain wheel blanks should be machined as indicated in the accompanying diagram.

Pitch Diameters.—The following table gives correct pitch diameters for all types of chain having a pitch of 1 inch. The pitch diameters for wheels to suit other pitches of chain are directly proportional to the pitch of the chain.

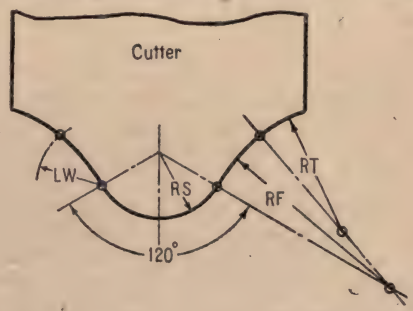
No. of Teeth	Pitch Diameter.	No. of Teeth	Pitch Diameter.	No. of Teeth	Pitch Diameter.	No. of Teeth	Pitch Diameter.	No. of Teeth	Pitch Diameter.	No. of Teeth	Pitch Diameter.
9	2.924	24	7.661	39	12.428	55	17.517	71	22.607	86	27.381
10	3.236	25	7.979	40	12.746	56	17.835	72	22.926	87	27.699
11	3.549	26	8.296	41	13.063	57	18.153	73	23.244	88	28.017
12	3.864	27	8.614	42	13.381	58	18.471	74	23.562	89	28.335
13	4.179	28	8.931	43	13.700	59	18.789	75	23.880	90	28.654
14	4.494	29	9.249	44	14.018	60	19.107	76	24.198	91	28.972
15	4.810	30	9.567	45	14.336	61	19.425	77	24.517	92	29.290
16	5.126	31	9.885	46	14.654	62	19.744	78	24.835	93	29.608
17	5.442	32	10.202	47	14.972	63	20.062	79	25.153	94	29.927
18	5.759	33	10.520	48	15.290	64	20.380	80	25.471	95	30.245
19	6.076	34	10.838	49	15.608	65	20.698	81	25.790	96	30.563
20	6.392	35	11.156	50	15.926	66	21.016	82	26.108	97	30.881
21	6.710	36	11.474	51	16.244	67	21.335	83	26.426	98	31.200
22	7.027	37	11.792	52	16.562	68	21.653	84	26.744	99	31.518
23	7.344	38	12.110	53	16.880	69	21.971	85	27.063	100	31.836
—	—	—	—	54	17.198	70	22.289	—	—	—	—

Limits of Accuracy for Cutting.—The tolerance for the bottom diameter of the tooth gaps may be .1 per cent. of the number of inches of the pitch diameter, but in any case shall be within the following limits:—

Minimum tolerance .005″. Maximum tolerance .020″.

CUTTER FORMS FOR ROLLER TYPE CHAINS.

For the convenience of chain users and to ensure complete interchangeability, the Association has standardized tooth forms which, while not being identical with any of the existing forms, incorporate the essential features of each. The general construction is shown in the diagram below. It consists of a ROLLER SEATING, WORKING FACES, and TOPPING CURVES, all of which are arcs of circles. The angle of 120° subtending the roller seating has its origin at the centre of the diameter of the roller seating. The working faces are comparatively flat curves tangential to the roller seating, and the topping curves are tangential to the working faces and of such a radius as to give a suitable height of tooth. The dimensions of tooth forms for the Association Standard Chains are given in the following table:—



Cutter Forms for Roller Type Chains (*Continued*).

Roller Diam.	Cutter No.	No. of Teeth to Cut.	L.W. Length of Working Face.	R.S. Rad. of Roller Seating.	R.F. Rad. of Working Face.	R.T. Rad. at Top of Tooth.
.250″	1	9 to 12	—	.126″	.45″	.45″
	2	13 to 19	.12″	.126″	1.125″	.18″
	3	20 and over	.154″ min.	.126″	3.825″ min.	.052″ max.
.305″	1	9 to 12	—	.154″	.6″	.6″
	2	13 to 19	.16″	.154″	1.5″	.24″
	3	20 and over	.205″ min.	.154″	5.1″ min.	.07″ max.
.335″	1	9 to 12	—	.169″	.6″	.6″
	2	13 to 19	.16″	.169″	1.5″	.24″
	3	20 and over	.205″ min.	.169″	5.1″ min	.07″ max.
.4″	1	9 to 12	—	.202″	.75″	.75″
	2	13 to 19	.20″	.202″	1.875″	.3″
	3	20 and over	.256″ min.	.202″	6.375″ min.	.087″ max.
.475″	1	9 to 12	—	.240″	.9″	.9″
	2	13 to 19	.24″	.240″	2.25″	.36″
	3	20 and over	.307″ min.	.240″	7.65″ min.	.105″ max.
.625″	1	9 to 12	—	.316″	1.2″	1.2″
	2	13 to 19	.32″	.316″	3.0″	.48″
	3	20 and over	.41″ min.	.316″	10.2″ min.	.14″ max.
.780″	1	9 to 12	—	.394″	1.5″	1.5″
	2	13 to 19	.40″	.394″	3.75″	.6″
	3	20 and over	.512″ min.	.394″	12.75″ min.	.175″ max.
.940″	1	9 to 12	—	.475″	1.8″	1.8″
	2	13 to 19	.48″	.475″	4.5″	.72″
	3	20 and over	.615″ min.	.475″	15.3″ min.	.21″ max.
1.1″	1	9 to 12	—	.556″	2.1″	2.1″
	2	13 to 19	.56″	.556″	5.25″	.84″
	3	20 and over	.717″ min.	.556″	17.85″ min.	.245″ max.
1.25″	1	9 to 12	—	.631″	2.4″	2.4″
	2	13 to 19	.64″	.631″	6.0″	.96″
	3	20 and over	.82″ min.	.631″	20.4″ min	.28″ max.
1.55″	1	9 to 12	—	.783″	3.0″	3.0″
	2	13 to 19	.80″	.783″	7.5″	1.2″
	3	20 and over	1.025″ min.	.783″	25.5″ min.	.35″ max.
1.9″	1	9 to 12	—	.960″	3.6″	3.6″
	2	13 to 19	.96″	.960″	9.0″	1.44″
	3	20 and over	1.23″ min.	.960″	30.6″ min.	.42″ max.

FRONT AXLE.

BY JAMES WATT.

Unlike a live rear axle, the mass at the middle of the front axle is insufficient to induce any appreciable dynamic load, and consequently the case becomes that of a simple beam loaded by forces applied at the spring seats, and supported at the centres of the tyres. The resulting bending moment diagram is shown in the lower portion of fig. 1, X*b*Y and X*c*Y representing respectively the individual bending moments due to F_1 and F_2, while X*de*Y is the combination of these two triangles. In passing, it may be noted that F_1 and F_2 are the nominal maximum spring loads, corrected for inertia effect.

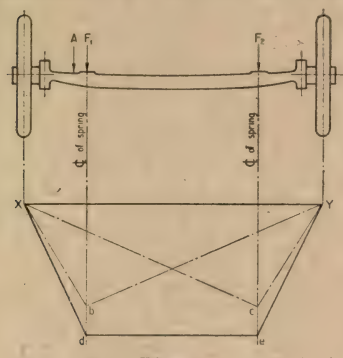


Fig. 1.

STEERING GEAR.

BY JAMES WATT.

As regards the stressing of the steering gear, in the author's opinion for commercial vehicle work the best method is to assume or actually find by experiment the maximum load that can be applied by the driver to the rim of the steering wheel, and, with this data, work down through the gear as far as and including the steering arm on the offside stub axle, keeping the factor of safety approximately the same throughout.

For the tie-rod connecting the nearside stub to that on the offside, and for the arms on which this rod is carried, the author favours a more empirical method, as the torque exerted by the driver on the steering wheel does not account for the maximum stresses coming on these parts. In his opinion the best method is to fix up one characteristic component, say the ball pin if this type of joint is adopted, in accordance with practice current for the type of chassis under consideration, and then design the rod and arms so that they will just be as strong as this ball pin. For vehicles in the lighter category, he rather imagines that this would be the best basis of design to adopt throughout the whole steering gear, as the driver will never have occasion to exert his full strength on the wheel. Thus, if the method suggested for dealing with commercial vehicles were adopted in this case, parts so designed would probably be found to be unnecessarily heavy. Even in the case of commercial vehicles, it is advisable to *check* the whole gear on this empirical basis.

STEERING GEAR ARTICULATION.

In order to fix up the length of the tie-rod connecting the nearside stub axle to that on the offside, it is usual to lay down a diagram incorporating a plan of the chassis, and at about two-thirds full lock, to arrange that the produced axes of both front wheels intersect at the same point the produced axis of the rear axle. If a reasonably large scale is used, this point of common intersection is frequently found to lie outside the limits of an ordinary drawing board, and Heldt in his book on the Automobile* gives a very convenient method which eliminates this trouble. The whole of this alternative diagram is contained within the centres of the stub axle pivot-pins and thus, drawn to the scale of half size, the diagram for any normal car can be laid out on a double-elephant sheet. Since the method has already been published, and since, after all, the construction of this diagram can hardly be looked upon as a calculation, a full description is not given, but those interested may with advantage consult the text-book referred to.

BRAKES.

BY MAURICE PLATT, M.ENG.

The following brief formulæ and calculations provide the simple relationships between retardation, pedal pressure, and leverage. The author uses the term "braking retardation efficiency" in the sense of meaning the ratio between the retardation set up by the brakes and the acceleration due to gravity, which is, of course, the same as the ratio between the retarding force and the weight of the car. A ratio of 0.7 is nowadays quite often attained and is generally accepted as being quite sufficient, although in authenticated tests a ratio more than double as great has been attained. Taking 0.7 as the figure, however, the retarda-

* "Motor Vehicles and Tractors," by P. M. Heldt.

tion is simply $0.7 \times g$, or 22.6 ft. per sec. per sec. The corresponding stopping distances can be read from fig. 1. The requisite retarding force (F lb.) for a car of medium size, weighing, say, 3,000 lb., is simply $3{,}000 \times 0.7 = 2{,}100$ lb., applied at the tyres.

The total outward force (P lb.) on the linings of the shoes is given by the formula

$$P = (F \times D) / (\mu \times d) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where D = tyre diameter in inches.

d = internal diameter of drum in inches.

μ = coefficient of friction of lining.

Assuming the ratio (D ÷ d) to be 2, and taking a conservative figure of 0.33 for μ, then for the magnitude of F previously ascertained (2,100 lb.) we obtain

P = 12,600 lb.

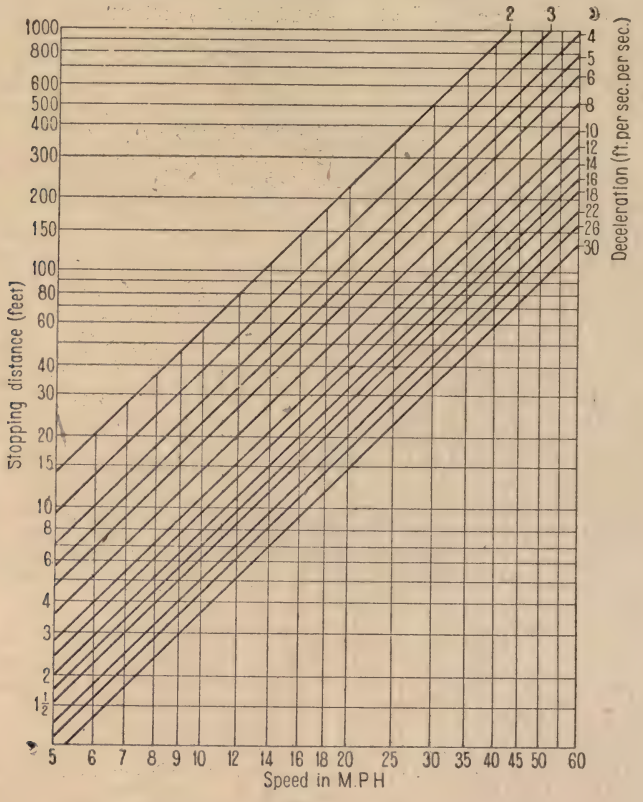


Fig. 1.

Chart relating speeds, stopping distances and rates of deceleration.*

EXAMPLE.—A vehicle which is travelling at 12 miles per hour and is stopped in a distance of 30 feet has an average deceleration of 5.2 feet per sec. per sec.

Owing to the curvature of the shoes and the consequent distribution of tangential forces with regard to the pivots, the total force which must be applied to the cam faces is somewhat less than 50 per cent. of the force on the linings (P)—the proportion suggested by the 2 : 1 leverage in the shoes themselves—so that for an average arc of lining subtending an angle of 100 degrees, the ratio can safely be taken as 45 per cent. For the car considered, therefore, the total force at the cam faces must be

$$12{,}600 \times 45 \div 100 = 5{,}700 \text{ lb.}$$

To indicate the mechanical advantage of the system the author uses the term "Linkage leverage" (L) to denote the overall "advantage" provided between the driver's foot and the faces against which the cams abut; a maximum figure is 50 : 1. For the car considered, the pedal pressure required to produce a retardation efficiency of 70 per cent. is, therefore, $5{,}700 \div 50$, or 114 lb., apart from losses due to friction, return springs and the lost work expended upon deforming the linkage. Allowing for a loss of 40 per cent. of the pedal

* Chart compiled by George W. Watson and reproduced from I.A.E. Data Sheet No. 214.

pressure from these causes, the driver will actually be called upon to exert a force of 190 lb., which is about the utmost that can be expected from a driver of average physique in an emergency and is nearly twice as great as the maximum force really desirable.

For a reasonable rate of wear it is common to employ roughly one sq. in. of lining on the service brakes per 28 lb. of car weight; for the car considered the area would work out at 106 sq. in., giving a mean pressure on the linings of (12,600 ÷ 106) or about 120 lb. per sq. in.—a reasonable figure.

Loads and Stresses.—With a few exceptions, the linkage leverage employed on current chassis varies between limits of 35 : 1 and 45 : 1; this is ordinarily made up as follows when no servo action is employed):

(*a*) A cam and lever ratio at the brake itself of between 6 : 1 and 8 : 1.
(*b*) A ratio in the cross-shaft levers or other intermediate levers of between 1.2 : 1 and 1.7 : 1 (but sometimes unity).
(*c*) A pedal leverage of between 4 : 1 and 6 : 1.

Average figures of (*a*) 7 : 1, (*b*) 1.3 : 1, and (*c*) 4.5 : 1, give a total linkage leverage of 41 : 1, which represents general modern practice. This means that, assuming the average driver can exert 200 lb. on the pedal in an emergency, the corresponding stress in a pull-rod of ⅜ in. diameter, loaded to 900 lb., is 8,150 lb. per sq. in. Much more important is the bearing pressure on the forked joints; for example, with a ⅜ in. pin and a fork with a slot ⅜ in. wide (common figures), the pressure on the projected area of the bearing surface for the load given above is 6,400 lb. per sq. in., or, for a normal pedal pressure of 100 lb., is 3,200 lb. per sq. in.

Assuming that a single cross-shaft is employed, carrying a pedal-operated lever 5 inches in length, the torque on the shaft will be 4,500 lb.-in. (maximum). In many cases the shaft is, of course, a tube of ample diameter, but in some instances it is a slender, solid rod; to quote an example: for the above torque a shaft of 1-in. diameter has to withstand a maximum skin stress of 23,000 lb. per sq. in., and will twist about 2½ degrees per foot length. This angle represents a movement (or "give") of about 0.22 in. between the outer ends of two 5-inch levers secured to the shaft at a distance of 1 ft. apart.

These figures are not merely theoretical; braking systems vary, of course, but in the main the stresses and bearing pressures are much too high, tending to result in undue stretch and increased risk of failure on the one hand and to rapid wear with increased backlash on the other. It will also be noticed that both stretch and backlash increase the pedal travel and so reduce the linkage leverage that can reasonably be allowed. Spring of the drums, shoes and shoe pivots may also add a contribution to the total "stretch."

In the opinion of the author braking linkages in general could be greatly improved by concentrating the mechanical advantage near to the cams, using a pedal leverage not greater than 2 : 1. This practice has the immediate advantage of more than halving the stresses and strains throughout the linkage, as compared with the usual plan, and also, by reducing bearing pressures, assists lubrication. Further, the relative movement between axles and frame has a much smaller proportional effect upon the brakes when the travel of the pull-rods or cables is increased. To make this recommended arrangement of leverages possible it is obviously necessary to adopt some special method of providing mechanical advantage near to the shoes.

Effect of Servo Devices.—Another method of reducing the linkage leverage, and, with it, the stresses and strains throughout, is to employ what have become generally known as "servo" or "self-energizing" shoes, such as the Bendix-Perrot, Maxted, Burgess, etc. Generally speaking, the linkage leverage can roughly be halved, bringing the ratio down to about 23 : 1.

Hand-Control Leverages.—When a four-brake (interconnected) system is employed the hand lever is usually coupled to the cross-shaft operating the rear brakes, and the overall leverage in the hand-controlled linkage is invariably greater than that of the pedal system. In many cases it is about 50 : 1 when the pedal linkage leverage is about 40 : 1. This makes for safety because the position of the lever is usually such that the driver cannot exert upon it nearly so great a force as that which he can apply to the pedal. When a four-brake system embodies a vacuum-type servo-motor it is particularly desirable to provide a big mechanical advantage in the hand control owing to the well-known difficulty of obtaining effective braking should the engine stop when the car is running downhill in neutral. Another point in connection with four-brake systems is that the safety margin is increased if the hand lever is afforded a particularly large range of movement, exceeding that of the pedal. Should the owner-driver then neglect to adjust the brakes until he finds that, with the pedal forced down to the floorboards, he is still unable to hold the car on a hill, he can obtain further movement of the shoes by employing the hand lever.

Area of Brake Lining.—The frequency with which brake adjustments are necessary is largely dependent upon the area and disposition of the brake linings; a figure of 1 sq. in. of lining per 28 lb. of car weight has already been mentioned as representing good current practice for a four-brake system. This can only be taken as a general guide, however, owing to the influence of the disposition of the linings. Incidentally, a retardation efficiency of 70 per cent. has been shown to require a load on the linings equal to about four and a half times the weight of the car, so that the mean pressure on the linings will obviously be four and a half times the above figure of 28 lb., namely 126 lb., per sq. in. Mean pressures up to 150 lb. per sq. in. are quite permissible with linings of good quality.

A short, wide lining is far more effective than one which is long and narrow, whilst for internal-expanding brakes of orthodox design it is inadvisable for the arc of lining material to subtend an angle greater than 120 degrees; an angle greater than this increases the likelihood of a grabbing action, and probably 100 degrees is the greatest angle that need ever be used. These facts are well known, but are restated because on many cars the arc of lining is still too great.

An area and disposition of linings such as those suggested should provide adequate safeguards against overheating on long descents, given reasonable facilities for the escape of heat from the drums. The temperature which a modern lining material will withstand without appreciable diminution of the coefficient of friction is rather remarkable, and in this connection the author has obtained through the courtesy of Ferodo, Ltd., a graphical record of their standard test results (fig. 2). In this severe test the lining is pressed against a rotating cast-iron disk, the load, reaction and temperature being continuously recorded for one hour, after which a pause for cooling-off occurs; the test is then repeated. The graph shows the results of first-hour and second-hour tests on a piece of new brake-lining material; the

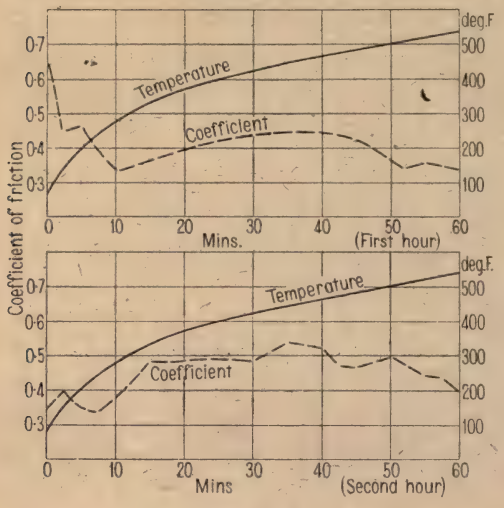


Fig. 2.

Temperature-rise and coefficient of friction obtained by testing sample of Ferodo lining.

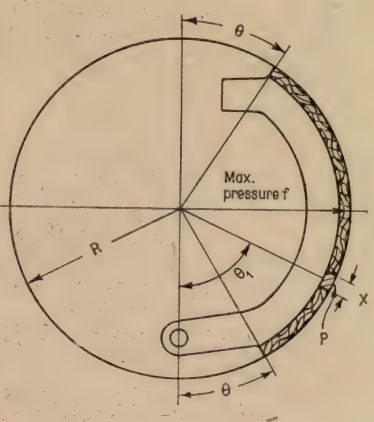


Fig. 3.

Simple two-shoe brake.

high coefficient maintained during the second hour, up to a temperature of 500° F., will be noticed.

Efficiency of Lining Disposition.—It has already been pointed out that a comparison between one car and another on the basis of weight per sq. in. of lining area is by no means satisfactory, as so much depends upon the disposition of the linings. The following line of reasoning on the subject was (so far as the author is aware) first suggested in a very interesting paper read by Dr. H. E. Merritt, when a graduate, before the London Graduates Centre in 1924. Dr. Merritt's definition for a ratio expressing the efficiency of lining disposition is as follows:—"The ratio of the actual braking torque produced by the brake to the hypothetical braking torque obtainable were the lining completely to cover the drum surface and be subjected at all points to a pressure equal to the maximum unit pressure occurring on the actual lining." It will be seen that an ideal brake, using the whole drum circumference and *subjected throughout* to the maximum unit pressure permissible would have a "disposition efficiency" of unity by this definition.

Using the symbol Z to denote this ratio, or efficiency, then as the torque Tm produced by the ideal brake is obviously μfRA, if μ is the coefficient of friction, f the maximum pressure, R the drum radius, and A the area of the inner working surface of the drum, it follows that the torque produced by any actual brake is

$$T a = Z\,(\mu f \mathrm{RA}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Or, conversely, Z can be calculated for any brake by ascertaining the theoretical value of Ta.

Thus in the ordinary symmetrical two-shoe brake in its simplest form (fig. 3) the actual torque Ta corresponding to a *maximum* pressure on the linings f is approximately given by

$$T a = 2\mu f \mathrm{RA} \cos \theta/\pi \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

(For the derivation of this formula see below.) The value of Z for such a brake (Ta/Tm) is therefore

$$Z = (2\mu f \mathrm{RA} \cos \theta) / (\pi \mu f \mathrm{RA}) = 2 \cos \theta/\pi \quad \ldots\ldots\ldots\ldots \quad (4)$$

As a matter of general interest, various values for Z (for a two-shoe brake) corresponding to arcs of lining subtending angles varying from 90 degrees to 180 degrees (corresponding to variations of the angle θ from 0 degrees to 45 degrees) have been calculated by this formula, and are shown plotted in fig. 4. It will be seen that the value of Z does not increase nearly so rapidly as does the length of the lining; thus, if the subtended angle is altered from 90 degrees to 180 degrees (to take an extreme case) the lining length is doubled, but the "disposition efficiency" increases only from 0.45 to 0.64. As already noted, therefore, an arc subtending an angle greater than about 100 degrees becomes wasteful of lining, whilst it has the grave disadvantage of making chatter or jamming much more liable to occur. The advantages of a three-shoe brake are at once obvious from this reasoning; the disposition-efficiency of a single 110-degree shoe is cos $35°/\pi = 0.26$, so that three such shoes in a single drum gives an efficiency of 0.78 without risk of jamming.

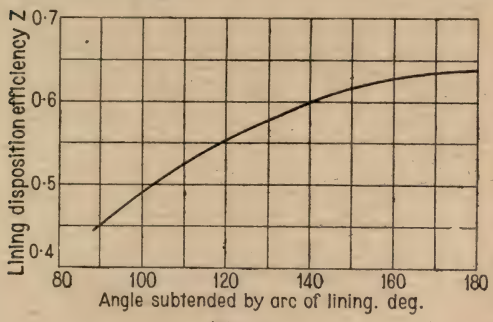


Fig. 4.

Lining disposition-efficiency for a two-shoe brake.

Comparative Figures. — Another use of this disposition-efficiency figure is found in the comparison of the brakes on one car with those of another. As already explained, the actual braking torque produced is given by Equation (2): $Ta = Z(\mu f RA)$.

Now it is important to notice that the product $(\mu f R)$ at any given speed of rotation of the wheels is a measure of the heat generated in friction per unit area and unit time; this follows from the facts that μf represents the tangential force, and that the drum radius R at a given revolution speed is proportionate to the rubbing speed. Consequently, the formula can be rewritten

$$Ta = ZQA \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

when Q is a figure dependent upon the speed capabilities of the car and the facilities for heat-dissipation from the drums. Thus, in general, the lower the value of Q the less liable is a car to overheating of the brakes. An average figure for the four-wheel brakes of orthodox cars with a speed range up to 60 miles per hour or so appears to be about 300.

Braking systems can therefore be compared on the basis of this quantity Q, calculated by a transposition of terms; thus

$$Q = Ta/ZA \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

where, to recapitulate:—

Ta = Total maximum braking torque in lb.-in., easily calculated from retarding efficiency and wheel size.
Z = Lining disposition-efficiency; about 0.5 for most orthodox two-shoe brakes.
A = Total area of internal working surfaces of the four drums in sq. in.

Derivation of Formula (3).—Accepting the usual assumption that the pressure throughout the arc of lining is proportional to the varying rates of lining wear from point to point, then (referring to the simple and symmetrical type of two-shoe brake shown in fig. 3) the maximum pressure f will occur on a radius struck at right-angles to the line of hub and pivot centres and the pressure at any other point P will be simply $f \sin \theta_1$. The frictional moment produced by a narrow strip of lining at any point P, of circumferential length x and width w will therefore be simply $wx\mu f R \sin \theta_1$ (where R is the drum radius and μ the coefficient of friction) which can be rewritten $\mu f R\ (wx \sin \theta_1)$.

Now the term $(wx \sin \theta_1)$ is obviously the projected area of the strip on a plane taken through the axes of the drum and pivot. Consequently, the frictional torque produced by a complete lining is simply found by taking the product of the term $(\mu f R)$ and the lining area projected on to this plane. This result is the same for each shoe, and, therefore, if the linings are symmetrical with regard to the line of pivot and drum centres and the angle subtended by each is $(180 - 2\theta)$, the frictional torque (for two shoes) corresponding to a *maximum* pressure f is simply

$$Ta = 2\ (\mu f R)\ (2wR \cos \theta).$$

If the total internal working surface of the drum has an area of A sq. in. then $A = 2\pi Rw$, or $2Rw = A/\pi$. Substituting in the above formula gives the final result

$$Ta = 2\mu f RA \cos \theta/\pi$$

as stated above.

This result is slightly modified when the shoes are provided with independent pivots offset to a small extent from the centre-line but is near enough for the purpose intended. The modification produced when the arc of lining is not exactly symmetrical with regard to the centre-line is also negligible in most practical brake designs.

Front Wheel Brakes.—Opinions differ as to the relative seriousness of front-wheel skids and rear-wheel skids: the latter can be corrected more readily, but the former are less

dangerous in that the car moves in a straight line instead of swinging round a vertical axis. However, even granting that the braking system should preferably be so arranged that the rear wheels will lock somewhat more readily than the front wheels, the author believes that in most British and American cars too much of the braking effort is diverted to the rear wheels; it is, indeed, notorious that on certain popular makes of car the front brakes are but little more than ornaments. Continental makers appear to be bolder in this respect.

A general rule has often been laid down to the effect that the allocation of braking effort, fore and aft, should follow the allocation of static load on the axles, or at any rate that this proportion should set a limit to the effort applied to the front brakes. Thus in a car with (static) axle weights of 900 lb. (front) and 1,100 lb. (rear) this rule would not permit more than 45 per cent. of the braking effort to be applied to the front wheels. The author disagrees with this arbitrary limit because its adoption prevents a really good retardation efficiency from being attained.

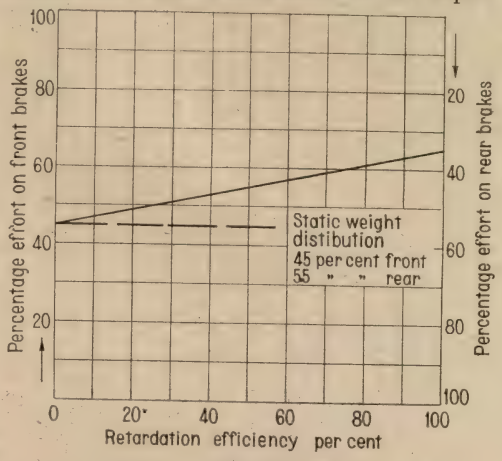


Fig. 5.

Best allocation of effort for various retardations.

To illustrate this point the graph shown in fig. 5 has been prepared, using the simple formula evolved by Mr. F. A. S. Acres,* applied to a car with a (static) weight distribution such that the front-axle weight and rear-axle weight are respectively 45 per cent. and 55 per cent. of the whole. The graph shows the proportion of front-brake and rear-brake effort which is required to make all four wheels lock simultaneously at "retardation efficiencies" ranging from zero to 100 per cent., assuming the height of the centre of gravity above the road to be one-fifth of the wheel-base—a common proportion. It is, of course, hardly necessary to point out that the weight transferred depends upon this factor and upon the retardation efficiency; the actual retardation is simply this efficiency multiplied by "g." From this graph it should be clear that although the static weight distribution, front to rear, is 45 : 55, it should be perfectly safe to use a 50 : 50 distribution of braking effort, or, bearing in mind the instinctive care with which most drivers apply the brakes on a greasy road, a bolder proportion of 55 : 45 might well prove perfectly safe.

For a fuller dissertation on brake design, the reader is referred to the issue of *The Automobile Engineer* for March, 1929, containing the paper presented to the Institution of Automobile Engineers by Mr. Platt, from which these notes are extracted.

* See Proc. I.A.E., Vol. XVIII, Part II, p. 474.

LAMINATED SPRINGS.

BY T. H. SANDERS.

The following formulæ should assist in simplifying the problem of obtaining the leading particulars of any laminated spring of the types in general use for road vehicles. Further elaborated particulars relative to these will be found in the author's book on "Laminated Springs" obtainable from the offices of *The Automobile Engineer*.

Fig. 1 indicates the use of certain important symbols, and definitions thereof follow. The formulæ given are :—

Nos. 1, 2 and 3.	For determination of "straight length."
No. 4.	Standard test formula on symmetrical semi-elliptics.
Nos. 5–8.	Formulæ for symmetrical semi-elliptics.
Nos. 9–12.	Formulæ for asymmetrical semi-elliptics.
Nos. 13–16.	Formulæ for symmetrical cantilevers.
Nos. 17–20.	Formulæ for asymmetrical cantilevers.
Nos. 21–24.	Formulæ for quarter-elliptics.
Nos. 25 and 26.	Weights of springs.

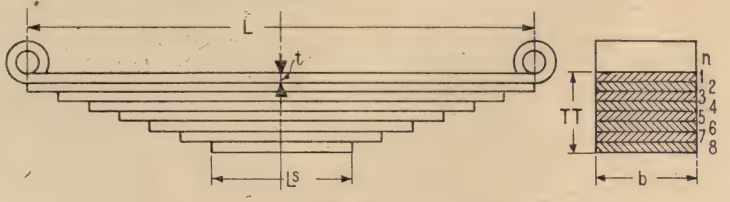


Fig. 1.

Definitions of Symbols used :—

A	pounds	Rate of spring per inch.
b	inches	Width of spring plates.
D	inches	Test Deflection (BSS). Also camber.
d	inches	Deflection of spring per ton.
L	inches	Length of spring between bearing centres—STRAIGHT.
L^s	inches	Length of short plate.
L^a	inches	Length of one arm—asymmetrical spring.
L^b	inches	Length of other arm—asymmetrical spring.
n	quantity	Number of plates in spring if of UNIFORM thickness, or otherwise as converted to a uniform thickness.
P	quantity	Periodicity of spring—swings per minute.
S	inches	Span or chord, between bearing centres of cambered spring.
T	inches	Thickness of spring plate.
TT	inches	Total thickness of spring.
t	sixteenths	Of inches—thickness of spring plate. $\frac{1}{16}=1$; $\frac{1}{4}=4$; $\frac{9}{16}=9$, etc.
W	tons	Load on spring.
w	pounds	Weight of spring.

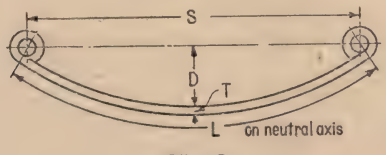


Fig. 2.

Top plate with rolled eyes.

$$L—S = \frac{2.65 \times (D + T)^2}{S} \quad ..(1)$$

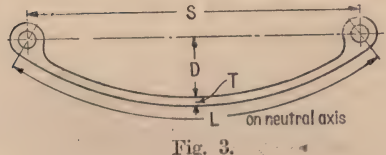


Fig. 3.

Top plate with solid eyes.

$$L—S = \frac{2.65 \times \left(D + \frac{T}{2}\right)^2}{S} \quad ..(2)$$

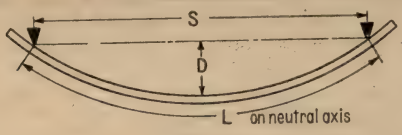


Fig. 4.

$$L—S = \frac{2.65 \times D^2}{S} \quad .. \quad ..(3)$$

TEST DEFLECTION—B.S. SPECIFICATION.

$$D = \frac{L^2}{900T}$$ Equivalent to a skin stress of 68.5 tons per sq. in. .. ..(4)

NOTE.—In springs with plates of varying thicknesses T must always be taken as the thickness of the *thickest* plate.

STATIC STRESSES RECOMMENDED FOR DESIGN.

"Popular" Cars :—	Front Spring	25 tons.	Rear Spring	30 tons.
"Luxury" Cars :—	,, ,,	27 tons.	,, ,,	35 tons.
"Luxury" Coaches :—	,, ,,	25 tons.	,, ,,	30 tons.
Omnibuses :—	,, ,,	23 tons.	,, ,,	27 tons.
Lorries :—				
Local Service :—	,, ,,	25 tons.	,, ,,	30 tons.
Lorries :—				
Long-distance :—	,, ,,	23 tons.	,, ,,	27 tons.

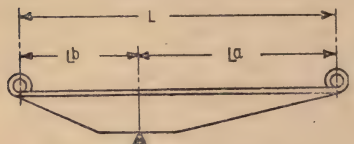
If all springs could be designed on a basis of 23 tons and 27 tons for front and rear respectively, it would approach an ideal. These figures, however, are dependent to a certain degree on static deflection—as the higher the latter, the greater the static stress which can be permitted.

NOTE.—Stresses must be taken as on the thickness of the *thickest* plate.

Semi-elliptic. Symmetrical.

$$A = \frac{22400 \times t^3bn}{L^3} \quad ..(5) \qquad D = \frac{L^2}{900\,T} \quad .. \quad ..(7)$$

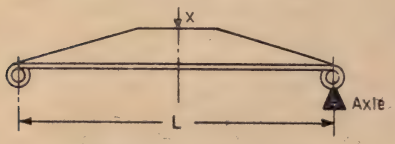
$$d = \frac{0.1 \times L^3}{t^3\,bn} \quad .. \quad ..(6) \qquad W = \frac{0.177 \times t^2bn}{L} \quad ..(8)$$



Semi-elliptic. Asymmetrical.

$$A = \frac{1400 \times t^3bn \times L}{L^{a2} \times L^{b2}} \quad (9) \qquad D = \frac{L^a \times L^b}{225\,T} \quad .. \quad ..(11)$$

$$d = \frac{1.6 \times L^{a2} \times L^{b2}}{t^3bn \times L} \quad (10) \qquad W = \frac{0.0445 \times t^2bn \times L}{L^a \times L^b} \quad (12)$$

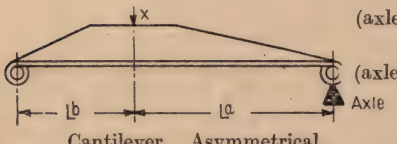


Cantilever. Symmetrical.

$$\text{(axle) } A = \frac{5600 \times t^3bn}{L^3} \quad (13) \qquad \text{(at x) } D = \frac{L^2}{900T} \quad ..(15)$$

$$\text{(axle) } d = \frac{0.4 \times L^3}{t^3bn} \quad (14) \qquad \text{(axle) } D = \frac{L^2}{450T} \quad ..(15A)$$

$$\text{(axle) } W = \frac{0.089 \times t^2bn}{L} \quad .. \quad ..(16)$$

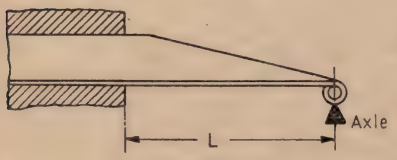


Cantilever. Asymmetrical.

$$\text{(axle) } A = \frac{1400 \times t^3bn}{L^{a2}L^b + L^{a3}} \quad (17) \qquad \text{(at x) } D = \frac{L^a \times L^b}{225T} \quad ..(19)$$

$$\text{(axle) } d = \frac{1.6(L^{a2}L^b + L^{a3})}{t^3bn} \quad (18) \qquad \text{(axle) } D = \frac{L^aL^b + L^{a2}}{225T} \quad (19A)$$

$$\text{(axle) } W = \frac{0.0445 \times L \times t^2bn}{L^a\,L^b + L^{a2}} \quad ..(20)$$



Quarter-elliptic.

$$A = \frac{1120 \times t^3bn}{L^3} \quad ..(21) \qquad D = \frac{5\,L^2}{900\,T} \quad .. \quad ..(23)$$

$$d = \frac{2\,L^3}{t^3bn} \quad .. \quad ..(22) \qquad W = \frac{0.0445 \times t^2bn}{L} \quad (24)$$

PLATE THICKNESSES.

If springs have plates of varying thicknesses, they should all be converted to one selected thickness—with the help of the table below—and "t" taken as the selected thickness. It is always the simplest method to convert thick plates into thin plates. For instance, if a spring has two plates of $\frac{1}{2}$ in., two of $\frac{7}{16}$ in., four of $\frac{3}{8}$ in., and four of $\frac{5}{16}$ in. thickness, it should be converted on the basis of the thickness $\frac{5}{16}$ in. The equivalent plates are taken from the table, as follows:—

1 of $\frac{1}{2}$ in. = 4 of $\frac{5}{16}$ in.	2 of $\frac{1}{2}$ in. = 8
1 of $\frac{7}{16}$ in. = $2\frac{3}{4}$ of $\frac{5}{16}$ in.	2 of $\frac{7}{16}$ in. = $5\frac{1}{2}$
1 of $\frac{3}{8}$ in. = $1\frac{3}{4}$ of $\frac{5}{16}$ in.	4 of $\frac{3}{8}$ in. = 7
	4 of $\frac{5}{16}$ in. = 4
	$24\frac{1}{2}$

Accordingly "t" is taken as $\frac{5}{16}$ in., and "n" as $=24\frac{1}{2}$.

Alternatively, the cubes can be added together, as below:—

1 of $\frac{1}{2}$ in. = 512	$\therefore$ 2 = 1024
1 of $\frac{7}{16}$ in. = 343	$\therefore$ 2 = 686
1 of $\frac{3}{8}$ in. = 216	$\therefore$ 4 = 864
1 of $\frac{5}{16}$ in. = 125	$\therefore$ 4 = 500
Total of cubes	$\therefore$ = 3074, equal to 24.6 plates of $\frac{5}{16}$ in. thickness.

Thickness.	In Sixteenths.	Cubed.	Equivalent to plates.					
			$\frac{1}{4}$"	$\frac{5}{16}$"	$\frac{3}{8}$"	$\frac{7}{16}$"	$\frac{1}{2}$"	$\frac{9}{16}$"
$\frac{1}{4}$	4	64	1	—	—	—	—	—
$\frac{5}{16}$	5	125	2	1	—	—	—	—
$\frac{3}{8}$	6	216	$3\frac{1}{4}$	$1\frac{3}{4}$	1	—	—	—
$\frac{7}{16}$	7	343	$5\frac{1}{2}$	$2\frac{3}{4}$	$1\frac{1}{2}$	1	—	—
$\frac{1}{2}$	8	512	8	4	$2\frac{1}{2}$	$1\frac{1}{2}$	1	—
$\frac{9}{16}$	9	729	$11\frac{1}{2}$	$5\frac{3}{4}$	$3\frac{1}{4}$	2	$1\frac{1}{2}$	1

WEIGHTS OF SPRINGS.

The following formula will be found sufficiently accurate for estimating purposes on the majority of automobile springs:—

Touring Car Types. $$w = \frac{(L + L^s) \times b \times TT}{6.5} \quad .. \quad .. \quad (25)$$

Commercial Vehicles. $$w = \frac{(L + L^s) \times b \times TT}{6} \quad .. \quad .. \quad (26)$$

PHYSICAL CHARACTERISTICS OF VARIOUS FUELS.

Fuel.	A. Specific Gravity at 15° C.	B. Boiling Range. Engler Distillation. 60° %	80° %	100° %	120° %	140° %	160° %	180° %	Final Temp. 0° C.	C. Approximate Composition of Fuel. (Percentage by Weight.) Paraffins. %	Aromatics. %	Naphthenes. %	D. Vapour Pressure at 0° C. mm. of Mercury.	E. Viscosity at 20° C. C.G.S. units.
Aromatic Free Petrol	0.718	1.0	16.0	49.0	72.0	85.0	93.0	—	—	63.0	1.7	35.0	—	0.004
"A" Petrol	0.782	—	—	15.0	54.0	83.0	96.0	—	164.0	26.0	39.0	35.0	28.0	0.005
"B" "	0.723	4.0	37.3	79.0	99.0	—	—	—	126.0	62.0	14.9	23.0	86.0	0.005
"C" "	0.727	—	11.5	47.0	79.0	92.0	98.5	—	160.0	61.0	8.5	30.5	54.0	0.005
"D" "	0.760	—	—	13.0	66.0	89.0	97.5	—	166.0	38.0	14.6	47.0	18.0	0.005
"E" "	0.719	2.0	14.5	43.0	71.0	86.0	96.0	—	170.0	68.0	11.3	20.0	70.0	0.005
"F" "	0.704	1.0	27.0	65.0	86.5	94.5	—	—	153.0	80.0	4.3	15.2	68.0	0.004
"G" "	0.750	—	7.0	24.0	47.0	67.0	81.5	91.0	210.0	—	7.5	—	44.0	0.005
"H" "	0.767	—	—	7.0	55.0	83.0	94.0	—	176.0	10.0	4.8	85.0	17.0	0.006
"I" "	0.727	—	5.0	25.0	50.0	74.0	93.0	—	187.0	—	7.8	—	—	0.005
Heavy Fuels.		160°C. %	180°C. %	200°C. %	220°C. %	240°C. %	260°C. %	280°C. %						
Heavy Aromatics	0.835	8.0	30.0	50.0	65.0	77.0	90.0	—	275.0	—	71.5	—	—	0.007
Kerosene	0.813	—	22.0	36.0	50.0	63.0	76.0	86.0	300.0	—	—	—	—	0.010
Paraffin Series.		Range of Boiling °C.												
Pentane (Normal)	0.624	36.3								100.0 (App.)	—	—	183.0	0.0025
Hexane (80% pure)	0.685	40.0 to 88.0 (Bulk at 68.0)								77.0	2.7	20.0 (App.)	45.0	0.003
Heptane (97% pure)	0.691	98.0								—	<0.5	—	11.5	0.004
Aromatic Series.														
Benzene (pure)	0.884	80.0								Negligible	98.0	Negligible	26.0	0.006
Toluene (99% pure)	0.870	110.0 (App.)								Negligible	99.0	Negligible	9.0	0.006
Xylene (91% pure)	0.862	84.0 to 143 (Bulk at 140.0)								—	91.0	—	—	0.006
Naphthene Series.														
Cyclohexane (93% pure)	0.786	80.8 to 81.0								—	4.6	93.0	27.5	0.006
Hexahydrotoluene (80%)	0.780	95.5 ,, 101.2								—	10.0	78.0	—	—
Hexahydroxylene (60%)	0.744	103.0 ,, 123.0								—	—	60.0	—	—
Olefines.										*Olefines.*				
Cracked Spirit (53% unsat.)	0.757	55.0 to 175.0								53.0	10.0	—	—	—
Alcohol Group, etc.										*Water.*				
Ethyl Alcohol (98.5%)	0.798	78.0 to 100.0								1.5	—	—	12.0	0.012
,, ,, (95 Vol. %)	0.815	78.0 ,, 100.0								7.0	—	—	—	—
Methyl Alcohol (Wood Naphtha)	0.829	66.0+								—	—	—	26.0	0.006
Methylated Spirit	0.821	—								7.0 (App.)	—	—	—	0.010
Butyl Alcohol (Coml.)	0.823	117.0+								—	—	—	—	0.030
Ether (50% in petrol)	0.727	35.0+								2.5 (App.)	—	50.0 Petrol	—	—
Carbon Disulph. (50%)	0.994	46.0+								—	—	50.0 Petrol	—	—

PHYSICAL CHARACTERISTICS OF VARIOUS FUELS (*Continued*).

Fuel.	F. Calorific (lower) Value (exclusive of Latent Heat).		G. Calorific (lower) Value (including Latent Heat at Constant Volume).		H. Heat of Combustion per cubic inch at n.t.p. of Mixture giving complete Combustion foot-lb.	I. Spec. Volume after Combustion ÷ that before Combustion or "Volume Ratio."	J. Total Energy liberated by Combustion per cu. in. at n.t.p. of Mixture giving complete Combustion foot-lb.	K. Air to Fuel Ratio by Weight for complete Combustion.	L. Latent Heat of Evaporation of Fuel (at Constant Pressure atmospheric). B.Th.U. per lb.	M. Fall in Temperature (calculated) of Air-fuel Mixture due to Latent Heat of Evaporation. Deg. C.
	B.Th.U. per lb.	B.Th.U. per gallon.	B.Th.U. per lb.	B.Th.U. per gallon.						
Aromatic Free Petrol	19,080	137,000	19,200	136,200	46.08	1.053	48.5	15.05	133.0	18.0
"A" Petrol	18,450	144,300	18,580	145,200	46.39	1.038	48.15	14.3	142.0	20.0
"B" "	18,890	136,600	19,020	137,500	46.19	1.049	48.45	14.7	140.0	19.0
"C" "	19.000	138,100	19,120	137,000	46.13	1.052	48.53	14.8	135.0	18.5
"D" "	18,770	142,600	18,890	143,500	46.18	1.047	48.35	14.6	132.0	18.3
"E" "	18,970	136,400	19,090	137,100	46.16	1.051	48.51	14.9	132.0	18.2
"F" "	19,130	134,700	19,250	135,500	46.1	1.053	48.54	15.0	134.0	18.2
"G" "	—	—	—	—	—	—	—	—	—	—
"H" "	18,790	144,100	18,920	145,000	46.1	1.048	48.31	14.7	145.0	20.0
"I" "	—	—	—	—	—	—	—	—	—	—
Heavy Fuels.										
Heavy Aromatics	17,900 (App.)	158,500 (App.)	18,030	159,600	46.66	1.04	48.52	13.8	136.0	19.8
Kerosene	19,000 (App.)	154,400 (App.)	19,100	155,200	46.14	1.06	48.91	15.0	108.0	14.5
Paraffin Series.										
Pentane (Normal)	19,600	122,300	19,740	123,100	46.25	1.051	48.7	15.25	154.0	21.0
Hexane (80% pure)	19,250	131,900	19,390	132,900	46.0	1.051	48.35	15.2	156.0	21.0
Heptane (97% pure)	19,300	132,800	19,420	134,100	46.06	1.056	48.64	15.1	133.0	18.0
Aromatic Series.										
Benzene (pure)	17,302	152,950	17,460	154,200	46.9	1.013	47.51	13.2	172.0	26.0
Toluene (99% pure)	17,522	152,500	17,660	153,600	46.9	1.023	47.98	13.4	151.0	22.5
Xylene (91% pure)	17,800	153,500	17,930	154,500	46.7	1.03	48.1	13.6	145.0	21.5
Naphthene Series.										
Cyclohexane (93% pure)	18,800	147,800	18,940	149,000	46.08	1.044	48.11	14.7	156.0	21.5
Hexahydrotoluene (80%)	18,760	146,200	18,890	147,200	46.04	1.047	48.2	14.7	138.0	19.0
Hexahydroxylene (60%)	18,770 (App.)	139,700 (App.)	18,890	140,600	46.1	1.054	48.59	14.8	133.0	18.0
Olefines.										
Cracked Spirit (53% unsat.)	18,400 (App.)	139,400 (App.)	18,540	140,200	47.0	1.054	49.54	14.8 (App.)	150.0 (App.)	20.8
Alcohol Group, etc.										
Ethyl Alcohol (98.5%)	11,480	91,600	11,840	94,500	44.5	1.065	47.39	8.9	406.0	85.0
" " (95 Vol. %)	10,790	88,000	11,130	92,000	44.0	1.065	46.86	8.4	442.0	98.0
Methyl Alcohol (Wood Naphtha)	9,630	79,900	10.030	83,300	45.5 (App.)	1.06 (App.)	48.2 (App.)	6.5	500.0 (App.)	140.0
Methylated Spirit	10,200	83,700	10,580	86,900	44.0	1.064	46.82	8.0 (App.)	450.0 (App.)	110.0
Butyl Alcohol (Coml.)	—	—	—	—	—	—	—	—	—	—
Ether (50% in petrol)	16,700 (App.)	121,300 (App.)	16,830	122,500	46.4	1.06	49.2	13.0	146.0 (App.)	22.0
Carbon Disulph. (50%)	10,600	105,400	10,730	106,600	40.2	0.98	39.4	10.8	146.0	27.0

EXPERIMENTAL RESULTS WITH VARIOUS FUELS.

Fuel.	A. Highest Useful Compression Ratio. Total Vol./ Clearance Vol.	B. Compression Pressure at Highest Useful Compression (calculated). lb. per sq. in.	C. Compression Temp. at Highest Useful Compression (calculated). Deg. C.	D. Toluene Value. Toluene=100% Aromatic Free Petrol=0.%.	E. Minimum Consumption at Compression Ratio of 5 : 1 per I.H.P.-Hour.		F. Minimum Consumption at Highest Useful Compression per I.H.P.-Hour.		G. Thermal Efficiency at Compression Ratio of 5 : 1. Per cent.	H. Thermal Efficiency at Highest Useful Compression. Per cent.
					lb.	Pints.	lb.	Pints.		
Aromatic Free Petrol	4.85	105.5	392.0	0	0.415*	0.462*	0.422	0.471	31.9*	31.4
"A" Petrol	6.0	148.5	430.0	38.0	0.432	0.442	0.393	0.402	31.7	34.9
"B" "	5.7	133.5	422.0	28.0	0.423	0.468	0.393	0.435	31.7	34.1
"C" "	5.25	118.0	407.0	13.5	0.421	0.463	0.410	0.451	31.6	32.5
"D" "	5.35	121.5	410.0	16.5	0.422	0.445	0.407	0.428	31.9	33.1
"E" "	4.7	100.5	387.0	−5.0	0.421*	0.469*	0.435	0.484	31.7*	30.7
"F" "	5.05	111.5	400.0	6.5	0.414	0.471	0.412	0.469	31.9	32.1
"G" "	4.55	96.0	381.0	−10.0	0.426	0.454	0.449	0.478	—	—
"H" "	5.9	140.5	428.0	35.0	0.425	0.443	0.389	0.405	31.7	34.6
"I" "	4.3	89.0	372.0	−20.0	0.418*	0.460*	0.457	0.503	—	—
Heavy Fuels.										
Heavy Aromatics	6.5	163.5	438.0	55.0	0.510	0.461	0.447	0.404	27.6	31.5
Kerosene	4.2	86.0	369.0	−22.0	0.523*	0.515*	0.581	0.571	25.4*	22.9
Paraffin Series.										
Pentane (Normal)	5.85	138.5	426.0	33.0	—	—	—	—	—	—
Hexane (80% pure)	5.1	113.5	401.0	8.0	0.411	0.480	0.405	0.473	32.0	32.4
Heptane (97% pure)	3.75	72.0	353.0	−37.0	0.410*	0.475*	0.491	0.568	31.9*	26.7
Aromatic Series.										
Benzene (pure)	6.9†	179.0	450.0	67.0	0.458	0.415	0.392	0.355	31.8	37.2
Toluene (99% pure)	>7.0	>183.0	>452.0	100.0	0.455	0.418	0.385	0.354	31.7	37.5
Xylene (91% pure)	>7.0	>183.0	>452.0	85.0	0.452	0.420	0.381	0.354	31.4	37.3
Naphthene Series.										
Cyclohexane (93% pure)	5.9†	140.5	427.0	35.0	0.420	0.427	0.385	0.392	31.9	34.9
Hexahydrotoluene (80%)	5.8	136.5	425.0	31.5	0.425	0.430	0.394	0.404	31.7	34.3
Hexahydroxylene (60%)	4.9	107.0	394.0	1.5	0.424*	0.456*	0.429	0.461	31.8*	31.5
Olefines.										
Cracked Spirit (53% unsat.)	5.55	128.0	416.0	23.5	0.429	0.453	0.405	0.428	32.0	33.9
Alcohol Group, etc.										
Ethyl Alcohol (98%)	>7.5	>204.0	>424.0	>88.0	0.663	0.665	0.532	0.533	32.4	40.4
" " (95 Vol. %)	>7.5	>204.0	>420.0	>88.0	0.705	0.692	0.565	0.555	32.5	40.5
Methyl Alcohol (Wood Naphtha)	5.2†	116.5	342.0*	—	0.777	0.750	0.725	0.700	32.7	35.1
Methylated Spirits	6.5†	>163.5	382.0*	—	0.740	0.721	0.625	0.609	32.5	38.5
Butyl Alcohol (Coml.)	7.3	195.0	—	80.0	0.566	0.550	0.472	0.459	—	—
Ether (50% in petrol)	3.9	77.0	350.0	(−32.0)	—	—	—	—	—	—
Carbon Disulph. (50%)	5.15†	115.0	390.0	(9.0)	—	—	—	—	—	—

Note. † This sign indicates that pre-ignition occurred before audible detonation.

* This sign indicates that the values are only calculated, since these fuels could not be tested at a compression ratio of 5 : 1 owing to detonation. The values have been inserted to show the efficiency and power obtained relatively to the other fuels if used at the same compression.

EXPERIMENTAL RESULTS WITH VARIOUS FUELS (*Continued*).

Fuel.	I. Max. Ind. M. E. P. at Compression Ratio of 5 : 1. Heat 65 B.Th.U./Min. lb. per sq. in.	J. Max. Ind. M. E. P. at Highest Useful Compression. Heat 65 B.Th.U./Min. lb. per sq. in.	K. Max. Ind. M. E. P. at Highest Useful Compression. No Heat. lb. per sq. in.	L. Rise or Fall of Temp. in Induction Pipe (indicating app. Mean Volatility). Heat 65 B.Th.U./Min. Deg. C.	M. Relative Thermal Efficiency (compared with that obtained with Toluene).		N. Relative I.M.E.P. (compared with that obtained with Toluene).	
					At the same Compression Ratio. Per cent.	At Highest Useful Compression. Per cent.	At the same Compression Ratio. Per cent.	At Highest Useful Compression. Per cent.
Aromatic Free Petrol	131.3*	130.0	138.1	+10.0	100.0 (App.)	83.7	100.0 (App.)	88.4
"A" Petrol	131.2	140.1	148.5	+11.0	100.0 (App.)	93.0	100.0 (App.)	95.3
"B" "	131.5	137.5	146.0	+ 3.0	100.0 (App.)	91.0	100.0 (App.)	93.5
"C" "	131.0	133.9	142.4	+ 7.0	100.0 (App.)	86.7	100.0 (App.)	91.0
"D" "	131.2	134.9	142.9	+11.0	100.0 (App.)	88.3	100.0 (App.)	91.7
"E" "	131.0*	128.6	136.7	+10.5	100.0 (App.)	81.8	100.0 (App.)	87.5
"F" "	131.8	132.7	140.5	+ 5.3	100.0 (App.)	85.6	100.0 (App.)	90.2
"G" "	131.5*	127.4	135.4	+18.0	—	—	100.0 (App.)	86.6
"H" "	131.0	139.5	147.8	+12.0	100.0 (App.)	92.2	100.0 (App.)	94.8
"I" "	131.7*	125.1	132.5	+14.0	—	—	100.0 (App.)	85.0
Heavy Fuels.								
Heavy Aromatics	131.1	142.5	—	+28.0	86.0	84.0	100.0 (App.)	96.9
Kerosene	130.7*	123.0	—	+31.0	80.0	61.2	99–100	83.6
Paraffin Series.								
Pentane (Normal)	131.3	139.0	—	—	—	—	100.0 (App.)	94.5
Hextane (80% pure)	132.3	133.1	141.2	0	100.0 (App.)	86.4	100.0 (App.)	90.5
Heptane (97% pure)	131.2*	119.5 at 3.8 : 1	125.5	+ 5.5	100.0 (App.)	71.2	100.0 (App.)	80.5
Aromatic Series.								
Benzene (pure)	131.6	146.5	156.0	— 7.3	100.0 (App.)	99.2	100.0 (App.)	99.7
Toluene (99% pure)	131.5	147.0 at 7.0 : 1	156.3	+ 8.0	100.0 (App.)	100.0	100.0 (App.)	100.0
Xylene (91% pure)	131.5	146.8 at 7.0 : 1	156.1	+18.0	100.0 (App.)	99.5	100.0 (App.)	99.9
Naphthene Series.								
Cyclohexane (93% pure)	131.3	139.0	148.0	— 3.0	100.0 (App.)	93.0	100.0 (App.)	94.6
Hexahydrotoluene (80%)	131.0	137.9	146.6	+ 3.0	100.0 (App.)	91.5	100.0 (App.)	93.9
Hexahydroxylene (60%)	130.8*	130.0	138.1	+13.5	100.0 (App.)	84.0	100.0 (App.)	88.4
Olefines.								
Cracked Spirit (53% unsat.)	131.6	136.0	145.4	+10.5	100.0 (App.)	84.0	100.0 (App.)	92.5
Alcohol Group, etc.								
Ethyl Alcohol (98%)	137.8	156.5 at 7.5 : 1	165.5	+ 1.5	102.0	107.9	105.0	106.4
" " (95 Vol. %)	142.0	161.2 at 7.5 : 1	170.0	+ 2.0	102.5	108.1	108.0	109.8
Methyl Alcohol (Wood Naphtha)	144.8	146.6	153.9	— 8.5	103.0	93.5	110.0	99.7
Methylated Spirits	144.5	155.5	165.0	— 1.0	102.5	102.7	110.0	105.8
Butyl Alcohol (Coml.)	138.0	156.0	164.5	+10.0	—	—	105.0	106.0
Ether (50% in petrol)	136.0*	125.0	132.5	+ 1.0	—	—	103.5	85.0
Carbon Disulph. (50%)	124.5	125.7	136.3	— 7.0	—	—	94.7	85.5

* This sign indicates that the values are only calculated, since these fuels could not be tested at a compression ratio of 5 : 1 owing to detonation. The values have been inserted to show the efficiency and power obtained relatively to the other fuels if used at the same compression.

TESTS OF MOTOR FUELS ON A RICARDO VARIABLE COMPRESSION ENGINE.

	Highest Useful Compression Ratio.	B.M.E.P.	I.M.E.P.	B.H.P.	I.H.P.	Pints per I.H.P. Hour.	Ignition Advance, degrees.	Speed r.p.m.
Petrol (No. 1):—								
Red Line Super	5.05	125.9	142.7	30.70	34.80	0.518	35	1,508
Shell	4.76	121.9	139.2	29.55	33.76	0.519	37	1,498
Pratts' Perfection	4.61	118.1	135.2	28.72	32.85	0.498	38	1,500
Glico	4.54	118.2	135.8	28.19	32.38	0.533	37	1,471
Russian Oil Products (No. 3)	4.52	119.0	136.2	28.90	33.15	0.515	37	1,500
British Petroleum	4.46	118.5	135.8	28.80	33.00	0.529	35	1,500
Blue Bird Private	4.39	113.8	131.0	27.48	31.58	0.561	37	1,490
Dominion	4.315	116.0	133.5	28.00	32.15	0.546	39	1,488
Anti-knock Mixtures:—								
Pratts' Ethylised Petrol	5.25–5.34	128.2	145.4	32.18	36.41	0.467	37	1,549
Red Line Benzole Mixture	5.14	126.0	143.0	30.78	34.98	0.486	39	1,509
Pratts' Benzole Mixture	4.98	124.2	141.2	30.05	34.20	0.521	32	1,493
National Benzole Mixture	4.875	124.3	142.0	30.15	34.40	0.493	34	1,498
Commercial Petrols:—								
Red Line Commercial	5.03	123.0	140.0	29.38	33.42	0.528	37	1,475
Pratts' Gasoline	4.655	119.0	136.0	28.80	32.90	0.542	37	1,493
Mex No. 3	4.63	119.2	136.3	28.59	32.72	0.503	37	1,480
Blue Bird No. 3	4.59	118.1	135.2	29.20	33.40	0.515	37	1,526
British Petroleum No. 3	4.46	115.6	132.8	28.40	32.61	0.521	37	1,517

CONDITIONS OF ENGINE TESTS.—Heat input to air intake, 750 watts. Ignition adjusted to give maximum power and checked by diagram produced by R.A.E. indicator before proceeding to actual determination of the Highest Useful Compression Ratio. Jacket water maintained between 57 and 60 deg. C.

PETROLS (No. 1).

Engler Distillation.	Red Line Petrol.	Shell Petrol.	Pratts' Petrol.	Glico.	R.O.P. (No. 3).	B.P. Petrol.	Blue Bird Private.	Dominion.
S.G. at 60/60 F.	0.7825	0.7295	0.734	0.7365	0.7585	0.727	0.7315	0.729
	Deg. C.	Deg. C.	Deg. C.	Deg. C.	Deg. C.	Deg. C.	Deg. C.	Deg. C.
First Drop (side arm)	35	32	36	39	54	42	40	36
First Drop (end of condenser)	39	30	39	43	72	47	44	42
1% over at	46	45	50	54	86	58	58	55
2% "	49	48	53	58	89	62	63	59
5% "	57	55	60	66	94	67	69	66
10% "	66	63	68	74	100	73	77	72
20% "	80	77	81	90	107	83	89	85
30% "	92	91	92	103	114	93	100	96
40% "	102	104	102	113	119	101	109	105
50% "	112	115	112	122	126	110	118	114
60% "	121	127	121	132	133	118	127	125
70% "	131	139	132	142	141	128	138	136
80% "	144	154	144	153	151	139	150	148
90% "	165	177	163	169	166	157	166	165
95% "	—	—	—	186	180	173	182	183
Dry Point	181	193	183	190	202	180	192	186
Colour of Residue	Very Pale Lemon Yellow	Pale Brownish Yellow	Pale Brownish Yellow	Yellow	Brownish Yellow	Pale Lemon Yellow	Yellow	Yellow
Approximate analysis:—	% wt.	% wt.	% wt.	% wt.	% wt.	% wt.	% wt.	% wt.
Aromatics	5.7	7.4	6.7	Nil	4.8	11.9	4.4	5.9
Napthenes	—	—	—	20.5	37.3	—	21.9	25.0
Unsaturateds	—	—	—	17.9	1.0	—	3.4	1.4
Paraffins (by difference)	—	—	—	61.6	56.9	—	70.3	67.7
Copper strip test for "Free" Sulphur	Good	Very Bad	Very Bad	Very Bad	Very Bad	Very Bad	Very Bad	Very Bad

Engler Distillation.	ANTI-KNOCK MIXTURES.				COMMERCIAL PETROLS.				
	Pratts' Ethylised Petrol.	Red Line Benzole Mixture.	Pratts' Benzole.	National Benzole Mixture.	Red Line Commercial.	Pratts' Gasoline.	Mex No. 3.	BlueBird No. 3.	British Petroleum No. 3.
S.G. at 60/60 F.	0.7305	0.760	0.768	0.774	0.7475	0.735	0.742	0.7525	0.7405
First Drop (side arm)	Deg. C. 40	Deg. C. 39	Deg. C. 37	Deg. C. 42	Deg. C. —	Deg. C. 37	Deg. C. 36	Deg. C. 43	Deg. C. 39
First Drop (end of condenser)	46	42	46	53	35	41	40	59	47
1% over at	55	53	58	66	49	52	50	74	59
2% "	59	57	63	69	55	56	55	80	63
5% "	65	65	69	73	64	63	63	86	69
10% "	72	74	75	78	75	72	72	93	76
20% "	84	87	83	85	93	86	87	103	87
30% "	95	97	91	92	107	98	100	110	97
40% "	106	105	97	98	117	108	110	117	106
50% "	116	115	104	106	128	119	120	123	116
60% "	125	127	115	117	139	128	131	131	126
70% "	136	142	129	132	152	139	142	139	137
80% "	146	158	143	150	165	150	154	149	149
90% "	163	177	161	170	184	165	172	164	167
95% "	177	195	177	187	—	181	191	180	184
Dry Point	186	195	186	199	195	189	198	195	193
Colour of Residue	—	—	Yellow	Brownish Yellow	Pale Yellow	Yellow	Yellow	Yellow	Yellow
Approximate analysis :—	% wt.	% wt.	% wt.	% wt.	% wt.	% wt.	% wt.	% wt.	% wt.
Aromatics	5.3	17.4	23.4	34.2	6.3	Nil.	9.3	5.0	13.2
Napthenes	12.5	35.6	24.4	—	39.5	22.2	29.7	35.0	20.3
Unsaturateds	12.2	1.1	7.4	—	1.3	17.6	1.8	0.8	0.7
Paraffins (by difference)	70.0	45.9	44.8	—	52.9	60.2	59.2	59.2	65.8
Copper strips test for "Free" Sulphur	Very bad	Fair	Very bad	Very bad	Good	Very bad	Very bad	Very bad	Very bad

TABLE OF KILOGRAMME CALORIES, EQUIVALENT TO BRITISH THERMAL UNITS.

British Thermal.	0	1	2	3	4	5	6	7	8	9	British Thermal.
0	—	.252	.504	.756	1.008	1.260	1.512	1.764	2.016	2.268	0
10	2.52	2.772	3.024	3.276	3.528	3.780	4.032	4.284	4.536	4.788	10
20	5.04	5.292	5.544	5.796	6.048	6.300	6.552	6.804	7.056	7.308	20
30	7.56	7.812	8.064	8.316	8.568	8.820	9.072	9.324	9.576	9.828	30
40	10.08	10.332	10.584	10.836	11.088	11.340	11.592	11.844	12.096	12.348	40
50	12.60	12.852	13.104	13.356	13.608	13.860	14.112	14.364	14.616	14.868	50
60	15.12	15.372	15.624	15.876	16.128	16.380	16.632	16.884	17.136	17.388	60
70	17.64	17.892	18.144	18.396	18.648	18.900	19.152	19.404	19.656	19.908	70
80	20.16	20.412	20.664	20.916	21.168	21.420	21.672	21.924	22.176	22.428	80
90	22.68	22.932	23.184	23.436	23.688	23.940	24.192	24.444	24.696	24.948	90
British Thermal.	0	1	2	3	4	5	6	7	8	9	British Thermal.

1 British thermal unit = 251.996 therms or gramme calories.

ENGLISH-FRENCH DICTIONARY.

ENGLISH.	FRENCH.
Above.	Au dessus.
Accelerate (to).	Accélérer.
Accelerator.	Accélérateur.
Accelerator pedal.	Pédale d'accélérateur.
Access.	Accès.
Accessible.	Accessible.
Accessories.	Accessoires.
Accident.	Panne.
Account (on).	à compte.
Account-payment.	Versement à compte.
Accumulator.	Accumulateur.
Acetylene.	Acetylène.
Acetylene lamp.	Lanterne acetylène.
Acetylite.	Acetylithe.
Acid.	Acide.
Act (to).	Agir.
Adapt (to).	Adapter.
Adjust (to).	Ajuster.
Adjusting screw.	Vis de réglage.
Adjustment.	Ajustage.
Admission.	Admission.
Admission port.	Lumière d'admission.
Admission valve.	Soupape d'admission.
Advance fire.	Avance à l'allumage.
Advance-sparking.	Avance à l'allumage.
Agent.	Agent.
Air.	Air.
Air bound.	Etanché.
Air cooling.	Refroidissement par air.
Air inlet.	Admission d'air.
Air lock.	Poche d'air.
Air pump.	Pompe à air ; gonfleur.
Air supply.	Supplément d'air.
Air tube.	Chambre à air.
Air valve.	Soupape d'air.
Alcohol.	Alcool.
Alignment.	Alignement.
Alloy.	Alliage ; composition.
Alternate.	Alternatif.
Alternating current.	Courant alternatif.
Aluminium.	Aluminium.
Ampère.	Ampère.
Ampère hour.	Ampère heure.
Ampère meter.	Ampèremètre.
Anchor.	Ancre.
Angle.	Angle.
Angle iron.	Fer en angle ; cornière.
Angle sheet-iron.	Tôle en angle.
Anneal (to).	Tempérer ; recuire.
Annular valve.	Soupape annulaire.
Antagonistic.	Antagonistique.
Anti-bouncer.	Amortisseur de choc.
Anti-freezing solution.	Solution anti-réfrigerante.
Anti-rust.	Anti-rouille.
Anti-slipping device.	Antidérapant.
Anvil.	Enclume.
Apart (to take).	Démonter.
Apparatus.	Appareil.
Apron.	Tablier.
Armature.	Armature.
Armature drum.	Tambour d'armature.
Arm file.	Carreau.
Artillery wheel.	Roue type d'artillerie.
Asbestos.	Amiante.
Asbestos cloth.	Toile d'amiante.
Ascend (to).	Monter.
Ascent.	Montée.
Assemble (to).	Monter.
Assist (to).	Assister ; aider.
Assistance.	Aide ; secours.
Atmospheric valve.	Soupape atmosphérique.
Atomiser.	Pulvérisateur.
Auger.	Tarrière.
Auto-induction.	Admission automatique.
Automatic.	Automatique.
Automatic valve.	Soupape automatique.
Automobile.	Voiture ; automobile.
Automobile (small).	Voiturette.
Automobile frame.	Chassis.
Automobilism.	Automobilisme.
Auto-trembler.	Trembleur automatique.
Auxiliary.	Auxiliare.
Average.	Moyenne.
Axle.	Essieu.
Axle bearing.	Fusée.
Axle cap.	Chapeau d'essieu.
Axle casing.	Enveloppe d'essieu.
Axle end.	Tourillon.
Axle sleeve.	Manchon d'essieu.
Backfire.	Explosion prématurée.
Backlash.	Jeu.
Back nut.	Contre ecrou.
Back pressure.	Contre pression.
Bad.	Mal, Mauvais.
Bad luck.	Malheur.
Baffle plate.	Chicane.
Bag.	Sac ; nécessaire.
Baggage.	Bagage.
Balance.	Balance ; équilibre.
Balance (to).	Equilibrer.
Ball.	Bille.
Balladeur train.	Train balladeur.
Ball and socket joint.	Joint sphérique.
Ball bearing.	Roulement à billes.
Ball race.	Cuvette à billes.
Ball thrust.	Butée à billes.
Ball valve.	Soupape à bille.
Band.	Ruban.
Band brake.	Frein à ruban.
Bar.	Barre.
Base bearing.	Palier.
Base chamber.	Chambre de moteur.
Basket.	Panier.
Bustard file.	Lime bâtarde.
Bath.	Bain.
Battery.	Batterie ; pile.
Bearing.	Coussinet.
Beginner.	Novice.
Bellows.	Soufflet.
Belt.	Courroie.
Belt drive.	Transmission par courroie
Belt pulley.	Poulie de courroie.
Belt shifter.	Fourchette de courroie.
Bend.	Courbure : plier.
Bent sheet-iron.	Tôle courbée.
Benzene.	Benzine.
Benzole.	Benzole.
Benzoline.	Benzoline.
Bevel.	Biseau.
Bevel gear.	Engrenage cônique.
Bevel gear drive.	Transmission à pignon cônique.
Bevel pinion.	Pignon cônique.
Bevel wheel.	Roue cônique.
Big end.	Tête de bielle.
Bill of lading.	Documents de transport.
Binding screw.	Serre fil.
Bit.	Mèche.
Black.	Noir.
Blacklead.	Plombagine, graphite.
Blacksmith.	Forgeron.
Blade.	Lame.
B ock.	Bloc.
Blow-back.	Retour de gaz.
Blow-lamp.	Lampe à souder.
Blow-off cock.	Robinet de vidange.
Blow-off pipe.	Tuyau purgeur.
Blow-off valve.	Soupape de purge.
Blow pipe.	Chalumeau à bouche.
Blue.	Bleu.
Board.	Planche.
Bobbin.	Bobine.
Body (car).	Carrosserie.

ENGLISH.	FRENCH.
Boil (to).	Bouillir.
Boiled linseed oil.	Huile de lin cuite.
Boiler.	Chaudière.
Boiling point.	Point d'ébullition.
Bolt.	Boulon.
Bolts and nuts.	Boulons et écrous.
Bonnet.	Capot.
Bore.	Alésage.
Bore (to).	Creuser ; percer ; forer.
Borer.	Foret ; percoir.
Boring machine.	Aléseuse.
Bosch ignition.	Magneto Bosch.
Bowden wire.	Câble flexible Bowden.
Box.	Caisse ; boîte.
Box seat.	Siège de conducteur.
Box spanner.	Clef à douille.
Brace.	Gousset.
Bracket.	Gousset.
Brake.	Frein.
Brake band.	Bande de frein.
Brake block.	Sabot du frein.
Brake clutch.	Machoire de frein.
Brake drum.	Tambour de frein.
Brake handle.	Manette de frein.
Brake lever.	Levier de frein.
Brake pedal.	Pédale de frein.
Brake pulley.	Poulie de frein.
Brake rod.	Tige de frein.
Brake shoe.	Sabot du frein.
Brake spring.	Ressort de frein.
Brand.	Marque.
Brass.	Cuivre jaune.
Brasses.	Coussinets.
Braze (to).	Braser.
Brazing.	Brazure.
Break.	Rupture.
Break (to).	Casser.
Breakdown.	Panne.
Bridge.	Pont.
Bridge-piece.	Culotte.
Brittle.	Fragile.
Bronze.	Bronze.
Brown.	Brun ; brune.
Brown paper packing.	Emballage en papier brun.
Brush.	Brosse ; balais.
Brush-holder.	Porte-balais.
Buckle.	Boucle.
Buckling.	Gauchissement.
Buffer.	Tampon.
Bulk.	Volume.
Burn (to).	Brûler.
Burner.	Brûleur.
Burner wick.	Mèche.
Bush ; bushing.	Coussinet.
Butterfly-nut.	Ecrou à oreilles.
Butterfly or throttle valve.	Soupape à papillon.
By-pass.	Robinet à deux voies.
Cable-rope.	Câble.
Calcium carbide.	Carbure de calcium.
Callipers.	Compas.
Caloric.	Calorique.
Cam.	Came.
Cams.	Cames.
Cambered live axle.	Essieu moteur arquée.
Cambered wheel.	Roue arquée.
Camshaft.	Arbre à cames.
Can (small).	Burette.
Can (large).	Bidon.
Candle.	Bougie.
Canopy top.	Dais ; capote à baldaquin.
Cap.	Chape.
Capacity.	Capacité.
Capacity, cyclinder.	Cylindrée.
Cape chisel.	Burin.
Cape top.	Capote pliante.
Capillary.	Capillaire.
Capsule.	Capsule.
Car (large).	Voiture.
Car (small).	Voiturette.
Carburation.	Carburation.
Carburator.	Carburateur.
Carburetted air.	Air carburé.
Carburetter.	Carburateur.
Car frame.	Chassis.
Cardan axle.	Arbre de cardan.
Cardan joint.	Joint de cardan.
Cardan shaft.	Arbre de cardan.
Carriage step.	Marchepied.
Carrier.	Portée.
Carrosserie.	Carrosserie.
Case.	Boîte.

ENGLISH.	FRENCH.
Case-harden.	Cémenter.
Cash.	Comptant.
Cast (to).	Fondre.
Casting.	Fonte ; moulage.
Cast-iron.	Fonte.
Castle-nut.	Ecrou à crans.
Catalytic ignition.	Allumage catalytique.
Catch.	Dent de loup.
Caulk (to).	Boucher.
Cell.	Pile.
Celluloid.	Celluloid.
Centre.	Centre.
Centre-bit.	Mèche anglaise.
Centre-punch.	Amorcoir.
Centrifugal.	Centrifuge.
Centrifugal force.	Force centrifuge.
Centrifugal pump.	Pompe centrifuge.
Centrifugal regulator.	Regulateur centrifuge.
Certificates.	Certificats.
Chain.	Chaîne.
Chain drive.	Transmission à chaîne.
Chain gearing.	Engrenage à chaîne.
Chain link.	Maillon ; anneau de chaîne.
Chain ring.	Pignon de chaîne.
Chain rivet.	Rivet de chaîne.
Chain wheel.	Hérisson ; roue de chaîne.
Chamber.	Chambre.
Chamfered.	Chamfreiné.
Change.	Changement.
Change of speed.	Changement de vitesse.
Change speed gear.	Engrenage de changement.
Channel.	Conduit.
Channel-iron.	Fer à U.
Charcoal.	Charbon de bois.
Charge (to).	Charger.
Charge.	Charge.
Charges.	Frais.
Charging accumulators.	Charger les accumulateurs.
Charging station.	Station de charge.
Chaser.	Filière à vis.
Chassis.	Châssis.
Chauffeur.	Chauffeur.
Check valve.	Soupape d'arrêt.
Cheese-head bolt.	Boulon à tête ronde.
Chisel.	Ciseau ; tranche ; burin.
Chisel (to).	Ciseler, buriner.
Chromic acid.	Acide chromique.
Circuit.	Circuit.
Circuit (closing of).	Fermeture de circuit.
Circuit (short).	Court circuit.
Circulating pump.	Pompe à circulation.
Circulation.	Circulation.
Clack valve.	Soupape à clapet.
Clamp.	Crampon.
Clamp (to).	Assembler ; emboîter.
Clamping-piece.	Griffe.
Claw.	Griffe.
Claw coupling.	Accouplement à griffe.
Clean (to).	Nettoyer.
Cleaning.	Nettoyage.
Clip.	Eclisse ; attache.
Clogged tubes.	Tubes bouchés.
Clothing.	Habits.
Clutch.	Cône d'embrayage.
Clutch cam.	Came d'embrayage.
Clutch cone.	Cône d'embrayage.
Clutch coupling.	Accouplement d'embrayage.
Clutch lever.	Levier d'embrayage.
Clutch pedal.	Pédale d'embrayage.
Clutch shaft.	Arbre d'embrayage.
Clutch spring.	Ressort d'embrayage.
Clutch stop.	Arrêt d'embrayage.
Coal.	Charbon.
Cock.	Robinet.
Cog.	Dent.
Cog wheel.	Roue dentée ; pignon.
Coil.	Bobine.
Coil clutch.	Embrayage à spirale.
Cold.	Froid.
Cold chisel.	Burin à froid.
Collar.	Col ; collier.
Collar bearing.	Coussinet à collier.
Colour.	Couleur.
Combustible.	Combustible.
Combustion.	Combustion.
Combustion chamber.	Chambre de combustion.
Command (to).	Commander.
Commutator.	Interrupteur commutateur.
Compartment.	Compartiment.
Compensating gear.	Engrenage différentiel.
Complicated.	Compliqué.
Compound engine.	Machine composé.

ENGLISH.	FRENCH.
Compress (to).	Comprimer.
Compression.	Compression.
Compression stroke.	Temps de compression.
Compression tap.	Robinet de compression.
Compression valve.	Soupape de compression.
Compound bearing.	Coussinet composé.
Condenser.	Condenseur.
Conductibility.	Conductibilité.
Conducting wire.	Fil conducteur.
Conductor.	Conducteur.
Cone.	Cône.
Cone bearing.	Coussinet à cône.
Cone clutch.	Embrayage à cône.
Cone pulley.	Poulie à cône.
Conical valve.	Soupape conique.
Connect (to).	Embrayer; relier.
Connecting plug.	Cheville de contact.
Connecting rod.	Bielle.
Connection.	Embrayage; connexion; liaison.
Construction.	Construction.
Consume (to).	Dépenser; consommer.
Contact.	Contact.
Contact arm or lever.	Doigt de contact.
Contact breaker.	Interrupteur.
Contact maker.	Paillette de contact.
Contact points.	Pointes de contact.
Contact screw.	Vis de contact.
Contact spring.	Lame de contact.
Contact surface.	Surface de contact.
Contents.	Contenu.
Continuous current.	Courant continu.
Contracting clutch.	Embrayage de contraction.
Controle.	Contrôle.
Cool (to).	Refroidir.
Cooling.	Refroidissement.
Copper.	Cuivre rouge.
Copper wire.	Fil de cuivre.
Cord.	Corde.
Core.	Noyeau.
Corner.	Coin.
Corrosive.	Corrosif.
Cost.	Frais.
Cotter.	Clavette.
Cotter-pin.	Goupille.
Column.	Colonne.
Counterbalance (to).	Equilibrer.
Counter pressure.	Contre pression.
Counter-shaft.	Contre arbre.
Countersunk bolt.	Boulon noyé.
Countersunk screw.	Vis noyée.
Counter-weight.	Contrepoids.
Coupling.	Accouplement.
Coupling box.	Cartouche; manchon.
Coupling lever.	Levier d'embrayage.
Coupling rod.	Bielle d'accouplement.
Cover.	Enveloppe; couvercle.
Cover (to).	Couvrir.
Crack.	Fente.
Crane.	Grue; chèvre.
Crank.	Manivelle.
Crank case.	Carter de vilebrequin.
Crank pin.	Boulon de manivelle.
Crankshaft.	Arbre manivelle; vilebrequin.
Crate.	Caisse à claire voie.
Crossbar.	Traverse.
Cross-cut chisel.	Bec d'âne (bédane).
Crossed belt.	Courroie croisée.
Cross-head.	Tête de bielle.
Cross-shaft.	Arbre transversal.
Crowbar.	Levier.
Crypto (or epicyclic gear).	Engrenage épicycloïdal.
Culasse.	Culasse.
Cup.	Cuvette.
Current.	Courant.
Current meter.	Ampèremètre.
Curtain.	Rideau.
Curve (road).	Virage.
Cushion.	Coussin.
Custom house.	Douane.
Custom house official.	Douanier.
Cut (to).	Couper.
Cut-out.	Coupe-circuit.
Cycle.	Cycle; bicyclette.
Cyclometer.	Compteur.
Cylinder.	Cylindre.
Cylinder bore.	Alèsage du cylindre.
Cylinder capacity.	Cylindrée.
Cylinder cover.	Couvert de cylindre.
Cylinder head.	Culasse.
Cylindrical wheel.	Roue cylindrique.

ENGLISH.	FRENCH.
Damper.	Amortisseur.
Danger.	Danger.
Dashboard.	Tablier.
Dashpot.	Amortisseur.
Davy lamp.	Lampe de Davy.
Daylight.	Jour.
Dead centre.	Point mort.
Dealer.	Marchand.
Defect.	Défaut.
Defective.	Défectueuse.
Degree.	Grade; dégré.
Delayed explosion.	Explosion retardée.
Delayed firing.	Allumage retardé.
Delivery.	Livraison.
Delivery valve.	Soupape de refoulement.
Demagnetisation.	Désaimantation.
Dense.	Dense.
Densimeter or hydrometer.	Densimètre.
Density.	Densité.
Depolarisation.	Dépolarisation.
Depolariser.	Dépolariser.
Design.	Dessin.
Destination.	Destination.
Detach (to).	Détacher; enlever.
Details.	Détails.
Detour.	Détour.
Develop (to).	Developper.
Diameter.	Diamètre.
Diaphragm.	Diaphragm.
Die.	Dé.
Dies.	Machoire de filière.
Difference.	Différence.
Differential.	Différentiel.
Differential gear.	Engrenage différentiel.
Differential pinion.	Pignon différentiel.
Diminish (to).	Diminuer.
Direct.	Direct.
Direction.	Direction.
Dirt.	Saleté.
Dirty.	Sale.
Disc.	Disque.
Discharge.	Décharge.
Discharge (to).	Décharger.
Disconnect (to).	Débrayer.
Disconnection.	Débrayage.
Discount.	Escompte.
Disengage (to).	Débrayer.
Disengagement.	Débrayage.
Disposition.	Disposition.
Distance.	Distance.
Distance meter.	Odomètre.
Distributer.	Distributeur.
Distribution.	Distribution.
Distribution-shaft.	Arbre à distributeurs.
Dog (mech.).	Crampon.
Dog clutch.	Embrayage à griffe.
Dome.	Dôme.
Door.	Porte.
Double.	Double.
Double acting.	à double effet.
Double-acting pump.	Pompe à double effet.
Double action.	Double action.
Double thread.	Double filet.
Double-threaded screw.	Vis à double filet.
Dovetail.	Queue d'aronde.
Dowel.	Cheville en bois.
Drain cock or tap.	Robinet de purge.
Drawing.	Dessin.
Dress.	Habits.
Drill (to).	Percer; forer.
Drill.	Percoir; foret.
Drip feed.	Compte-gouttes.
Drive (to).	Conduire.
Driven shaft.	Arbre secondaire.
Driver.	Chauffeur.
Driving-shaft.	Arbre primaire.
Drop forging.	Pièce estampée.
Drop oiler.	Grasseur à comptes gouttes.
Drum.	Tambour.
Dry.	Sec; sèche.
Dry battery.	Batterie sèche.
Dry cells.	Piles sèches.
Dual ignition.	Double allumage.
Dumb irons.	Menottes de ressorts.
Duplicate.	Double; duplicat.
Durability.	Durabilité.
Durable.	Durable.
Dust.	Poussière.
Dutiable.	Soumis aux droits.
Duties (Customs).	Droits; frais de douane.
Dynamo.	Dynamo
Dynamometer.	Dynamomètre.

ENGLISH.	FRENCH.
Earth.	Terre.
Earth wire.	Fil de terre.
East.	Est.
Easy.	Facile.
Ebonite.	Ebonite.
Eccentric.	Excentrique.
Edge.	Bord ; tranchant.
Effective.	Effectif.
Efficiency.	Rendement.
Elastic.	Elastique.
Electric.	Electrique.
Electric cars.	Voitures électriques.
Electric connection.	Connexion electrique.
Electric ignition.	Allumage électrique.
Electricity.	Electricité.
Electric lamp.	Lampe électrique.
Electric motor.	Moteur électrique.
Electric motor car.	Voiture électrique.
Electric switch.	Interrupteur.
Electric wire.	Fil électrique.
Electrode.	Electrode.
Electrolyte.	Electrolyte.
Electric magnet.	Electro-aimant.
Electro motive force.	Force électromotrice.
Element.	Elément.
Elevation.	Elévation ; hauteur.
Elliptic.	Elliptique.
Elliptic springs.	Ressorts elliptiques.
Emergency.	Circonstance imprévue.
Emery.	Emeri.
Emery-cloth.	Toile d'emeri.
Empty.	Vide.
Emptying.	Vidange.
Enamel.	Email.
End.	Queue.
Endless screw.	Vis sans fin.
Enforced.	Armé-e.
Engage (to).	Embrayer ; engrener.
Engagement.	Embrayage.
Engine (motor).	Moteur.
Engine base.	Carter de moteur.
Engine brake.	Frein de moteur.
Engineer.	Ingénieur.
Engine pressure.	Pression de moteur.
Engine-shaft.	Arbre vilebrequin.
Entrance.	Entrée.
Epicyclic gear.	Engrenage épicycloïdal.
Equalise (to).	Egaliser.
Equaliser.	Egalisateur.
Equilibrium.	Equilibre.
Equipment.	Equipement.
Equivalent.	Equivalent.
Escape (to).	Echapper ; couler.
Essence.	Essence.
Estimate (to).	Estimer ; évaluer.
Estimation.	Estimation.
Evaporate (to).	Evaporer.
Evaporation.	Evaporation.
Exchange (to).	Echanger.
Exhaust.	Echappement.
Exhaust box.	Silencieux.
Exhaust cam.	Came d'échappement.
Exhaust cut-out.	Disjoncteur d'échappement
Exhaust gas.	Gaz d'échappement.
Exhaust pipe.	Tuyau d'échappement.
Exhaust port.	Lumière d'échappement.
Exhaust steam.	Vapeur épuisée.
Exhaust stroke.	Temps d'expulsion.
Exhaust valve.	Soupape d'échappement.
Exhaust valve lifter.	Leve-soupape d'échappement.
Exhaust valve regulator.	Regulateur pour soupape d'échappement.
Exhaust valve stem.	Tige pour soupape d'échappement.
Expand (to).	Etendre ; déployer.
Expanded joint.	Joint étendu.
Expander (tube).	Elargisseur de tubes.
Expanding clutch.	Embrayage extensible.
Expanding pulley.	Poulie extensible.
Expansion.	Détente ; expansion.
Expansion joint.	Joint glissant.
Expenses.	Frais ; dépenses.
Explode.	Eclater.
Explosion.	Explosion.
Explosion chamber.	Chambre d'explosion.
Explosion in carburetter.	Explosion dans le carburateur.
Explosion in silencer.	Explosion dans le silencieux
Explosive mixture.	Mélange détonant.
Extensible.	Extensible.
External.	Externe.

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ENGLISH.	FRENCH.
Extra air inlet.	Admission d'air supplémentaire.
Factory.	Usine ; fabrique.
Fall.	Chute.
False.	Faux ; fausse.
Fan.	Ventilateur.
Fang bolt.	Boulon à griffe.
Fast.	Rapide.
Fasten (to).	Serrer ; lier.
Fastener.	Agrafe.
Fat.	Graisse.
Fat spark.	Etincelle chaude.
Faucet.	Robinet.
Feather.	Clavette.
Feed.	Alimentation.
Feeding.	Alimentation.
Feed pipe.	Tube d'alimentation.
Feed pump.	Pompe d'alimentation.
Feed tank.	Réservoir d'alimentation.
Feed valve.	Soupape d'alimentation.
Feed water.	Eau d'alimentation.
Feed water heater.	Réchauffeur d'alimentation
Feed water regulator.	Régulateur d'alimentation.
Felloe.	Bande ; jante.
Felt.	Feutre.
Fence.	Palissade ; barrière.
Fibre.	Fibre.
Fibre packing.	Garniture de fibre.
Field of force.	Champ de force.
File.	Lime.
File (to).	Limer.
Fill (to).	Remplire.
Filling.	Remplissage.
Filter.	Filtre.
Find (to).	Trouver.
Fine.	Fin.
Finger nut.	Ecrou à oreilles.
Finish.	Finir ; achever.
Fire.	Feu.
Fire (to).	Allumer.
Fire-box.	Foyer.
Fire extinguisher.	Extincteur.
Fire-tube boiler.	Chaudière tubulaire.
First speed.	Première vitesse.
Fit (to).	Monter ; ajuster.
Fitted with.	Munie de ; garnie de.
Fixed axle.	Essieu fixé.
Fixing screw.	Vis de fixation.
Flame.	Flamme.
Flange.	Rebord.
Flange joint.	Joint à brides.
Flap valve.	Soupape à clapet.
Flare up.	Flamber ; s'enflammer.
Flash boiler.	Chaudière serpolet.
Flat.	Plat.
Flaw.	Défaut.
Flexible.	Souple.
Flexible coupling.	Accouplement fléxible.
Flexible shaft.	Arbre fléxible.
Flexible wire.	Fil fléxible.
Flexibility.	Souplesse.
Flitch plate.	Flasque de chassis.
Float.	Flotteur.
Float chamber.	Chambre du flotteur.
Float feed.	Alimentation à flotteur.
Floating axle.	Essieu flottant.
Float spindle.	Tige de flotteur.
Flooding.	Noyage.
Floor.	Plancher ; sol.
Fly-nut.	Ecrou à oreilles.
Fly-wheel.	Volant.
Folding seat.	Strapontin.
Foot.	Pied.
Foot brake.	Frein à pied.
Force.	Force.
Force-feed.	Alimentation par pression.
Force-feed lubricator.	Graisseur à coup de poing.
Force pump.	Pompe de pression.
Forecar.	Avant-train.
Forecarriage.	Avant-train.
Forge.	Forge.
Forge (to).	Forger.
Forging.	Pièce forgée.
Fork.	Fourchette.
Forward.	Avant.
Foundry.	Fonderie.
Four-cycle motor.	Moteur à quatre temps.
Fourth speed.	Quatrième vitesse.
Frame.	Chassis.
Freeze (to).	Geler.
Freezing point.	Point de congélation.
Freight.	Cargaison.

ENGLISH.	FRENCH.
Freight charges.	Frais de transport.
French chalk.	Talc.
Friction.	Friction ; frottement.
Frictional loss.	Perte de frottement.
Friction clutch.	Embrayage à cônes de friction.
Friction gear.	Engrenage à poulie de friction.
Friction surface.	Surface de friction.
Friction wheel.	Roue de friction.
Front.	Front.
Front.	En avant.
Front axle.	Essieu avant.
Front wheel.	Roue avant.
Frosty weather.	Temps de gelée.
Frozen water.	Eau glacée.
Fuel.	Combustible.
Fuel consumption.	Consommation de combustible.
Full.	Rempli.
Function.	Fonction.
Funnel.	Entonnoir.
Furnish (to).	Fournir ; garnir.
Fuse (to).	Fondre.
Fuse wire.	Fil fusible.
Galvanised.	Galvanisé.
Garage.	Garage.
Gas.	Gaz.
Gas bag.	Ballon.
Gasket.	Tresse.
Gasoline.	Essence.
Gasoline (use of).	Dépense de pétrole.
Gate change.	Grille de changement de vitesse.
Gate control.	Grille de commande.
Gauge.	Jauge ; indicateur.
Gauge cock.	Robinet d'indicateur.
Gauge glass.	Indicateur de niveau.
Gauze.	Toile métallique.
Gear or gearing.	Engrenage.
Gear box.	Boîte d'engranage.
Gear case.	Boîte d'engrenage.
Gear changing.	Changement d'engrenage.
Gear pinion.	Pignon.
Gear pump.	Pompe d'engrenage.
Gearshaft.	Arbre de transmission.
Gear wheel.	Roue d'engrenage.
Generator.	Générateur.
Gib.	Contre clavette.
Gills.	Ailettes.
Gimlet.	Forêt ; percoir.
Gland or stuffing-box.	Presse étoupe.
Glass.	Verre.
Glass gauge.	Tube de niveau.
Globe joint.	Joint à rotule.
Gloves.	Gants.
Go (to).	Aller ; marcher.
Goggles.	Lunettes.
Good.	Bon ; bonne.
Governing.	Réglage automatique.
Governor.	Régulateur.
Grade.	Rampe.
Gradient.	Rampe côte.
Gradometer.	Gradomètre.
Grain.	Grain.
Graphite.	Plombagine.
Grasshopper springs.	Ressorts demi-pincettes.
Gravel.	Gravier ; sable.
Gravity-fed lubricator.	Graisseur à compe-gouttes.
Gravity feed.	Alimentation à compte-gouttes.
Grease.	Graisse ; graissage.
Grease (to).	Graisser.
Grease cup (or box).	Codet à graisse.
Grease pump.	Pompe à graisse.
Green.	Vert ; verte.
Grind (to).	Roder ; aiguiser.
Grinding powder.	Poudre rodage.
Grinding valves.	Roder les soupapes.
Groove.	Rainure ; gorge.
Groove (to).	Rainer ; gorger.
Gross weight.	Poids brut.
Ground.	Sol.
Ground wire.	Fil de terre.
Grub screw.	Vis d'arret.
Guards.	Garde-boues.
Gudgeon.	Goujon.
Guide.	Direction ; guide.
Guide rod.	Tige de direction.
Guides.	Guides.
Gunmetal.	Bronze.

ENGLISH.	FRENCH.
Gusset.	Gousset.
Gusset plate.	Gousset.
Half.	Moitié.
Half-speed shaft.	Arbre à cames.
Hammer.	Marteau.
Hamper.	Panier.
Hand-brake.	Frein à main.
Hand feed pump.	Pompe d'alimentation à main.
Handle.	Manette ; manche.
Handle (to).	Opérer ; manier.
Hand lever.	Manette.
Hand pump.	Pompe à main.
Hand wheel.	Manette.
Hard.	Dur ; dure.
Harden (to).	Tremper.
Hard rubber.	Caoutchouc durci.
Haul (to).	Remorquer ; tirer.
Head.	Tête.
Headlight.	Phare.
Heat.	Echauffement ; chaleaur.
Heat (to).	Echauffer ; chauffer.
Heating.	Echauffement ; chauffage.
Heavy.	Lourd ; lourde.
Heavy oil motor.	Moteur à huile lourde.
Heavy traffic motors.	Moteur pour poids lourds.
Height.	Hauteur.
Helical gearing.	Engrenage helicoïdal.
Helical spring.	Ressort helicoïdal.
Helicoid nut.	Ecrou helicoïdal.
Help (to).	Aider ; donner un coup de main.
Help.	Aide ; assistance.
Helper.	Aide.
Hemp packing.	Garniture de chanvre.
Hermetical.	Hermétique ; étanché.
Hexagon bolt.	Boulon à six pans.
Hexagon nut.	Ecrou à six pans.
High.	Haut.
High gear.	Forte multiplication.
High pressure.	Haute pression.
High-pressure cylinder.	Cylindre à haute pression.
High-pressure steam.	Vapeur à haute pression.
High-tension circuit.	Circuit à haute tension.
High-tension current.	Courant de haute tension.
High-tension wire.	Fil à haute tension.
Hill.	Rampe ; élévation ; montée ; côte.
Hill-climbing.	Gravir des rampes.
Hills.	Côtes.
Hinge.	Charnière.
Hit and miss.	Tout ou rien.
Hoist (to).	Hausser.
Holding-down bolts.	Boulons d'ancrage.
Holding-up bolts.	Boulons d'assemblage.
Hole.	Trou.
Hollow out (to).	Emboutir.
Honeycomb radiator.	Radiateur à d'abeille.
Hood.	Capote.
Hook.	Crampon ; crochet.
Hooter.	Corne d'appel.
Horizontal.	Horizontal.
Horizontal motor.	Moteur horizontal.
Horn.	Corne ; trompe.
Horse-power.	Puissance de cheval.
Horses.	Chevaux.
Hose.	Tuyau caoutchouc.
Hose coupling.	Joint en caoutchouc.
Hot.	Chaud ; chaude.
House.	Maison.
Housing.	Cuvette de roulement de billes.
Hub.	Moyeu.
Hydrometer.	Hydromètre.
Ice.	Glace.
Ignite (to).	Allumer.
Igniter.	Allumeur.
Ignition.	Allumage.
Ignition tube.	Tuyau d'allumage.
I.H.P.	Cheval-vapeur indiqué.
Illuminate.	Eclairer.
Imperfect sparking.	Allumage irrégulier.
Improve (to).	Perfectionner.
Inch.	Pouce.
Increase (to).	Augmenter.
Incrustation.	Incrustation.
Indiarubber.	Caoutchouc.
Indiarubber valve.	Soupape en caoutchouc.
Indiarubber tube.	Tube de caoutchouc.
Indicate (to).	Indiquer.
Indicator.	Indicateur.

ENGLISH.	FRENCH.
Indicator diagram.	Diagramme d'indicateur.
Induce (to).	Induire.
Induced current.	Courant induit.
Induction.	Induction.
Induction coil.	Bobine d'induction.
Induction pipe.	Tuyau d'admission.
Induction valve.	Soupape d'admission.
Inductor.	Inducteur.
Inertia.	Inertie.
Inexplosive.	Inexplosif.
Initial pressure.	Pression initiale.
Injector.	Injecteur ; gicleur.
Injured.	Blessé ; endommagé.
Inlet.	Admission.
Inlet cam.	Came d'admission.
Inlet pipe.	Tuyau d'admission.
Inlet port.	Lumière d'admission.
Inlet valve.	Soupape d'admission.
Inlet valve cotter.	Clavette de soupape d'admission.
Inlet valve seat.	Siège de soupape d'admission.
Inlet valve spring.	Ressort de soupape d'admission.
Inlet valve stem.	Tige de soupape d'admission.
Inner tube.	Chambre à air.
Inquire (to).	S'informer.
Inside.	Intérieur.
Inside brake.	Frein intérieur.
Inspect (to).	Inspecter ; visiter.
Inspection lamp.	Lampe de visite.
Inspection pit.	Fosse de réparation.
Inspection plate.	Porte de visite.
Install (to).	Etablir.
Instrument.	Instrument.
Insulate (to).	Isoler.
Insulated wire.	Fil isolé.
Insulating cover.	Couverture isolante.
Insulating tape.	Ruban isolant.
Insulation.	Isolement.
Insulator.	Isolateur.
Insurance.	Assurance.
Intact.	Intact.
Intensifier.	Intensificateur.
Intensity coil.	Bobine.
Interchangeable.	Interchangeable.
Intermediate.	Intermédiaire.
Intermediate-shaft.	Arbre intermédiaire.
Internal.	Intérieur.
Internal combustion engine.	Moteur à explosion.
Interrupt (to).	Interrompre.
Interrupter.	Interrupteur.
Interrupter catch.	Toc de rupture.
Interruption.	Interruption.
Invention.	Invention.
Iron.	Fer.
Iron wire.	Fil de fer.
Iron mounting.	Ferrure.
Iron-plating.	Blindage.
Irreversible.	Irréversible.
Irreversible steering.	Direction irréversible.
Jack.	Cric.
Jacketed cylinder.	Cylindre à chemise.
Jack screw.	Verin.
Jammed clutch.	Embrayage grippé.
Jam-nut.	Contre écrou.
Jaws.	Machoires.
Jerk.	Secousse.
Jet.	Jet ; gicleur.
Jig.	Gabarit.
Jockey pulley.	Poulie de tension.
Join (to).	Relier.
Joining.	Liaison.
Joint.	Jointure.
Joints.	Joints.
Jolt.	Cahot.
Journal.	Fusée.
Jump spark.	Etincelle.
Kerosene.	Pétrole, napthe.
Key.	Clavette ; clef.
Key-driver.	Chasse-clef.
Key-groove.	Rainure de clavette.
Key-seat.	Rainure de calage.
Key-way.	Rainure de calage.
Kick (of motor).	Contre coup.
Kilogramme.	Kilogramme.
Kilometre.	Kilomètre.
Kit.	Equipment ; trousse.
Kit-bag.	Sac à outils.

ENGLISH.	FRENCH.
Knee.	Coude.
Knee lever.	Levier courbé.
Knife switches.	Interrupteur à couteau.
Knocking.	Tapage.
Knot.	Nœud.
Knuckle.	Jointure ; charnière.
Knuckle-joint.	Joint à la cardan.
Knurled or milled nut.	Ecrou moleté.
Knurling.	Moletage.
Labour.	Travail.
Lamp.	Lampe.
Lamp bracket.	Porte lanterne.
Lamps.	Lampes.
Lantern.	Lanterne.
Lap robe.	Housse.
Large.	Grand ; grande.
Latch.	Loquet.
Lateral thrust.	Poussée latèrale.
Lathe.	Tour.
Laws.	Statuts ; Lois.
Layshaft.	Arbre secondaire.
Lead (metal).	Plomb.
Lead (electric wire).	Conduite.
Leaf.	Feuille.
Leak (to).	Fuire.
Leakage.	Fuite ; perte.
Leaking joints.	Joints defectifs.
Leaks.	Fuites.
Leather.	Cuir.
Leather washer.	Rondelle de cuir.
Left.	Gauche.
Length.	Longueur.
Lens.	Lentille.
Lessen (to).	Diminuer.
Level.	Au niveau ; égal.
Lever.	Levier.
Lever (speed).	Levier de vitesse.
Licence.	Permit.
Life of motors.	Durée des moteurs.
Lift (to).	Hausser.
Lift (to give a).	Donner un coup de main.
Lifter.	Toc.
Light.	Eclairage ; lumière.
Light.	Léger ; légère.
Lines of force.	Lignes de force.
Link.	Maillon ; anneau.
Link motion.	Coulisse.
Liquid fuel.	Liquide combustible.
Liquid fuel burners.	Bruleur à liquide combustible.
Litre.	Litre.
Live axle.	Essieu à cardan.
Live steam.	Vapeur sous pression.
Load.	Charge.
Locking devices.	Dispositifs d'enclenchement
Lock-nut.	Contre écrou.
Locksmith.	Serrurier.
Lock (steering).	Arrêt de direction.
Loss.	Perte.
Loss of pressure.	Perte de pression.
Low.	Bas ; basse.
Lower.	Inférieur.
Low gear.	Engrenage démultiplié.
Low-pressure cylinder.	Cylindre à basse pression.
Low tension.	Basse tension.
Lubricant.	Graisse.
Lubricate (to).	Graisser.
Lubricating oil.	Huile lubricant.
Lubrication.	Graissage.
Lubricator.	Graisseur.
Lubricators.	Graisseurs.
Luggage.	Bagage.
Machine.	Machine.
Machinist.	Machiniste.
Magnet.	Aimant.
Magnetic.	Magnétique.
Magnetic clutch.	Embrayage magnétique.
Magnetic field.	Champ magnétique.
Magneto.	Magnéto.
Magneto ignition.	Allumage par magnéto.
Main bearing.	Support principal.
Maintenance.	Maintien ; entretien.
Make.	Marque.
Make and break ignition.	Allumage à rupture.
Mandrel.	Mandrin.
Manometer.	Manomètre.
Manufacture.	Fabrication.
Material.	Matière.
Maximum speed.	Limite de vitesse.
Measure.	Dimension ; mesure.
Measure (to).	Mesurer.

ENGLISH.	FRENCH.
Mechanician.	Mécanicien.
Mechanical.	Mécanique.
Mechanical efficiency.	Rendement mécanique.
Mechanically operated inlet valve.	Soupape d'admission mécanique.
Mechanism.	Mécanisme.
Melt (to).	Fondre.
Mend (to).	Réparer.
Metal.	Métal.
Metallic packing.	Garniture métallique.
Metal-to-metal clutch.	Embrayage à friction métallique.
Meter.	Compteur.
Metre.	Mètre.
Metric system.	Système métrique.
Mica.	Mica.
Mica insulation.	Isolement au mica.
Mica washer.	Rondelle de mica.
Micrometer.	Micromètre.
Millimetre.	Millimètre.
Mineral oil.	Huile minérale.
Misfire.	Un raté.
Mishap.	Panne.
Miss (to).	Manquer.
Mitre gear.	Engrenage conique.
Mitre wheel.	Pignon conique.
Mixer.	Appareil mélangeur.
Mixing chamber.	Chambre à mélange.
Mixing tube.	Tuyau de mélange.
Mixture.	Mélange.
Mixture chamber.	Chambre de mélange.
Model.	Modèle ; type.
Monkey wrench.	Clef anglaise.
Mortise chisel.	Bédane.
Motion.	Mouvement.
Motion (to put in).	Actionner.
Motor.	Moteur.
Motor bicycle.	Motocyclette.
Motor car.	Automobile.
Motor car.	Voiture automobile.
Motor base.	Carter de moteur.
Motor-shaft.	Arbre moteur.
Moulding.	Moulage.
Mountain.	Montagne.
M.O.I.V.	Soupape d'admission mécanique.
Movable.	Mobile.
Mud.	Boue.
Mudguard.	Garde boue.
Multiple disc clutch.	Embrayage à disques.
Nail.	Clou.
Nail (to).	Clouer.
Nail-catcher.	Arrache-clous.
Name.	Nom.
Naphtha.	Naphthe.
Nave.	Moyeu.
Necessary.	Nécessaire.
Necessity.	Besoin ; nécessité.
Neck.	Col.
Needle valve (petrol).	Tige de contrôl d'essence.
Negative.	Négative.
Negative pole.	Pôle négatif.
Net weight.	Poids net.
Neutral.	Neutre.
Neutral point.	Point mort.
New.	Nouveau ; nouvelle.
Nick.	Entaille.
Nickel.	Nickel.
Nickel (to).	Nickeler.
Nipper.	Pince.
Nippers.	Pincettes.
Nipple.	Gicleur.
Noise.	Bruit.
Noisy.	Bruyant.
Nominal horse-power.	Puissance nominale.
Non-return valve.	Soupape d'arrêt.
Non-skid.	Antidérapant.
Non-slip tyre.	Antidérapant.
Normal.	Normal.
North.	Nord.
Notch.	Cran.
Notching-up.	Entailler.
Nozzle.	Bout.
Number.	Nombre, Numéro.
Number-plate.	Plaque numérotée.
Nut.	Ecrou.
Nuts.	Ecrous.
Obstruct (to).	Encombrer.
Obstruction.	Encombrement.

ENGLISH.	FRENCH.
Odometer.	Odomètre.
Odour.	Odeur.
Offset cylinders.	Cylindres désaxés.
Oil.	Huile graisse.
Oil (to).	Graisser.
Oil feed.	Graisseur.
Oil gas	Gaz d'huile.
Oil gauge.	Indicateur d'huile.
Oiling.	Graissage.
Oil lamp.	Lampe à huile.
Oil pump.	Pompe à huile.
Oil tank.	Réservoir à huile.
Open (to).	Ouvrir.
Open.	Ouvert.
Opening.	Orifice.
Operate (to).	Opérer.
Opposed.	Opposé.
Option.	Choix.
Order.	Command.
Order (to).	Commander.
Outfit.	Equipement.
Outside.	Dehors ; extérieur.
Overflow pipe.	Tuyau de trop plein.
Overhaul.	Examiner ; réparer.
Overhauling.	Remettre en état.
Overheat (to).	Surchauffer.
Overheating.	Surchauffement.
Overlap (to).	Dépasser.
Overloading.	Surcharge.
Overturn (to).	Renverser.
Owner.	Propriétaire.
Oxide.	Oxyde.
Pace.	Allure.
Pack (to).	Emballer.
Packing.	Emballage.
Packing (mach.).	Garniture ; étoupage.
Paint.	Couleur ; peinture.
Paint (to).	Peindre.
Painter.	Peinteur
Panne.	Panne.
Paraffin.	Paraffine ; pétrole.
Paralleling.	Couplant en parallel.
Part.	Pièce.
Pass (to).	Passer.
Passage.	Passage.
Passenger vehicles.	Voitures à voyageurs.
Patent.	Brevet d'invention.
Pattern.	Echantillon.
Pawl.	Crochet d'arrêt.
Payment.	Paiement.
Payment (conditions of).	Conditions de paiement.
Pedal.	Pédale.
Pedals.	Pédales.
Peg.	Cheville.
Perfect (to).	Perfectionner.
Peroxide of lead.	Péroxide de plomb.
Petcock.	Robinet d'essai.
Petrol.	Essence.
Piece.	Pièce.
Pierce (to).	Percer.
Pig-iron.	Fer en saumon.
Pig-lead.	Plomb en saumon.
Pin.	Cheville.
Pincers.	Pince ; pincette.
Pinion.	Pignon.
Pins.	Chevilles.
Pipe.	Tuyau.
Pipe connections.	Raccords.
Piping.	Tuyauterie.
Pipe union.	Raccord.
Piston.	Piston.
Piston bore.	Alésage de piston.
Piston pin.	Axe de piston.
Piston pump.	Pompe à piston.
Piston ring.	Segment de piston.
Piston speed.	Vitesse du piston
Piston stroke.	Course de piston.
Pitch.	Dégré ; hauteur ; chute.
Pitch (screw).	Pas (vis).
Pitted valve.	Soupape piquée.
Pivot.	Pivot.
Place.	Place ; siège.
Place (to).	Placer.
Plain bearings.	Coussinets lisses.
Plane.	Rabot.
Plane (mech.).	Plan.
Planetary gear.	Transmission planetaire.
Plate.	Plaque.
Plate clutch.	Embrayage à plateau.
Platinum.	Platine.
Platinum-tipped screw.	Vis platinée.

ENGLISH.	FRENCH.
Platinum wire.	Fil de platine.
Play.	Jeu.
Pliers.	Pince.
Plug.	Bouchon ; noyau.
Plug spanner.	Clef à bouchon.
Plumbago.	Graphite.
Plumber.	Plombier.
Plummer block.	Palier.
Plunge (to).	Plonger.
Plunger pump.	Pompe à piston plongeur
Pneumatic.	Pneumatique.
Pneumatic tyres.	Pneumatiques ; pneus.
Point.	Point.
Polarity.	Polarité.
Pole.	Pôle.
Pole-finding.	Indicateur de pôle.
Polish (to).	Polir.
Pop valve.	Soupape de sûreté.
Porosity.	Porosité.
Porous head.	Culasse poreuse.
Port.	Orifice.
Position.	Position.
Positive.	Positive.
Positive pole.	Pôle positif.
Potential.	Potentiel.
Power.	Force ; puissance.
Premature.	Prématuré.
Premature ignition.	Allumage prématurée.
Prepay (to).	Payer d'avance.
Press hollow (to).	Emboutir.
Pressure.	Pression.
Pressure feed.	Alimentation par pression.
Pressure pump.	Pompe à pression.
Pressure valve.	Valve à pression.
Price.	Prix.
Primary battery.	Batterie primaire.
Primary current.	Courant primaire.
Primary shaft.	Arbre primaire.
Primary wire.	Fil primaire.
Principle.	Principe.
Profile.	Profil.
Propeller-pump.	Pomp à propulseur.
Propeller-shaft.	Arbre propulseur.
Provided with.	Munie de ; garnie de
Pull (to).	Tirer.
Pulley.	Poulie.
Pump.	Pompe.
Pump (to).	Gonfler, pomper.
Pump pinion.	Pignon de pompe.
Pumps.	Pompes.
Punch.	Poincon.
Puncture.	Crevaison de pneumatique
Punctured float.	Flotteur crevé.
Punctured tyre.	Pneu crevé.
Purchase (to).	Acheter.
Push (to).	Pousser.
Push-button.	Bouton de contact.
Push-pedal.	Pédale à poussoir.
Qualitative.	Qualitatif.
Quality.	Qualité.
Quantitative.	Quantitatif.
Quantity.	Quantité.
Question (to).	Questionner.
Quick.	Rapide.
Quote (to).	Coter.
Race.	Course.
Race (to).	Courir.
Rack gear.	Engrenage à crémaillère.
Racing (of engine).	Emballement (du moteur).
Radiator.	Radiateur.
Radius.	Ravon.
Radius rod.	Barre tendeur.
Railway.	Chemin de fer.
Rain.	Pluie.
Ratchet.	Cliquet ; cric ; segment denté.
Ratchet wheel.	Roue à déclic.
Ratio.	Rapport.
Rawhide.	Cuir vert.
Reamer.	Alésoir.
Rear.	Arrière.
Rear axle.	Essieu arrière.
Rear entrance.	Entrée arrière.
Rear wheel.	Roue arrière.
Reason.	Cause.
Rebushing.	Refaisant le coussinet.
Receipt.	Quittance.
Record.	Record.
Recharge (to).	Recharger.
Red.	Rouge.
Red lead.	Minium.

ENGLISH.	FRENCH.
Reduce (to).	Diminuer ; réduire.
Reflector.	Reflecteur.
Registration.	Enregistrement.
Regulate (to).	Régler.
Regulation.	Réglage.
Regulator.	Régulateur.
Regulator pedal.	Pédale de régulateur.
Relief cock.	Robinet de décompression.
Relief valve.	Soupape de soulagement.
Remove (to).	Déplacer.
Rent (to).	Louer.
Repair (to).	Réparer.
Repair part.	Pièce de rechange.
Repair outfit.	Trousse à réparation.
Repairs.	Réparations.
Replace (to).	Remplacer.
Reserve piece.	Pièce de rechange.
Reservoir.	Réservoir.
Residuum.	Résidu.
Resin.	Résine.
Resistance.	Résistance.
Resistance coil.	Bobine de résistance.
Retard (to).	Retarder.
Retarder.	Ralentisseur.
Reverse.	Marche arrière.
Reverse (to).	Renverser la marche.
Reverse lever.	Levier de changement de marche.
Reversing gear.	Mécanisme de changement de marche.
Reversing lever.	Levier de changement.
Reversing shaft.	Arbre de changement de marche.
Reversible.	Reversible.
Revolution.	Tour ; révolution.
Rheostat.	Rheostat.
Rib.	Nervure.
Right.	Droite.
Right-hand screw.	Vis filitée à droite.
Rigid.	Rigide.
Rim.	Jante ; bord.
Ring.	Anneau ; bague.
Ring lubrication.	Graissage à bagues.
Rings.	Anneaux ; bagues.
Rivet.	Rivet.
Rivet (to).	River.
Rivet-hole.	Trou de rivet.
Road.	Route.
Road resistance.	Résistance à la jante.
Road wheel.	Roue de voiture.
Rug.	Couverture.
Rocker.	Levier-bascule.
Rod.	Bielle ; tige.
Rolled (mach.).	Laminé.
Roller.	Galet.
Roller bearing.	Coussinet à rouleaux.
Room.	Place ; chambre.
Roomy.	Vaste ; spacieux.
Rope.	Corde.
Rotary pump.	Pompe rotative.
Rotary valve.	Soupape rotative.
Rotation.	Rotation.
Rough.	Brut.
Round.	Rond ; ronde.
Round-head bolt.	Boulon à champignon.
Round-headed screw.	Vis à tête ronde.
Rub (to).	Frotter.
Rubber.	Caoutchouc.
Rubber solution.	Caoutchouc en solution.
Rubbing.	Frottement.
Run.	Course ; marche.
Run (to).	Courir, rouler.
Runabout.	Voiturette.
Runaway.	Fuyarde.
Running.	Marche ; roulement.
Running-board.	Marchepied.
Rupture.	Rupture.
Rust.	Rouille.
Rusty.	Rouillé.
Rut.	Ornière.
Safety valve.	Soupape de sûreté.
Salt.	Sel.
Sand.	Sable.
Saturated steam.	Vapeur saturée.
Saw.	Scie.
Scale.	Echelle.
Scales.	Balance.
Screen (dust).	Garde poussière.
Screen (wind).	Pare-brise.
Screw.	Vis.
Screw (to).	Serrer, viser.
Screwdriver.	Tournevis.

ENGLISH.	FRENCH.
Screw gear.	Engrenage à vis.
Screw-jack.	Cric.
Screw-pitch.	Pas d'une vis.
Screw-plate.	Filière à vis.
Screw-thread.	Filet de vis.
Screwed union.	Raccord à vis.
Screw-wrench.	Clef anglaise.
Searchlight.	Projecteur.
Seat or seating.	Place ; siège ; coussin.
Secondary battery.	Accumulateur.
Secondary current.	Courant secondaire.
Secondary shaft.	Arbre secondaire.
Secondary wire.	Fil secondaire.
Second speed.	Seconde vitesse.
Sector.	Secteur.
Sediment.	Résidu.
Segment.	Segment.
Seize (to).	Saisir.
Self-ignition.	Auto-allumage.
Self-induction.	Auto-induction.
Self-starter.	Auto-démarreur.
Service.	Service.
Set-screw.	Vis de réglage.
Shackle.	Lien ; boucle.
Shaft.	Arbre.
Shaft-drive.	Transmission à cardan.
Shafts.	Arbres.
Sharp.	Tranchant.
Sheeting.	Blindage.
Sheet-iron.	Tôle.
Shock.	Choc.
Shock-absorber.	Amortisseur de chocs.
Short circuit.	Court circuit.
Shorten (to).	Raccourcir.
Shoulder.	Nervure.
Shunt.	Dérivation.
Shut (to).	Fermer.
Shut off gas (to).	Etrangler le gaz.
Side.	Côté.
Side-door.	Entrée latérale.
Side-slip.	Dérapage.
Sight feed lubricator.	Grasseur à débit visible.
Signal.	Signal ; signe.
Silencer.	Silencieux.
Sill.	Longeron.
Simple.	Simple.
Single.	Seul ; seule.
Syphon.	Siphon.
Skew gear.	Engrenage helicoïdal.
Skid.	Patin.
Skid (to).	Déraper.
Skidding.	Dérapage, patinage
Sleeve.	Manchon.
Slide valve.	Tiroir.
Sliding gear.	Train balladeur.
Sliding sleeve.	Manchon glissant.
Slip (to).	Déraper ; glisser.
Slow.	Lent ; lente.
Slow up (to).	Ralentir.
Small.	Petit ; petite.
Smell.	Odeur.
Smoke.	Fumée.
Smooth.	Poli.
Smooth (to).	Aplanir.
Snow.	Neige.
Snug bolt.	Boulon à ergot.
Soap.	Savon.
Socket.	Douille ; cavité.
Socket joint.	Joint à vis.
Socket wrench.	Clef à douille.
Soft.	Mou ; molle.
Solder.	Soudure.
Solder (to).	Souder.
Soldering iron.	Fer à soudure.
Soldering lamp.	Lampe à soudure.
Solution.	Solution.
Solution (rubber).	Solution (de caoutchouc).
Sooting (of the plug).	Encrassement de la bougie.
South.	Sud.
Space.	Espace.
Spanner.	Clef.
Spare part.	Pièce de réserve.
Spares.	Pièces de rechange.
Spare wheel.	Roue de rechange.
Spark.	Etincelle.
Spark fire.	Allumage par étincelle.
Spark gap.	Entrefer.
Spark lever.	Manivelle d'allumage.
Spark plug.	Bougie.
Special.	Spécial ; spéciale.
Specific gravity.	Gravité spécifique.
Speed.	Vitesse.
Speed gear.	Engrenage régulateur de vitesse.
Speed indicator.	Indicateur de vitesse.
Speed lever.	Levier de vitesse.
Speed limit.	Limite de vitesse.
Spigot bearing.	Coussinet à fausset.
Spigot nut.	Ecrou de fausset.
Spindle.	Broche ; tige ; fusée arbre.
Spiral gear.	Engrenage en spirale.
Spiral spring.	Ressort à spiral.
Spirit.	Essence.
Splash-board.	Garde-crotte.
Splashing.	Barbotage.
Splash lubricator.	Grasseur par barbotage.
Split pin.	Goupille fendue.
Spoke.	Rayon.
Spoke nipple.	Ecrou de rayon.
Spontaneous ignition.	Ignition spontanée.
Sprag.	Bequille.
Sprayer.	Pulvérisateur.
Spraying nipple.	Gicleur.
Spring.	Ressort.
Spring hanger.	Support de ressort.
Springs.	Ressorts.
Spring washer.	Rondelle à ressort.
Sprocket wheel.	Roue à chaîne.
Spur gear.	Engrenage à roue dentée.
Spur pinion.	Pinion droit.
Spur wheel.	Roue dentée droite.
Spur wheel (internal).	Roue dentée droite intérieure.
Square.	Carré.
Square-headed bolt.	Boulon carré.
Square nut.	Ecrou carré.
Stages.	Etapes.
Staggered spoke.	Beaubant.
Stale petrol.	Vieux pétrole.
Stamp (to).	Estamper.
Start (to).	Mettre en marche.
Starting.	Mise en marche.
Starting crank.	Manivelle de lancement.
Starting handle.	Manivelle de mise en marche.
Station.	Gare ; garage ; station.
Stauffer grease.	Graisse consistante.
Stay.	Tirant.
Steam.	Vapeur.
Steam car.	Voiture à vapeur.
Steam chest.	Boîte à vapeur.
Steam cock.	Robinet à vapeur.
Steam engine.	Machine à vapeur.
Steam gauge.	Manomètre.
Steam pipe.	Tuyau à vapeur.
Steam pump.	Pompe à vapeur.
Steel.	Acier.
Steel plate.	Tôle d'acier.
Steer (to).	Diriger.
Steering.	Direction.
Steering box.	Boîte de direction.
Steering gear.	Mécanisme de direction.
Steering knuckle.	Charnière de direction.
Steering link.	Chaînon de direction.
Steering post.	Tige de direction.
Steering wheel.	Roue de direction.
Stem.	Tige.
Stiff.	Rigide.
Stillson wrench.	Clef à tuyau.
Stop.	Arrêt.
Stop (to).	Arrêter.
Stop-cock.	Robinet d'arrêt.
Stop-valve.	Soupape d'arrêt.
Storage battery.	Batterie d'accumulateur.
Straight.	Droit ; droite.
Strainer.	Filtre.
Strangling of gas.	Etranglement de gaz.
Strap.	Courroie.
Strengthen (to).	Renforcer.
Stroke (piston).	Course de piston.
Strong.	Fort ; forte.
Strutting.	Contre-fiche.
Stud.	Goujon.
Stuffing-box.	Presse-étoupe.
Substance.	Matière.
Suction.	Aspiration.
Suction pump.	Pompe d'aspiration.
Suction stroke.	Temps d'aspiration.
Suction valve.	Soupape d'aspiration.
Sulphating.	Sulfatation.
Sulphuric acid.	Acide sulfurique.
Sunk screw.	Vis perdue.
Superheated steam.	Vapeur surchauffée.
Superheater.	Surchauffeur.

ENGLISH.	FRENCH.
Superheating.	Surchauffe.
Supply.	Provision.
Supply (to).	Approvisionner.
Support.	Support.
Suppress (to).	Supprimer.
Surface.	Surface.
Surface carburetter.	Carburateur à léchage.
Suspension.	Suspension.
Switch.	Interrupteur.
Switch (to).	Houssiner; cingler.
Switch plug.	Clef de contact.
Swivel.	Emerillon.
Synchronise (to).	Synchroniser.
System.	Système.
T iron.	Fer en T.
T joint.	Pièce en T.
Tachometer.	Tachymètre.
Tackle.	Poulie.
Tail light.	Lampe arrière.
Tail piece.	Queue.
Tank.	Réservoir.
Tap.	Robinet.
Tape (insulating).	Ruban isolant.
Tape measure.	Mètre en ruban.
Taper (to).	Effiler.
Taper pin.	Goupille conique.
Tappet gear.	Engrenage de taquet.
Tappet rod.	Taquet de soulèvement.
Tariff.	Tarif.
Tear (to).	Déchirer; arracher.
Technical.	Technique.
Telegram.	Télégramme.
Telegraph (to).	Télégraphier.
Temper (to).	Tremper.
Template or templet.	Garbarit.
Tensile strength.	Résistance à la traction.
Tension.	Tension.
Terminals.	Bornes.
Terms.	Conditions.
Test (to).	Eprouver.
Test.	Epreuve.
Test lamp.	Lampe témoin.
Thermosyphon.	Thermosyphon.
Thick.	Epais.
Thickness.	Epaisseur.
Thin.	Mince.
Third speed.	Troisième vitesse.
Thorn-catcher.	Arrache-clous.
Thread (screw).	Pas; hélice.
Three-point suspension.	Suspension par trois points.
Throttle lever.	Manivelle d'étranglement.
Throttle (to).	Etrangler.
Throttle control.	Commande par étranglement.
Throttle valve.	Soupape à papillon.
Throw.	Course.
Throw of crank.	Course du vilebrequin.
Thrust.	Poussée.
Thrust bearing.	Palier de butée.
Thumb nut.	Ecrou à oreilles.
Thumb screw.	Vis à oreilles.
Ticket.	Billet.
Tight.	Etanche.
Tighten (to).	Serrer.
Tiller steering.	Direction par barre.
Tilting-seat.	Siège pivotant.
Time.	Temps.
Timing.	Réglage.
Timing gear and half-speed shaft.	Appareil d'avance à l'allumage et arbre de demi-vitesse.
Tin.	Etain.
Tinplate.	Fer blanc.
Tire.	Pneu; bandage.
Tire casing.	Pneumatique; bandage.
Toggle joint.	Joint coudé.
Toll.	Péage.
Tonneau.	Tonneau.
Tool.	Outil.
Toolbox.	Boîte à outils.
Tooling.	Outillage.
Tools and accessories.	Outils et accessoires.
Tooth.	Dent.
Toothed.	Denté; dentée.
Toothed wheel rim.	Couronne dentée.
Top.	Capote.
Torque.	Torque.
Torque rod.	Bielle de torque.
Torsion-shaft.	Arbre torsion.
Touring.	Tourisme.
Touring cars.	Voitures de tourisme.
Tractive resistance.	Résistance à la traction.

ENGLISH.	FRENCH.
Trade mark.	Marque de fabrique.
Train.	Train.
Transformer.	Bobine d'induction.
Transmission.	Transmission.
Transmission system.	Système de transmission.
Transport (to).	Transporter.
Transportation.	Transport.
Transverse.	Transversal.
Transverse-shaft.	Arbre transversal.
Travel.	Voyage.
Tread.	Voie.
Trembler.	Trembleur.
Trembler coil.	Bobine à trembleur.
Trial.	Essai; concours.
Tricar.	Tricar.
Trip (or trip lever).	Levier à bascule.
Triple.	Triple.
Trouble.	Trouble.
Trueing.	Ajustage.
Trumpet.	Trompe.
Trunnion.	Tourillon.
Truss.	Support; traverse.
Tube.	Tuyau.
Tube ignition.	Allumage par tube incandescent.
Tubes.	Tubes.
Tubular.	Tubulaire.
Tubular spokes.	Rayons tubulaires.
Tumbler or tumbler block.	Dé de culbuteur.
Turn (road).	Virage.
Turn (to).	Tourner.
Turnpike.	Barrière de péage.
Turntable.	Pont tournant.
Twin cylinders.	Cylindres jumelés.
Twist gear.	Engrenage torse.
Two-cycle motor.	Moteur à deux temps.
Two-in-one gear.	Engrenage demultipliant de moitié.
Two-way pump.	Pompe à deux voies.
Two-way tap.	Robinet à deux voies.
Type.	Type; modèle.
Tyres.	Pneus.
U-iron.	Fer en U.
Unable.	Incapable.
Unattended cars.	Voitures sans contrôle.
Uncontrollable.	Incontrôlable.
Undamaged.	Intact.
Under-frame.	Chassis inférieur.
Underneath.	Dessous.
Undershield.	Enveloppe métallique inférieure.
Uneven.	Inégal.
Unfasten (to).	Détacher.
Unfinished.	Imparfait.
Ungovernable.	Ingouvernable.
Uniformly.	Uniformément.
Union.	Raccord.
Unit.	Unité.
Unite (to).	Unir; joindre.
Universal.	Universel.
Universal coupling.	Joint universel.
Universal driving-shaft.	Cardan.
Universal joint.	Joint universel.
Unpack (to).	Déballer.
Unscrew (to).	Dévisser; déserrer.
Upholstery.	Capitonnage.
Upkeep.	Entretien.
Upper.	Supérieur.
Usage.	Usure; usage.
Use.	Usage; dépense.
Use (to).	User.
Useful.	Utile.
Vacuum.	Vide.
Value.	Valeur.
Valve.	Soupape; clapet.
Valve cap.	Chapeau de soupape.
Valve chamber.	Chambre de soupape.
Valve joint.	Joint de la soupape.
Valve lift.	Levée de soupape.
Valve rod.	Tige de la soupape.
Valve seat.	Siège de soupape.
Valve stem.	Tige de soupape.
Van (delivery).	Voiture de livraison.
Vapour.	Vapeur.
Vaporise (to).	Evaporer.
Vaporisation.	Vaporisation.
Vaporiser.	Pulverisateur.
Variable.	Variable.
Variable expansion.	Expansion variable.
Variation.	Changement; variation.
Varnish.	Vernis; vernissure.

ENGLISH.	FRENCH.
Varnish (to).	Vernir.
Velocity.	Velocité.
Ventilator.	Ventilateur.
Vertical.	Vertical ; verticale.
Vertical motors.	Moteurs verticaux.
Vibrate (to).	Trembler ; vibrer.
Vibration.	Vibration ; trepidation.
Vice.	Etau.
View.	Vue.
Viscosity.	Viscosité.
Visible steam.	Vapeur visible.
Volt.	Volt.
Voltage.	Voltage.
Voltmeter.	Voltmètre.
Volume.	Volume.
Volute springs.	Ressorts en volute.
Vulcanise (to).	Vulcaniser.
Vulcanised fibre.	Fibre vulcanisé.
Vulcanisers.	Vulcaniseurs.
Wages.	Salaire.
Warehouse.	Magasin ; entrepôt.
Warm.	Chaud ; chaude.
Wash (to).	Layer.
Washer.	Contre plaque ; rondelle.
Washing.	Lavage.
Watch.	Montre.
Water.	Eau.
Water-circulating pump.	Pompe pour circulation d'eau.
Water circulation.	Circulation d'eau.
Water cock	Robinet d'eau.
Water column.	Colonne d'eau.
Water-cooling.	Refroidissement par l'eau.
Water gauge.	Hydromètre.
Water-jacket.	Chemise d'eau.
Water pipes.	Tuyaux d'eau.
Water pressure.	Pression hydraulique.
Waterproof.	Imperméable.
Water supply.	Approvisionnement d'eau.
Watt.	Watt.
Way.	Chemin.
Weak.	Faible.
Weaken (to).	Affaiblir.
Wear.	Usure.
Wear and tear.	Usure.
Wedge.	Cheville ; cale.
Weigh (to).	Peser.
Weight.	Poids.
Weights and measures.	Poids et mesures.
Weld (to).	Souder.
Welding.	Brasure.
West.	Ouest.
Wet.	Mouillé ; humide.
Wet battery.	Batterie humide.
Wet steam.	Vapeur saturée.
Wheel.	Roue.
Wheelbase.	Empattement ; écartement des roues.
Wheel bearings.	Coussinets.
Wheelwright.	Charron.
Whet (to).	Aiguiser.
White.	Blanc ; blanche.
White lead.	Plomb blanc.
White metal.	Métal blanc.
Wholesale.	En gros.
Wick.	Mêche.
Wick carburetter.	Carburateur à mêche.
Wide.	Large.
Width.	Largeur.
Wind-screen.	Pare-brise.
Wing.	Aile.
Wing nut.	Ecrou à oreilles.
Wings.	Ailes.
Wipe contact.	Contact par frottement.
Wiper.	Came.
Wire.	Fil métallique.
Wire gauge.	Jauge pour fil métallique.
Wire gauze.	Toile métallique.
Wire guard.	Grillage.
Wire netting.	Tissu métallique.
Wire rope.	Cable.
Wire spring.	Ressort à boudin.
Wire wheels.	Roues à rayons métalliques.
Wiring.	Montage de fils.
Wood.	Bois.
Work.	Travail.
Work (to).	Travailler.
Workman.	Ouvrier.
Workshop.	Atelier.
Worm and wheel gear.	Engrenage à vis sans fin.
Worm drive.	Transmission par vis sans fin.
Worm gear.	Engrenage à vis sans fin.
Worm wheel.	Roue hélice.
Wrench.	Clef.
Wrist pin.	Goujon.
Wrought iron.	Fer forgé.
Yoke.	Etrier.
Zinc.	Zinc.
Zinc plate.	Tôle de zinc.

FRENCH-ENGLISH DICTIONARY.

FRENCH.	ENGLISH.
Abaisser.	To lower.
Accélérateur.	Accelerator.
Accélérer.	To accelerate.
Accès.	Access.
Accessible.	Accessible.
Accessoires.	Accessories.
Acétylène.	Acetylene.
Acetylithe.	Acetylite.
Accouplement d'embrayage.	Clutch coupling.
Accouplement flexible.	Flexible coupling.
Accouplement à griffe.	Dog coupling.
Accouplement universel.	Universal coupling.
Accumulateur.	Accumulator.
Acheter.	To purchase.
Achever.	To finish.
Acide.	Acid.
Acide chromique.	Chromic acid.
Acide sulfurique.	Sulphuric acid.
Acier.	Steel.
Acier fondu.	Cast steel.
A compte.	On account.
Actionner.	To put in motion.
Adapter.	To adapt.
Admission.	Admission ; inlet.
Admission automatique.	Automatic inlet.
Admission, orifice d'.	Admission port.
Admission, soupape d'.	Admission valve ; inlet valve ; suction valve.
Admission, tige de soupape d'.	Inlet valve stem.
Affaiblir.	To weaken.
Agent.	Agent.
Agir.	To act.
Agrafe.	Fastener.
Aide.	Assistance ; help.
Aide.	Helper.
Aider.	To assist ; to help.
Aiguille.	Needle.
Aiguiser.	To whet ; sharpen ; grind.
Aile.	Wing ; fan ; mudguard.
Ailette.	Flange.
Ailettes.	Gills.
Aimant.	Magnet.
Air.	Air.
Air carburé.	Carburetted air.
Air, chambre à.	Air tube ; inner tube.
Air, pompe à.	Air pump.
Air, refroidissement par.	Air cooling.
Air, soupape à.	Air valve.
Air, supplément d'.	Extra air supply.
Ajustage.	Adjustment ; trueing.
Ajuster.	To adjust ; to fit.
Alcool.	Alcohol.
Alésage.	Bore.
Alésage du cylindre.	Cylinder bore.
Alésage du piston.	Piston bore.
Aléseuse.	Boring machine.
Alignement.	Alignment.
Alimentation.	Feeding.
Alimentation à compte gouttes.	Gravity feed.
Alimentation à flotteur.	Float feed.
Alimentation par pression.	Force feed ; pressure feed.
Aller.	To go.
Alliage.	Alloy.
Allonger.	To lengthen.
Allumage.	Ignition.
Allumage à magneto.	Magneto ignition.
Allumage à rupture.	Make-and-break ignition.
Allumage catalytique.	Catalytic ignition.
Allumage électrique.	Electric ignition.
Allumage irregulier.	Imperfect sparking.
Allumage, manivelle d'.	Spark lever.
Allumage, par étincelle.	Spark firing.
Allumage par tube incandescent.	Tube ignition.

FRENCH.	ENGLISH.
Allumage prématuré.	Premature ignition.
Allumage retardé.	Retarded ignition.
Allumage spontanée.	Self-ignition.
Allumage trop avancé.	Ignition too advanced.
Allumage, tuyeau d'.	Ignition tube.
Allumer.	To ignite ; to fire.
Allumeur.	Igniter.
Allure.	Pace.
Alternatif-ive.	Alternate.
Aluminium.	Aluminium.
Amiante.	Asbestos.
Ampèremètre.	Ampère meter ; ammeter.
Amorçoir.	Centre-punch.
Amortisseur.	Damper ; dashpot.
Amortisseur de chocs.	Anti-bouncer ; shock absorber.
Ampère.	Ampère.
Ampèremètre.	Current meter ; ammeter.
Ampère heure.	Ampère hour.
Ancre.	Anchor.
Angle.	Angle.
Anneau (chaîne).	Link ; ring.
Antagonistique ; opposé.	Antagonistic ; opposed.
Antidérapant.	Anti-slipping device ; non-slip tyre.
Anti-rouille.	Anti-rust.
Aplanir.	To smooth.
Appareil.	Apparatus.
Appareil d'avance à l'allumage.	Advanced spark mechanism.
Appareil melangeur.	Mixer.
Approvisionnement d'eau.	Water supply.
Approvisionner.	To supply.
Arbre.	Shaft ; spindle ; tree.
Arbre à cames.	Camshaft.
Arbre de changement de marche.	Reversing shaft.
Arbre à distributeur.	Distribution shaft.
Arbre à cardan.	Cardan axle and cardan shaft.
Arbre moteur.	Motor shaft.
Arbre de demi-vitesse.	Half-time shaft.
Arbre de transmission.	Gear shaft.
Arbre d'embrayage.	Clutch shaft.
Arbre des cames.	Cam shaft.
Arbre flexible.	Flexible shaft.
Arbre intermédiare.	Intermediate shaft.
Arbre primaire.	Driving shaft.
Arbre propulseur.	Propeller shaft.
Arbres.	Shafts.
Arbre secondaire.	Secondary shaft and lay shaft.
Arbre transversal.	Cross shaft ; transverse shaft.
Arbre de torsion.	Torsion shaft.
Arbre vilebrequin.	Engine shaft ; crank shaft.
Armature.	Armature.
Armature en cylindre.	Armature drum.
Armé-e.	Enforced ; reinforced.
Arrache-clous.	Thorn-catcher ; nail-catcher.
Arracher.	To tear.
Arrêt.	Stop.
Arrêt d'embrayage.	Clutch stop.
Arrêt de direction.	Lock (steering).
Arrêter.	To stop.
Arrière.	Rear.
Asbeste.	Asbestos.
Asbeste, toile d'.	Asbestos cloth.
Aspiration.	Suction.
Assembler ; emboîter.	To clamp.
Assistance.	Help.
Assister.	To assist.
Assurance.	Insurance.
Atelier.	Workshop.

FRENCH.	ENGLISH.
Augmenter.	To increase.
Auto-démarreur.	Self-starter.
Automatique.	Automatic.
Automobile.	Automobile; motor car.
Automobilisme.	Automobilism.
Auxiliaire.	Auxiliary.
Avance à l'allumage.	Ingition advance.
Avant.	Front; forward.
Avant-train.	Forecar and fore-carriage.
Avertisseur.	Tell-tale.
Axe.	Axle; axis.
Axe de piston.	Piston pin; gudgeon pin.
Bagage.	Luggage; baggage.
Bague.	Ring.
Bain.	Bath.
Balance.	Balance.
Balance (meas.).	Scales.
Balance à bascule.	Weighbridge.
Ballon.	Gas bag.
Bandage solide.	Solid tyre.
Bande.	Felloe.
Bande de frein.	Brake band.
Barbotage.	Splashing.
Barre.	Bar; rod.
Barre tendeur.	Radius rod.
Barrière.	Fence; barrier.
Barrière de péage.	Turnpike; tollgate.
Bas; basse.	Low.
Basse tension.	Low tension.
Batterie.	Battery.
Batterie d'accumulateur.	Storage battery.
Batterie humide.	Wet battery.
Batterie primaire.	Primary battery.
Batterie sèche.	Dry battery.
Beaulant.	Staggered spoke.
Bédâne.	Cross-cut chisel; mortise chisel.
Benzine.	Benzine.
Benzol.	Benzol.
Benzoline.	Benzoline.
Bequille.	Sprag.
Besoin.	Necessity.
Bidon.	Can.
Bielle.	Rod; connecting rod.
Bielle d'accouplement.	Coupling rod.
Bielle de piston.	Piston rod.
Bielle de torque.	Torque rod.
Bille.	Ball.
Bille d'acier.	Steel ball.
Billet.	Ticket.
Biseau.	Bevel.
Blanc; blanche.	White.
Blessé-e.	Injured.
Bleu.	Blue.
Blindage.	Sheeting; iron plating.
Bloc.	Block.
Bobine.	Bobbin.
Bobine à trembleur.	Trembler coil.
Bobine d'induction.	Transformer; induction coil.
Bobine de résistance.	Resistance coil.
Bois.	Wood.
Boîte.	Case; box.
Boîte à vapeur.	Steam chest.
Boîte de direction.	Steering box.
Boîte d'engrenage.	Gear box.
Boîte à outils.	Toolbox.
Bon; bonne.	Good.
Bord.	Rim; edge.
Bornes.	Terminals.
Boucher.	To calk.
Bouchon.	Plug.
Boucle.	Buckle.
Boue.	Mud.
Bougie.	Spark plug; candle.
Bouillir.	To boil.
Boulon.	Bolt.
Boulon à champignon.	Round-head bolt.
Boulon à clavette.	Crank pin.
Boulon à ergot.	Snug bolt.
Boulon à griffe.	Fang bolt.
Boulon à six pans.	Hexagon bolt.
Boulon à tête ronde.	Cheese-head bolt.
Boulon tête carré.	Square-headed bolt.
Boulon noyé.	Countersunk bolt.
Boulons d'ancrage.	Holding-down bolts.
Boulons d'assemblage.	Holding-up bolts.
Boulons et écrous.	Bolts and nuts.
Bouton de contact.	Push-button; switch plug.

FRENCH.	ENGLISH.
Boyau.	Hose.
Braser.	To braze.
Brasure.	Brazing; welding.
Brayage.	Connection.
Brevet d'invention.	Patent.
Bride.	Flange.
Brise-circuit.	Commutator.
Broche.	Spindle.
Bronze.	Bronze; gunmetal.
Brosse.	Brush.
Bruit.	Noise.
Brûler.	To burn.
Brûleur.	Burner.
Brûleur à combustible liquide.	Liquid fuel burner.
Brun-e.	Brown.
Brut-e.	Rough.
Bruyant-e.	Noisy.
Burette.	Small can.
Burin.	Cape chisel.
Buse.	Nozzle; blast pipe.
Buttée à billes.	Ball thrust.
Câble.	Wire-rope; cable.
Câble de fer.	Cable-rope.
Câble flexible Bowden.	Bowden wire.
Cadran.	Dial.
Cahot.	Jolt.
Caisse.	Box; case.
Caisse à claire voie.	Crate.
Cale.	Wedge.
Calorique.	Caloric.
Came.	Cam; wiper.
Came d'admission.	Inlet cam.
Came d'échappement.	Exhaust cam.
Came d'embrayage.	Clutch cam.
Camion.	Truck.
Caoutchouc.	Rubber.
Caoutchouc durci.	Hard rubber; vulcanite.
Capacité.	Capacity.
Capillaire.	Capillary.
Capitonnage.	Upholstery.
Capote.	Hood top.
Capote à baldaquin.	Canopy top.
Capote pliante.	Cape top.
Capsule.	Capsule.
Carburateur.	Carburetter.
Carburateur à léchage.	Surface carburetter.
Carburateur à mèche.	Wick carburetter.
Carburation.	Carburation.
Carbure de calcium.	Calcium carbide.
Cardan.	Universal driving-shaft.
Cargaison.	Freight.
Carré.	Square.
Carreau.	Arm file.
Carrosserie.	Car body.
Cartouche.	Coupling box sleeve.
Casse.	Break.
Casser.	To break.
Cause.	Reason; cause.
Cavité.	Socket; cavity.
Celluloïd.	Celluloid.
Cémenter.	Case-harden.
Centre.	Centre.
Centrifuge.	Centrifugal.
Certificats.	Certificates.
Chaîne.	Chain.
Chaînon de direction.	Steering link.
Chaleur.	Heat.
Chalumeau à bouche.	Blowpipe.
Chambre.	Room; chamber.
Chambre de moteur.	Engine base; crank case.
Chambre d'engrenage.	Gear case.
Chambre de vilebrequin.	Crank case.
Chambre à manivelle.	Base chamber.
Chambre à mélange.	Mixture chamber.
Chambre à air.	Air tube; inner tube.
Chambre de combustion.	Combustion chamber.
Chambre de mélange.	Mixing chamber.
Chambre de soupape.	Valve chamber.
Chambre d'explosion.	Explosion chamber.
Chambre du flotteur.	Float chamber.
Chamfreine.	Chamfered.
Champ de courses.	Race track.
Champ de force.	Field of force.
Champ magnétique.	Magnetic field.
Changement.	Change; variation.
Changement d'engrenage.	Gear changing.
Changement de vitesse.	Change of speed.
Chape.	Cap.
Chapeau à poussière.	Dust cap.
Chapeau de soupape.	Valve cap.
Chapeau d'essieu.	Axle cap.

FRENCH.	ENGLISH.
Charbon.	Coal.
Charbon de bois.	Charcoal.
Charge.	Charge; load.
Charger.	To charge.
Charger les accumulateurs.	Charging accumulators.
Charnière.	Hinge; knuckle.
Charnière de direction.	Steering knuckle.
Charron.	Wheelwright.
Chasse-clef.	Key-driver.
Chassis.	Car frame; chassis.
Chassis inférieur.	Underframe.
Chaud-e.	Hot; warm.
Chaudière.	Boiler.
Chaudière serpolet.	Flash boiler.
Chauffer.	To heat.
Chauffeur.	Driver (male).
Chauffeuse.	Driver (female).
Chemin.	Way; road.
Chemin de fer.	Railway.
Chemise d'eau.	Water-jacket.
Cheval vapeur.	Horse-power.
Cheval vapeur indiqué.	I.H.P.
Chevaux.	Horses.
Cheville.	Peg; pin; wedge.
Cheville de contact.	Connecting plug.
Cheville en bois.	Dowel.
Chevilles.	Pins.
Chèvre.	Jack; crane.
Chicane.	Baffle-plate.
Cadran.	Dial.
Choc.	Shock; jolt.
Choix.	Option; choice.
Chute.	Fall; pitch.
Cingler.	To switch.
Circonstance imprévue.	Emergency.
Circuit.	Circuit.
Circuit à haute tension.	High-tension circuit.
Circuit, fermeture de.	Closing of circuit.
Circulation.	Circulation.
Circulation d'eau.	Water circulation.
Circuler.	To circulate.
Ciseau.	Chisel.
Ciseau à froid.	Cold chisel.
Ciseler.	To chisel.
Clapet.	Valve.
Clavette.	Peg; pin; key; cotter.
Clavette de soupape d'admission.	Inlet valve cotter.
Clef.	Key; peg; wrench; spanner.
Clef à bouchon.	Plug spanner.
Clef à douille.	Socket wrench.
Clef anglaise.	Monkey-wrench.
Clef à tuyau.	Stillson wrench; tube spanner.
Clef de contact.	Switch plug.
Cliquet.	Ratchet.
Clou.	Nail.
Clouer.	To nail.
Coin.	Corner; wedge.
Col.	Collar; neck.
Colonne.	Column.
Colonne d'eau.	Water column.
Combustible.	Combustible; fuel.
Combustible liquid.	Liquid fuel.
Combustion.	Combustion.
Commande.	Order; control.
Commande d'étranglage.	Throttle control.
Commander.	To order; to command.
Commutateur.	Commutator.
Compartiment.	Compartment.
Compas.	Callipers.
Compliqué.	Complicated.
Composé (machine).	Compound engine.
Composition alliage.	Alloy.
Compression.	Compression.
Comprimer.	To compress.
Comptant.	Cash.
Compte.	Account.
Compte, à.	On account.
Compte-gouttes.	Drip feed.
Compteur.	Meter; cyclometer.
Concours.	Meeting (race, etc.).
Concurrence.	Competition.
Condenseur.	Condenser.
Conditions.	Terms; conditions.
Conditions de paiement.	Conditions of payment.
Conducteur.	Conductor.
Conductibilité.	Conductibility.
Conduire.	To drive.
Conduit.	Channel.
Conduite.	Lead.
Cône.	Cone.

FRENCH.	ENGLISH.
Cône d'embrayage.	Clutch; coupling cone.
Congélation, point de.	Freezing point.
Connexion.	Connection.
Connexion électrique.	Electric connection.
Consommation de combustible.	Fuel consumption.
Constructeur.	Manufacturer; builder.
Construction.	Construction.
Contact.	Contact.
Contact par frottement.	Wipe contact.
Contact, surface de.	Contact surface.
Contenu.	Contents.
Continu-e.	Continuous.
Contre arbre.	Counter-shaft.
Contre clavette.	Gib.
Contre coup.	Backfire; kick.
Contre écrou.	Lock-nut; jam-nut.
Contre-fiche.	Strutting.
Contre-plaque.	Washer.
Contre-poids.	Counter-weight.
Contre-pression.	Counter-pressure.
Contrôle.	Control.
Corde.	Cord; rope.
Corne.	Horn.
Corne d'appel.	Hooter.
Cornière.	Angle-iron.
Corrosif-ive.	Corrosive.
Côté.	Side.
Coter.	To quote.
Côte.	Hill.
Couche.	Layer.
Coude.	Knee (mach.).
Couler.	To escape; to leak.
Couleur.	Paint; colour.
Coulisse.	Link motion.
Coup.	Stroke; throw; blow.
Coupe-circuit.	Cutting out.
Couper.	To cut.
Couplage.	Switch.
Coupler en parallel.	Paralleling.
Courant.	Current.
Courant alternatif.	Alternative current.
Courant continu.	Continuous current.
Courant de haute tension.	High-tension current.
Courant induit.	Induced current.
Courant primaire.	Primary current.
Courant secondaire.	Secondary current.
Courber.	To bend.
Courbure.	Bend.
Courir.	To race.
Couronne dentée.	Toothed wheel rim.
Couronne pour boîte à étoupe.	Stuffing box cover.
Courroie.	Belt; strap.
Courroie croisée.	Crossed belt.
Course.	Race; race-track; run.
Course de piston.	Piston stroke.
Course de route.	Road race.
Course du vilebrequin.	Throw of crank.
Court circuit.	Short circuit.
Court-e.	Short.
Coussin.	Cushion.
Coussinet.	Bearing; bush.
Coussinet à collier.	Collar bearing.
Coussinet à cône.	Cone bearing.
Coussinet à gousset.	Spigot bearing.
Coussinet à rouleaux.	Roller bearing.
Coussinet composé.	Compound bearing.
Coussinets.	Wheel bearing brasses.
Coussinets lisses.	Plain bearings.
Couture.	Seam.
Couvercle.	Cover.
Couverture.	Rug.
Couverture d'isolant.	Insulating cover.
Couvrir.	To cover.
Crampon.	Clamp; hook.
Cran.	Notch.
Creuser.	To groove; to bore.
Creusure.	Groove.
Creux.	Hollow.
Crevaison de pneu.	Tyre puncture.
Cric.	Jack.
Crochet.	Hook.
Crochet d'arrêt.	Pawl.
Cuir.	Leather.
Cuir vert.	Rawhide.
Cuivre jaune.	Brass.
Cuivre rouge.	Copper.
Culasse.	Cylinder head.
Culasse poreuse.	Porous head.
Culotte.	Bridge piece.
Cuvette.	Cup.
Cuvette à billes.	Ball race.

FRENCH.	ENGLISH.
Cuvette de roulement de billes.	Housing of ball bearing.
Cycle.	Cycle.
Cylindre.	Cylinder.
Cylindre à basse pression.	Low-pressure cylinder.
Cylindre à chemise.	Jacketed cylinder.
Cylindre à haute pression.	High-pressure cylinder.
Cylindrée.	Cylinder capacity.
Cylindres jumelés.	Twin cylinders.
Cylindrique.	Cylindrical.
Dais.	Canopy top.
Danger.	Danger.
Dé.	Die.
Déballer.	To unpack.
Débrayage.	Disengagement; disconnection.
Débrayer.	To disengage; to disconnect.
Décharge.	Discharge.
Décharger.	To discharge.
Déchirer.	To tear.
Dé de culbuteur.	Tumbler or tumbler block.
Défaut.	Defect.
Défectueuse.	Defective.
Dégré.	Pitch; grade.
Dehors.	Outside.
Demi.	Half.
Démonter.	To take apart.
Dense.	Dense.
Densimètre.	Densimeter or hydrometer.
Densité.	Density.
Dent.	Tooth.
Dent de loup.	Catch.
Denté-e.	Toothed.
Dépasser.	To overlap; to pass.
Dépense.	Expenses; consumption.
Dépense de pétrole.	Petrol consumption.
Dépenser.	To consume.
Déplacer.	To remove.
Déployer.	To expand.
Dépolarisation.	Depolarisation.
Dépolariseur.	Depolariser.
Dérapage.	Skidding.
Déraper.	To skid; to slip.
Dérivation.	Shunt.
Désaimantation.	Demagnetisation.
Désaxés (cylindres).	Offset-cylinders.
Desserrer.	To unscrew.
Dessin.	Drawing; design.
Dessous.	Underneath.
Dessus, au-.	Above.
Destination.	Destination.
Détacher.	To detach; to unfasten.
Détails.	Details.
Détour.	Detour.
Développer.	To develop.
Dévisser.	To unscrew.
Diagramme d'indicateur.	Indicator diagram.
Diamètre.	Diameter.
Diaphragm.	Diaphragm.
Différence.	Difference.
Différentiel (engrenage).	Differential.
Dimension.	Measure.
Diminuer.	To diminish; lessen; reduce.
Direct-e.	Direct.
Direction.	Direction; steering; guide.
Direction irréversible.	Irreversible steering.
Direction par barre.	Tiller steering.
Diriger.	To steer.
Disjoncteur d'échappement.	Exhaust cut-out.
Dispositifs d'entrenchement.	Locking-devices.
Disposition.	Disposition.
Dissolution de caoutchouc.	Rubber solution.
Disque.	Disc.
Distance.	Distance.
Distributeur.	Distributer.
Distribution.	Distribution.
Document de transport.	Bill of lading.
Doigt de contact.	Contact arm or lever.
Dôme.	Dome.
Donner un coup de main.	To help; to give a lift.
Douane.	Custom-house.
Douanier.	Custom-house official.
Double.	Double.
Double allumage.	Dual ignition.
Double action.	Double action.
Double effet.	Double acting, effect.

FRENCH.	ENGLISH.
Double filet.	Double thread.
Douille.	Socket; cavity.
Drapeau.	Flag.
Droit-e.	Right; straight.
Droits.	Duties (Customs).
Duplicat.	Duplicate.
Dur-e.	Hard.
Durable.	Durable.
Durabilité.	Durability.
Durée des moteurs.	Life of motors.
Dynamo.	Dynamo.
Dynamomètre.	Dynamometer.
Eau.	Water.
Eau à refroidir.	Cooling water.
Eau, chemise d'.	Water jacket.
Eau, circulation d'.	Water circulation.
Eau d'alimentation.	Feed water.
Eau glacée.	Frozen water.
Eau, refroidissement par.	Water cooling.
Eau, réservoir d'.	Water tank.
Ebonite.	Ebonite.
Écartement des roues.	Wheelbase.
Échange.	Exchange.
Échanger.	To exchange.
Échantillon.	Pattern; sample.
Échappement.	Escape; exhaust.
Échappement, soupape d'.	Exhaust valve.
Échappement, tige de soupape d'.	Exhaust valve stem.
Échappement, tuyeau d'.	Exhaust pipe.
Échapper.	To escape.
Échauffement.	Heat; heating.
Échauffer.	To heat.
Échelle.	Scale; ladder.
Éclairage.	Light.
Éclairer.	To illuminate.
Éclaireur.	Headlight.
Éclater.	To explode.
Éclisse.	Clip.
Économie.	Economy.
Écrou.	Nut.
Écrou à crans.	Castle nut.
Écrou à oreilles.	Wing nut; finger nut; butterfly nut; thumb nut.
Écrou à six pans.	Hexagon nut.
Écrou carré.	Square nut.
Écrou de fausset.	Spigot nut.
Écrou molleté.	Knurled or milled nut.
Écrou helicoïdal.	Helicoid nut.
Écrou de rayon.	Spoke nipple.
Effectif-ive.	Effective.
Effet.	Effect.
Effiler.	To taper.
Égal-e.	Level.
Égalisateur.	Equaliser.
Égaliser.	To equalise.
Élargisseur de tubes.	Tube expanders.
Élastique.	Elastic.
Électricité.	Electricity.
Électrique.	Electric.
Électro-aimant.	Electro-magnet.
Électrode.	Electrode.
Électrolyte.	Electrolyte.
Élément.	Element.
Élévation.	Elevation.
Éliminatoire.	Elimination run.
Elliptique.	Elliptic.
Émail.	Enamel.
Emballage.	Packing.
Emballage en papier brun.	Brown paper packing.
Emballement.	Racing (of engine).
Emballer.	To pack.
Emboutir.	To hollow; to press hollow.
Embrayage.	Connection; coupling.
Embrayage à cône.	Cone clutch.
Embrayage à cônes de friction.	Friction clutch.
Embrayage à disques.	Multiple disc clutch.
Embrayage à friction métallique.	Metal-to-metal clutch.
Embrayage à griffe.	Dog clutch.
Embrayage à plateau.	Plate clutch.
Embrayage à spirale.	Coil clutch.
Embrayage, cône d'.	Clutch; coupling cone.
Embrayage de contraction.	Contracting clutch.
Embrayage extensible.	Expanding clutch.
Embrayage grippé.	Jammed clutch.
Embrayage magnétique.	Magnetic clutch.
Embrayer.	To connect; to engage.
Émeri.	Emery.
Émoudre.	To grind.

FRENCH.	ENGLISH.
Empattement.	Wheelbase.
Encliquetage.	Ratchet wheel.
Enclume.	Anvil.
Encombrement.	Obstruction.
Encombrer.	To obstruct.
Encrassement de la bougie.	Sooting of the plug.
Endommagé.	Injured.
Endurance.	Endurance.
Engrenage.	Gear.
Engrenage à crémaillière.	Rack gear.
Engrenage à poulie de friction.	Friction gear.
Engrenage à vis.	Screw gear.
Engrenage à vis sans fin.	Worm and wheel gear.
Engrenage cônique.	Bevel gear.
Engrenage de chaîne.	Chain gearing.
Engrenage de changement.	Change speed gear.
Engrenage de taquet.	Tappet gear.
Engrenage démultipliant de moitié.	Two-in-one gear.
Engrenage démultiplié.	Low gear.
Engrenage différentiel.	Differential; compensating gear.
Engrenage en spirale.	Spiral gear.
Engrenage épicycloïdal.	Crypto or epicyclic gear.
Engrenage helicoïdal.	Skew gear; helical gearing.
Engrenage planétaire.	Planetary gear.
Engrenage régulateur de vitesse.	Speed gear.
Engrenage torse.	Twist gear.
Engrener.	To mesh.
En gros.	Wholesale.
Enlever.	To detach; to remove.
Enregistrement.	Registration.
Entaille.	Nick.
Entailler.	Notching up.
Entonnoir.	Funnel.
Entourage; capot.	Bonnet.
Entrée.	Door; entrance.
Entrée d'arrière.	Rear entrance.
Entrée d'air.	Air inlet.
Entrée de l'air supplémentaire.	Extra air inlet.
Entrée latérale.	Side door.
Entrefer.	Spark gap.
Entretien.	Maintenance.
Enveloppe.	Cover; casing.
Enveloppe d'essieu.	Axle casing.
Enveloppe du cylindre.	Cylinder cover.
Enveloppe métallique inférieure.	Undershield.
Epais-se.	Thick.
Epaisseur.	Thickness.
Epreuve.	Test.
Eprouver.	To test.
Equilibre.	Balance; equilibrium.
Equilibrer.	To balance; to counterbalance.
Equipement.	Equipment; kit.
Equivalent.	Equivalent
Escompte.	Discount.
Espace.	Space.
Essai.	Trial.
Essence.	Gasoline.
Essence, tige de control d'.	Needle valve.
Essieu.	Axle.
Essieu d'arrière.	Rear axle.
Essieu d'avant.	Front axle.
Essieu fixe.	Fixed axle.
Essieu flottant.	Floating axle.
Essieu moteur arquée.	Cambered live axle.
Est.	East.
Estamper.	To stamp.
Estimation.	Estimation.
Établir; installer.	To install.
Étain.	Tin.
Étanche.	Hermetical; tight.
Étape.	Halting station; stage.
Étau.	Vice.
Étendre.	To expand.
Étincelle.	Spark.
Étincelle chaude.	Fat spark.
Etincelle éclatante.	Jump spark.
Étoupage.	Packing.
Étoupe.	Waste.
Étranglement, manivelle d'.	Throttle.
Étranglement de gaz.	Strangling of gas.
Étrangler.	To throttle.
Étrangler le gaz.	To shut off gas.
Étrier.	Yoke.
Évaluer.	To estimate.

FRENCH.	ENGLISH.
Évaporation.	Evaporation.
Évaporer.	To evaporate.
Examen.	Overhauling.
Examiner.	To overhaul; to examine.
Excentrique.	Eccentric.
Expansion.	Expansion.
Explosion.	Explosion.
Explosion dans le carburateur.	Back-firing in carburetter.
Explosion dans le silencieux.	Explosion in silencer.
Explosion prématuré.	Backfire; premature explosion.
Explosion retardé.	Delayed explosion.
Extensible.	Extensible.
Extérieur.	Outside.
Externe.	External.
Extincteur.	Fire extinguisher.
Fabricant.	Manufacturer.
Fabrication.	Manufacture.
Fabrique.	Factory.
Facile.	Easy.
Facture.	Bill; invoice.
Faible.	Weak.
Faux; fausse.	False.
Fente.	Crack.
Fer.	Iron.
Fer à soudure.	Soldering iron.
Fer à U.	Channel iron.
Fer blanc.	Tinplate.
Fer en angle.	Angle-iron.
Fer en saumon.	Pig-iron.
Fer en T.	T-iron.
Fer en U.	U-iron.
Fer forgé.	Wrought-iron.
Fermer.	To shut; to close.
Fermeture de circuit.	Closing of circuit.
Ferrure.	Iron mounting.
Feu.	Fire.
Feuille.	Leaf; blade.
Feutre.	Felt.
Fibre.	Fibre.
Fibre vulcanisé.	Vulcanised fibre.
Fil à haute tension.	High-tension wire.
Fil conducteur.	Conducting wire.
Fil de cuivre.	Copper wire.
Fil de fer.	Iron wire.
Fil de platine.	Platinum wire.
Fil de terre.	Ground wire; earth wire.
Fil électrique.	Electric wire.
Fil flexible.	Flexible wire.
Fil fusible.	Fuse wire.
Filière à vis.	Screw-plate; chaser.
Fil isolé.	Insulated wire.
Fil métallique.	Wire.
Fil primaire.	Primary wire.
Fil secondaire.	Secondary wire.
Filet de vis.	Screw-thread.
Filtre.	Filter; strainer.
Fin-e.	Fine.
Finir.	To finish.
Flamber; s'enflammer.	Flare up.
Flamme.	Flame.
Flasque de chassis.	Flitch plate.
Flotteur.	Float.
Flotteur crevé.	Punctured float.
Fonction.	Function.
Fonderie.	Foundry.
Fondre.	To cast; to fuse; to melt.
Fonte.	Casting; cast-iron.
Force.	Force; power.
Force centrifuge.	Centrifugal force.
Force électromotrice.	Electro-motive force.
Force nominale.	Nominal horse-power.
Forer.	To drill; to bore.
Foret.	Drill; borer; gimlet.
Forge.	Forge.
Forger.	To forge.
Forgeron.	Blacksmith.
Fort-e.	Strong.
Forte multiplication.	High gear.
Fosse de réparation.	Inspection pit.
Fourchette.	Fork.
Fourchette de débrayage.	Clutch fork.
Fournir.	To furnish.
Foyer.	Fire-box.
Fragile.	Brittle.
Frais.	Costs; charges; expense.
Frais de douane.	Customs duties.
Frais de transport.	Freight charges.
Frein.	Brake.
Frein à main.	Hand brake.

FRENCH.	ENGLISH.
Frein à pédale.	Foot brake.
Frein à ruban.	Band brake.
Frein de moteur.	Engine brake.
Frein intérieur.	Inside brake.
Frein, levier de.	Brake lever.
Frein, mâchoire du.	Brake clutch.
Frein, manette de.	Brake handle.
Frein, tambour du.	Brake drum.
Frein, tige de.	Brake rod.
Friction.	Friction.
Friction, surface de.	Friction-surface.
Froid-e.	Cold.
Front.	Front.
Frottement.	Friction; rubbing.
Frotter.	To rub.
Fuite.	Leakage.
Fuites.	Leaks.
Fumée.	Smoke.
Fusée.	Axle bearing; stub axle.
Fuyarde.	Runaway.
Gabarit.	Jig; template; templet.
Gagnant.	Winner.
Galet.	Roller.
Galvanisé.	Galvanised.
Gants.	Gloves.
Garage.	Garage.
Garde-boues.	Mudguards.
Garde-crotte.	Mudguard.
Garde poussière.	Dust screen.
Gare.	Railway station.
Garnie de.	Provided with; fitted with.
Garniture.	Packing (mach.).
Garniture de chanvre.	Hemp packing.
Garniture de fibre.	Fibre packing.
Garniture métallique.	Metallic packing.
Gauche.	Left.
Gauchissement.	Buckling.
Gaz.	Gas.
Gaz brûlé.	Exhaust gas.
Gaz d'huile.	Oil gas.
Geler.	To freeze.
Générateur.	Generator.
Gicleur.	Injector; jet.
Glace.	Ice.
Glisser.	To slip.
Godet à graisse.	Grease cup or box.
Gonfler.	To inflate.
Gonfleur.	Air pump.
Gorge.	Groove.
Goujon.	Wrist pin; stud gudgeon.
Goupille.	Cotter pin.
Goupille conique.	Taper pin.
Goupille fendue.	Split pin.
Gousset.	Gusset; bracket; brace.
Grade; dégré.	Degree.
Gradomètre.	Gradometer.
Grain.	Grain.
Graissage.	Grease; oiling.
Graissage à bagues.	Ring lubrication.
Graisse.	Fat; oil; lubricant.
Graisse consistante.	Stauffeur grease.
Grasser.	To grease; lubricate; oil.
Graisseur.	Grease; lubricator; oil feed; oil tank.
Graisseur à compte-gouttes.	Gravity-feed lubricator.
Graisseur à comptes-gouttes.	Drop-oiler.
Graisseur à coup de poing.	Force-feed lubricator.
Graisseur à débit visible.	Sight-feed lubricator.
Graisseur par barbotage.	Splash lubricator.
Grand-e.	Large.
Graphite.	Graphite.
Gravier.	Gravel.
Gravir des rampes.	To climb hills.
Gravité spécifique.	Specific gravity.
Griffe.	Claw.
Grillage.	Wire guard.
Grille.	Grating.
Grille de changement de vitesse.	Gate change.
Grille de commande.	Gear control gate.
Gripper.	To seize.
Grue.	Crane.
Guide.	Guide; guide rod.
Habits.	Clothing or dress.
Hache.	Hatchet.
Handicap.	Handicap.

FRENCH.	ENGLISH.
Hausser.	To hoist; to lift.
Haut-e.	High.
Hauteur.	Height; pitch.
Haut pression.	High pressure.
Hélice.	Thread.
Hérisson.	Spur wheel; sprocket wheel.
Hérisson; roue de chaîne.	Chain wheel.
Hermetique.	Hermetical; tight.
Horizontal-e.	Horizontal.
Housse.	Dust cover.
Huile.	Oil.
Huile de lin cuite.	Boiled linseed oil.
Huile lubricante.	Lubricating oil.
Huile minérale.	Mineral oil.
Humide.	Wet.
Hydromètre.	Hydrometer; water gauge.
Ignition spontanée.	Spontaneous ignition.
Imparfait-e.	Imperfect.
Imperméable.	Waterproof.
Incapable.	Unable.
Incontrôlable.	Uncontrollable.
Incrustation.	Incrustation.
Indicateur.	Gauge; indicator.
Indicateur de niveau.	Gauge glass.
Indicateur de pôle.	Pole indicator.
Indicateur de vitesse.	Speed indicator.
Indicateur d'huile.	Oil gauge.
Indiquer.	To indicate.
Inducteur.	Inductor.
Induction.	Induction.
Induction automatique.	Self-induction.
Induire.	To induce.
Inégal-e.	Uneven.
Inertie.	Inertia.
Inexplosif-ive.	Non-explosive.
Inférieur-e.	Lower.
Informer.	To inquire.
Ingénieur.	Engineer.
Ingouvernable.	Ungovernable.
Injecteur.	Injector.
Inspecter.	To inspect.
Instrument.	Instrument.
Intact-e.	Undamaged; intact.
Intensificateur.	Intensifier.
Interchangeable.	Interchangeable.
Intérieur.	Inside; internal.
Intermédiaire.	Intermediate.
Interrompre.	To interrupt.
Interrupteur.	Electric switch; interrupter; commutator.
Interrupteur à couteau.	Knife switch.
Interruption.	Interruption.
Interstice.	Interstice; space.
Intervalle.	Interval.
Invention.	Invention.
Irreversible.	Irreversible.
Isolateur.	Insulator.
Isolement.	Insulation.
Isolement au mica.	Mica insulation.
Isoler.	To insulate.
Jante.	Rim; felloe.
Jauge pour fil métallique.	Wire gauge.
Jet.	Jet.
Jeu.	Play; backlash.
Joindre.	To unite.
Joint.	Joint.
Joint à brides.	Flange joint.
Joint à la cardan.	Knuckle joint; cardan joint.
Joint à rotule.	Globe joint.
Joint à vis.	Screw joint.
Joint coudé.	Toggle joint.
Joint défectif.	Leaking joint.
Joint de la soupape.	Valve joint.
Joint en caoutchouc.	Hose coupling.
Joint étendue.	Expanded joint.
Joint glissant.	Expansion joint.
Joint sphérique.	Ball and socket joint.
Joint universel.	Universal joint.
Jointure.	Joint; knuckle.
Jour.	Day; daylight.
Jumelé.	Coupled; paired; twin.
Kilogramme.	Kilogramme.
Kilomètre.	Kilometre.
Lame.	Blade.
Lame de contact.	Contact spring.

FRENCH.	ENGLISH.
Laminé-e.	Rolled (mach.).
Lampe arrière.	Tail light.
Lampe à souder.	Blowlamp.
Lampe à soudure.	Soldering lamp.
Lampe de Davy.	Davy lamp.
Lampe de visite.	Inspection lamp.
Lampe électrique.	Electric lamp.
Lampes.	Lamps.
Lampe témoin.	Test lamp.
Lance.	Nozzle.
Lanterne.	Lantern ; lamp.
Lanterne à acétylene.	Acetylene lamp.
Large.	Wide.
Largeur.	Width.
Lavage.	Washing.
Laver.	To wash.
Léger ; légère.	Light.
Lent-e.	Slow.
Lentille.	Lens.
Levée de soupape.	Valve lift.
Lève soupape d'échappement.	Exhaust valve lifter.
Levier.	Lever ; crowbar.
Levier à bascule.	Trip or trip lever.
Levier-bascule.	Rocker.
Levier courbé.	Knee-lever.
Levier de changement de marche.	Reverse lever.
Levier de frein.	Brake lever.
Levier d'embrayage.	Coupling lever.
Levier de vitesse.	Speed lever.
Levier de vitesse d'arrêt.	Clutch lever.
Liaison.	Joining ; connection.
Lien ; boucle.	Shackle.
Lier.	To fasten.
Ligne.	Line.
Lignes de force.	Lines of force.
Lime.	File.
Lime bâtarde.	Bastard file.
Limer.	To file.
Limite de vitesse.	Maximum speed.
Litre.	Litre.
Livraison.	Delivery.
Longeron.	Sill.
Longueur.	Length.
Loquet.	Latch.
Louer.	To rent ; to hire.
Lourd-e.	Heavy.
Lumière.	Light.
Lumière d'échappement.	Exhaust port.
Lunettes.	Goggles.
Machine.	Machine.
Machine à vapeur.	Steam engine.
Machine composé.	Compound engine.
Machiniste.	Machinist.
Mâchoire.	Jaw ; claw ; clutch.
Mâchoire de filière.	Dies.
Mâchoire du frein.	Brake clutch.
Magasin.	Warehouse.
Magnétique.	Magnetic.
Magnéto.	Magneto.
Magnéto Bosch.	Bosch ignition.
Maintien.	Maintenance.
Maillon.	Link ; chain link.
Maison.	House.
Mal, mauvais.	Bad.
Malheur.	Bad luck.
Manche.	Handle.
Manchon d'essieu.	Axle sleeve.
Manchon.	Coupling box ; sleeve.
Mandrin.	Mandrel.
Manette.	Handle ; hand lever.
Manette de frein.	Brake handle.
Manier.	To handle.
Manivelle.	Crank handle.
Manivelle d'allumage.	Spark lever.
Manivelle de lancement.	Starting crank.
Manivelle de mise en marche.	Starting handle.
Manivelle d'étranglement.	Throttle.
Manomètre.	Manometer ; steam gauge.
Manquer.	To miss.
Marchand.	Dealer ; merchant.
Marche.	Running ; going.
Marche arrière.	Reverse.
Marchepied.	Carriage step ; running board.
Marcher.	To go ; to run.
Marque.	Brand ; make.
Marque de fabrique.	Trade mark.
Marteau.	Hammer.

FRENCH.	ENGLISH.
Matière.	Material ; substance.
Mécanicien.	Mechanic.
Mécanique.	Mechanical.
Mécanisme.	Mechanism.
Mécanisme de direction.	Steering gear.
Mécanisme de changement de marche.	Reversing gear.
Mèche.	Bit ; wick.
Mèche anglaise.	Centre-bit.
Mélange.	Mixture.
Mélange détonant.	Explosive mixture.
Menottes de ressorts.	Dumb-irons.
Mesure.	Measure.
Mesurer.	To measure.
Métal.	Metal.
Métal blanc.	White metal.
Mètre.	Metre.
Mètre en ruban.	Tape measure.
Mettre en marche.	To put in motion.
Mica.	Mica.
Micromètre.	Micrometer.
Millimètre.	Millimetre.
Mince.	Thin.
Minium.	Red lead.
Mise en marche.	Starting.
Mobile.	Movable.
Modèle.	Model ; type.
Moitié.	Half.
Moleté.	Knurling.
Mou, molle.	Soft.
Moment.	Momentum.
Montage de fils.	Wiring.
Montagne.	Mountain.
Montée.	Ascent ; hill.
Monter.	To fit ; to assemble (mach.) ; to ascend.
Montre.	Watch.
Moteur.	Engine ; motor.
Moteur à deux temps.	Two-cycle motor.
Moteur à explosion.	Internal combustion engine.
Moteur à huile lourde.	Heavy oil motor.
Moteur à quatre temps.	Four-cycle motor.
Moteur électrique.	Electric motor.
Moteur horizontal.	Horizontal motor.
Moteur pour poids lourds.	Heavy traffic motor.
Moteur verticaux.	Vertical motor.
Motocyclette.	Motor cycle.
Mouillé-e.	Wet.
Moulage.	Casting ; moulding.
Mouvement.	Motion.
Moyenne.	Average.
Moyeu.	Hub ; nave.
Munie de.	Fitted with ; provided with.
Napthe.	Kerosene ; naphtha.
Nécessaire.	Bag ; satchel.
Nécessaire.	Necessary.
Nécessité.	Necessity.
Négatif-ve.	Negative.
Neige.	Snow.
Nervure.	Rib ; shoulder.
Nettoyage.	Cleaning.
Nettoyer.	To clean.
Neutre.	Neutral.
Nickel.	Nickel.
Nickeler.	To nickel.
Niveau.	Level.
Niveau, au-.	On the level.
Nœud.	Knot.
Noir-e.	Black.
Nombre.	Number.
Nom.	Name.
Nord.	North.
Normal-e.	Normal.
Nouveau, nouvelle.	New.
Novice.	Beginner.
Noyage.	Flooding.
Noyau.	Core.
Odeur.	Odour.
Odomètre.	Distance-meter.
Opérer.	To handle ; to operate
Opposée.	Opposed.
Organe.	Organ ; part.
Orifice.	Opening.
Ornière.	Rut.
Ouest.	West.
Outil.	Tool.
Outillage.	Tooling.
Outils et accessoires.	Tools and accessories.
Ouvert-e.	Open.

FRENCH.	ENGLISH.
Ouvrier.	Workman.
Ouvrir.	To open.
Oxyde.	Oxide.
Paiement.	Payment.
Paiement, conditions de.	Conditions of payment.
Pailliette de contact.	Contact maker.
Palier.	Base; bearing; plummer block.
Palisade.	Fence.
Panier.	Basket; hamper.
Panne.	Accident; mishap; breakdown.
Paraffine.	Paraffin.
Pare-brise.	Wind screen.
Parcour.	Run.
Palier de butée.	Thrust bearing.
Pas.	Pace; thread; pitch (screw).
Pas d'une vis.	Screw pitch.
Passage.	Passage.
Passer.	To pass.
Patiner.	Skid.
Payer d'avance.	To prepay.
Péage.	Toll.
Pédale.	Pedal.
Pédale à poussoir.	Push-pedal.
Pédale à régulateur.	Regulator pedal.
Pédale d'accélerateur.	Accelerator pedal.
Pédale de frein.	Brake pedal.
Pédale d'embrayage.	Clutch pedal.
Pédales.	Pedals.
Peindre.	To paint.
Peintre.	Painter.
Peinture.	Paint.
Percer.	To bore; to drill; to pierce.
Perçoir.	Borer; drill.
Perdant.	Loser.
Perfectionner.	To perfect; to improve.
Permit.	Licence.
Péroxyde de plomb.	Peroxide of lead.
Perte.	Leakage; loss.
Perte de charge.	Loss of pressure.
Perte de frottement.	Loss of friction.
Peser.	To weigh.
Petit-e.	Small.
Pétrole.	Paraffin.
Phare.	Headlight.
Phase.	Phase; cycle.
Pièce.	Part; piece.
Pièce de rechange.	Repair part; reserve piece.
Pièce de reserve.	Spare part.
Pièce en T.	T joint.
Pièce estampée.	Drop forging.
Pièce forgée.	Forging.
Pied.	Foot.
Pignon.	Pinion; small cogwheel.
Pignon à éperon.	Spur gear.
Pignon conique.	Bevel pinion.
Pignon de chaîne.	Chain ring.
Pignon différentiel.	Differential pinion.
Pignon de pompe.	Pump pinion.
Pignon droit.	Spur pinion.
Pile.	Cell.
Piles.	Dry battery.
Piles sèches.	Dry cells.
Pince.	Nippers; pincers; pliers.
Piston.	Piston.
Piston, segment de.	Piston ring.
Pivot.	Pivot.
Place.	Place; room; seat.
Placer.	To place.
Plan.	Plane.
Planche.	Board.
Plancher.	Floor.
Planetaire.	Planetary.
Plat-e.	Flat.
Platine.	Platinum.
Plaque.	Plate.
Plaque numérotée.	Number-plate.
Plier.	To bend.
Plomb.	Lead.
Plombagine.	Graphite; blacklead.
Plomb blanc.	White lead.
Plomb en saumon.	Pig-lead.
Plombier.	Plumber.
Pluie.	Rain.
Pneu.	Tyre.
Pneu crevé.	Punctured tyre.
Pneumatique.	Tyre; pneumatic.

FRENCH.	ENGLISH.
Pneumatique; bandage.	Tyre casing.
Poche d'air.	Air-lock.
Poids.	Weight.
Poids brut.	Gross weight.
Poids et mesures.	Weights and measures.
Poids net.	Net weight.
Poinçon.	Punch.
Point.	Point.
Point d'ébullition.	Boiling point.
Point de congélation.	Freezing point.
Pointes de contact.	Contact points.
Point mort.	Neutral point.
Point objectif.	Objective point.
Polarité.	Polarity.
Pôle.	Pole.
Pôle negatif.	Negative pole.
Pôle positif.	Positive pole.
Poli.	Smooth.
Polir.	To polish.
Pompe.	Pump.
Pompe à circulation.	Circulating pump.
Pompe à deux voies.	Two-way pump.
Pompe à double effet.	Double-acting pump.
Pompe à graisse.	Grease pump.
Pompe à main.	Hand pump.
Pompe à piston.	Piston pump.
Pompe à piston plongeur.	Plunger pump.
Pompe à pression.	Pressure pump.
Pompe à propulseur.	Propeller pump.
Pompe à vapeur.	Steam pump.
Pompe centrifuge.	Centrifugal pump.
Pompe à air.	Air pump.
Pompe d'alimentation.	Feed pump.
Pompe d'alimentation à main.	Hand-feed pump.
Pompe d'aspiration.	Suction pump.
Pompe d'eau.	Water-circulating pump.
Pompe à engrenage.	Gear pump.
Pompe d'huile.	Oil pump.
Pompe de pression.	Force pump.
Pompe rotative.	Rotary pump.
Ponce.	Pumice-stone.
Pont.	Bridge.
Pont tournant.	Turntable.
Porosité.	Porosity.
Porte.	Door; inlet.
Porte-balais.	Brush-holder.
Porte de visite.	Inspection-plate.
Portée.	Carrier.
Porte lanterne.	Lamp bracket.
Position.	Position.
Positive.	Positive.
Potentiel.	Potential.
Pot silencieux.	Silencer.
Pouce.	Inch.
Poudre de rodage.	Grinding powder.
Poulie.	Pulley; tackle.
Poulie à cone.	Cone pulley.
Poulie de courroie.	Belt pulley.
Poulie de frein.	Brake pulley
Poulie de tension.	Jockey pulley.
Poulie extensible.	Expanding pulley.
Poussée.	Thrust.
Poussée latérale.	Lateral thrust.
Pousser.	To push.
Poussière.	Dust.
Prématuré-e.	Premature.
Première vitesse.	First speed.
Presse étoupe.	Stuffing-box.
Pression.	Pressure.
Pression dans le moteur.	Engine pressure.
Pression hydraulique.	Water pressure.
Pression initiale.	Initial pressure.
Principe.	Principle.
Prise directe.	Direct coupling; direct drive.
Prix.	Price; prize.
Profil.	Profile.
Projecteur.	Searchlight.
Protecteur.	Protector.
Propriétaire.	Owner.
Provision.	Supply.
Puissance.	Power.
Puissance de cheval.	Horse-power.
Pulvérisateur.	Vaporiser; sprayer; atomiser.
Qualitatif-ive.	Qualitative.
Qualité.	Quality.
Quantitatif-ive.	Quantitative.
Quantité.	Quantity.
Quatrième vitesse.	Fourth speed.

FRENCH.	ENGLISH.
Questionner.	To question.
Queue.	End ; tail-piece.
Queue d'aronde.	Dovetail.
Quittance.	Receipt.
Rabot.	Plane.
Raccord.	Union ; pipe union.
Raccord à vis.	Screwed union.
Raccords.	Pipe connections.
Raccourcir.	To shorten.
Radiateur.	Radiator.
Radiateur à nid d'abeille.	Honeycomb radiator.
Rainer.	To groove.
Rainure.	Groove.
Rainure de calage.	Key-seat ; key-way.
Rainure de clavette.	Key-groove.
Ralentir.	To slow up.
Ralentisseur.	Retarder.
Rampe.	Grade ; hill.
Rapide.	Fast ; quick.
Rapport.	Ratio.
Rayon.	Radius (circle).
Rayon.	Radius ; spoke.
Rayons tubulaires.	Tubular spokes.
Rebord.	Flange.
Recharger.	To recharge.
Rechauffeur d'alimentation.	Feed water heater.
Reconstruction.	Reconstruction.
Record.	Record.
Recuire.	To anneal.
Réduire.	To reduce.
Refaissant le coussinet.	Rebushing.
Réflecteur.	Reflector.
Refroidir.	To cool.
Refroidissement.	Cooling.
Refroidissement par air.	Air-cooling.
Refroidissement par eau.	Water-cooling.
Réglage.	Regulation.
Réglage automatique.	Governing.
Régler.	To regulate.
Régulateur.	Governor ; regulator.
Régulateur centrifuge.	Centrifugal regulator.
Régulateur d'alimentation	Feed water regulator.
Régulateur à soupape d'échappement.	Exhaust valve regulator.
Relier.	To join ; to connect.
Remorquer.	To haul.
Remplacer.	To replace.
Rempli.	Full.
Remplir.	To fill.
Remplissage.	Filling.
Rendement.	Efficiency.
Rendement mécanique.	Mechanical efficiency.
Renforcer.	To strengthen.
Renverser.	To overturn.
Renverser la marche.	To reverse.
Réparations.	Repairs.
Réparer.	To mend ; to repair.
Réservoir.	Tank.
Réservoir d'alimentation.	Feed tank.
Réservoir d'eau.	Water tank ; water jacket.
Réservoir d'huile.	Oil tank.
Résidu.	Residuum ; sediment.
Résine.	Resin.
Résistance.	Resistance.
Résistance à la jante.	Road resistance.
Résistance à la traction.	Tensile strength.
Ressort.	Spring.
Ressort à boudin.	Wire spring.
Ressort à spirale.	Spiral spring.
Ressort de frein.	Brake spring.
Ressort d'embrayage.	Clutch spring.
Ressort de soupape d'admission.	Inlet valve spring.
Ressort helicoïdal.	Helical spring.
Ressorts demi-pincettes.	Grasshopper springs.
Ressorts elliptiques.	Elliptic springs.
Ressorts en volute.	Volute springs.
Retarder.	To retard.
Retour de gaz.	Blow-back.
Retourner.	To return.
Reversible.	Reversible.
Révolution.	Revolution.
Rheostat.	Rheostat.
Rideau.	Curtain.
Rigide.	Rigid ; stiff.
River.	To rivet.
Rivet.	Rivet.
Rivet de chaîne.	Chain rivet.
Robinet.	Cock ; faucet ; tap.

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FRENCH.	ENGLISH.
Robinet à deux voies.	Two-way tap ; by-pass.
Robinet à vapeur.	Steam cock.
Robinet d'arrêt.	Stop cock.
Robinet d'eau.	Water cock.
Robinet de compression.	Compression tap.
Robinet de décompression.	Relief cock.
Robinet de purge.	Drain cock or tap.
Robinet d'essai.	Petcock.
Robinet de vidange.	Blow-off cock.
Robinet d'indicateur.	Gauge cock.
Roder les soupapes.	Grinding valves.
Rond-e.	Round.
Rondelle.	Washer.
Rondelle à ressort.	Spring washer.
Rondelle de cuir.	Leather washer.
Rondelle de mica.	Mica washer.
Rotation.	Rotation.
Roue.	Wheel.
Roue à chaîne.	Sprocket wheel.
Roue à déclic.	Ratchet wheel.
Roue à friction.	Friction wheel.
Roue à main.	Hand wheel.
Roue à rayons métalliques.	Wire wheels.
Roue arquée.	Cambered wheel.
Roue conique.	Bevel wheel.
Roue arrière.	Rear wheel.
Roue avant.	Front wheel.
Roue de direction.	Steering wheel.
Roue d'engrenage.	Gear wheel.
Roue dentée.	Cog wheel.
Roue de rechange.	Spare wheel.
Roue de voiture.	Road wheel.
Roue droite.	Cylindrical wheel ; spur wheel.
Roue hélice.	Worm wheel.
Roue type d'artillerie.	Artillery wheel.
Rouge.	Red.
Rouillé.	Rusty.
Rouleaux, coussinet à-.	Roller bearing.
Roulement.	Running.
Roulement à billes.	Ball bearing.
Rouler.	To run.
Route.	Road.
Ruban.	Band.
Ruban isolant.	Insulating tape.
Rupture.	Rupture ; break.
Sable.	Sand ; gravel.
Sabot du frein.	Brake block ; brake shoe.
Sac.	Bag.
Sac à outils.	Kitbag.
Salaire.	Wages.
Sale.	Dirty.
Saleté.	Dirt.
Sans fin.	Endless.
Savon.	Soap.
Scie.	Saw.
Sec ; sèche.	Dry.
Seconde vitesse.	Second speed.
Secours.	Assistance.
Secousse.	Jerk ; shock.
Secteur.	Sector.
Segment.	Segment.
Segment denté.	Ratchet.
Segment de piston.	Piston ring.
Sel.	Salt.
Serpent à vapeur.	Steam coil.
Serre fil.	Binding screw ; terminal.
Serrer.	To fasten ; screw ; tighten.
Serrurier.	Locksmith.
Service.	Service.
Seul-e.	Single.
Siège.	Place ; seat.
Siège de conducteur.	Box-seat.
Siège de soupape d'admission.	Inlet valve seat.
Siège d'une soupape.	Valve seat.
Siège pivotant.	Tilting seat.
Signal.	Signal.
Signe.	Signal ; sign.
Silencieux.	Silencer ; exhaust box.
Simple.	Simple.
Sol.	Floor ; ground.
Solid-e.	Solid.
Solution.	Solution.
Solution anti-réfrigérante.	Anti-freezing solution.
Souder.	To solder ; to weld.
Soudure.	Solder ; seam.
Soufflet.	Bellows.
Soumis aux droits.	Dutiable.
Soupape.	Valve.

FRENCH.	ENGLISH.
Soupape à bille.	Ball valve.
Soupape à clapet.	Clack valve; flap valve.
Soupape à papillon.	Butterfly or throttle valve.
Soupape atmosphérique.	Atmospheric valve.
Soupape automatique.	Automatic valve.
Soupape conique.	Conical valve.
Soupape d'admission.	Admission valve; inlet valve; suction valve.
Soupape d'admission mécanique.	M.O.V.; mechanically operated inlet valve.
Soupape d'air.	Air valve.
Soupape d'alimentation.	Feed valve.
Soupape annulaire.	Annular valve.
Soupape d'arrêt.	Check valve.
Soupape d'échappement.	Exhaust valve.
Soupape de compression.	Compression valve.
Soupape de refoulement.	Delivery valve.
Soupape de soulagement.	Relief valve.
Soupape de sureté.	Safety valve.
Soupape en caoutchouc.	Indiarubber valve.
Soupape piquée.	Pilled valve.
Soupape purgeur.	Blow-off valve.
Soupape rotative.	Rotary valve.
Souple.	Flexible.
Souplesse.	Flexibility.
Spécial-e.	Special.
Start.	Start.
Starter.	Starter.
Station de charge.	Charging station.
Statuts.	Laws.
Strapontin.	Folding-seat.
Succès.	Success.
Sud.	South.
Sulfatation.	Sulphating.
Supérieur-e.	Upper.
Supplément d'air.	Air supply; extra air.
Support.	Support; truss.
Support de ressort	Spring hanger.
Support principale.	Main bearing.
Supprimer.	To suppress.
Surcharge.	Overloading.
Surchauffe.	Superheating.
Surchauffement.	Overheating.
Surchauffer.	To overheat.
Surface.	Surface.
Surface de contact.	Contact surface.
Surface de friction.	Friction surface.
Suspension.	Suspension.
Suspension par trois points.	Three-point suspension.
Synchroniser.	To synchronise.
Syphon.	Syphon.
Système.	System.
Système de transmission.	Transmission system.
Système métrique.	Metric system.
Tablier.	Apron; dashboard.
Tachymètre.	Tachometer.
Talc.	French chalk.
Talon de pneu.	Bead of tyre.
Tambour.	Drum.
Tambour du frein.	Brake drum.
Tampon.	Buffer.
Tapage.	Knocking.
Taquet de soulèvement.	Tappet rod.
Tarif.	Tariff.
Tarrière.	Auger.
Technique.	Technical.
Télégramme.	Telegram.
Télégraphier.	To telegraph.
Temps.	Time; weather.
Temps d'aspiration.	Suction stroke.
Temps de compression.	Compression stroke.
Temps d'expulsion.	Exhaust stroke.
Tension.	Tension.
Tête.	Head.
Tête de bielle.	Crosshead; big end.
T, fer en-.	T iron.
Thermosyphon.	Thermosyphon.
Tige.	Rod; stem.
Tige de control d'essence.	Needle valve.
Tige de direction.	Steering-post.
Tige de flotteur.	Float spindle.
Tige de frein.	Brake rod.
Tige de la soupape.	Valve rod.
Tige de soupape.	Valve stem.
Tige de soupape d'admission.	Inlet valve stem.
Tige de soupape d'échappement.	Exhaust valve stem.
Tirant.	Stay.

FRENCH.	ENGLISH.
Tire-clou.	Nail-puller.
Tirer.	To haul; to pull.
Tiroir.	Slide valve.
Tissu métallique.	Wire-cloth.
Toc.	Lifter; tappet.
Toc de rupture.	Interrupter catch.
Toile.	Linen; cloth.
Toile d'amiante.	Asbestos cloth.
Toile émeri.	Emery-cloth.
Toile métallique.	Wire-gauze; gauze.
Tôle.	Sheet-iron.
Tôle courbée.	Bent sheet-iron.
Tôle emboutie.	Pressed steel.
Tôle d'acier.	Sheet-steel; steel-plate.
Tôle en angle.	Angle sheet-iron.
Tonneau.	Tonneau.
Torque.	Torque.
Torsion.	Torsion.
Tour.	Lathe; revolution.
Tourillon.	Axle-end.
Tourisme.	Touring.
Tourner.	To turn.
Tournevis.	Screwdriver.
Tourniquet.	Swivel.
Train.	Train.
Train balladeur.	Sliding-gear.
Tranchant.	Edge.
Tranchant.	Sharp.
Tranche.	Chisel.
Transmission.	Transmission.
Transmission à cardan.	Shaft drive.
Transmission à chaîne.	Chain drive.
Transmission à pignon conique.	Bevel gear drive.
Transmission par courroie.	Belt drive.
Transmission par vis sans fin.	Worm drive.
Transmission planetaire.	Planetary gear.
Transport.	Transportation.
Transporter.	To transport.
Transversal-e.	Transverse.
Travail.	Labour; work.
Travailler.	To work.
Traverse.	Cross-bar; truss.
Trembler.	To vibrate.
Trembleur.	Contact breaker.
Trembleur automatique.	Auto-trembler.
Tremper.	To temper; to harden; to soak.
Trépidation.	Vibration.
Trésse.	Gasket.
Tricar.	Tricar.
Triple.	Triple.
Troisième vitesse.	Third speed.
Trompe.	Trumpet; horn.
Trou.	Hole.
Trouble.	Trouble.
Trou de rivet.	Rivet-hole.
Trousse à réparation.	Repair outfit.
Trouver.	To find.
Tube.	Tube.
Tube d'alimentation.	Feed pipe.
Tube de caoutchouc.	Indiarubber tube.
Tube de niveau.	Glass gauge.
Tubes bouchés.	Clogged tubes.
Tubes de la chaudière.	Boiler tubes.
Tubulaire.	Tubular.
Tuyau.	Pipe; tube.
Tuyau à vapeur.	Steam pipe.
Tuyau d'admission.	Inlet pipe; induction pipe.
Tuyau d'allumage.	Ignition tube.
Tuyau d'échappement.	Exhaust pipe.
Tuyau de mélange.	Mixing tube.
Tuyau de trop plein.	Overflow pipe.
Tuyau purgeur.	Blow-off pipe.
Tuyauterie.	Piping.
Tuyaux d'eau.	Water pipes.
Type.	Type; model.
Uniformément.	Uniformly.
Unir.	To unite.
Unité.	Unit.
Universel-le.	Universal.
Un raté.	Misfire.
Usage.	Use; usage.
User.	To use.
Usine.	Factory.
Usure.	Usage; wear and tear.
Utile.	Useful.
Utilité.	Utility.

FRENCH.	ENGLISH.
Valeur.	Value.
Vapeur.	Steam ; vapour.
Vapeur à haute pression.	High-pressure steam.
Vapeur epuisée.	Exhaust steam.
Vapeur saturée.	Saturated steam ; wet steam.
Vapeur sous pression.	Live steam.
Vapeur surchauffée.	Superheated steam.
Vapeur visible.	Visible vapour.
Vaporisation.	Vaporisation.
Variable.	Variable.
Variation.	Variation.
Vaste.	Roomy ; big.
Véhicule.	Vehicle.
Vélocité.	Velocity ; speed.
Ventilateur.	Ventilator ; fan.
Vérin.	Jack screw.
Vernir.	To polish.
Vernis.	Varnish.
Vernisser.	To varnish.
Verre.	Glass.
Versement à compte.	Account-payment.
Vert-e.	Green.
Vertical-e.	Vertical.
Vibration.	Vibration.
Vibrer.	To vibrate.
Vidange.	Emptying.
Vide.	Vacuum ; empty ; hollow.
Vieux pétrole.	Stale petrol.
Vilebrequin.	Crankshaft.
Virage.	Turn (road).
Vis.	Screw.
Vis à double filet.	Double-threaded screw.
Vis à oreille.	Thumb screw.
Vis à tête ronde.	Round-headed screw.
Viscosité.	Viscosity.
Vis d'arrêt.	Grub screw.
Vis de contact.	Contact screw.
Vis de fixation.	Fixing screw.
Vis de réglage.	Set screw ; adjusting screw.
Vis filetée à droite.	Right-hand screw.
Visiter.	To inspect ; to examine.
Vis noyée.	Countersunk screw.
Vis perdue.	Sunk screw.
Vis platinée.	Platinum tipped screw.
Vis san fin.	Endless screw.
Visser.	To screw.
Vitesse.	Speed.
Vitesse du piston.	Piston speed.
Voie.	Tread ; way.
Voiture.	Carriage ; automobile.
Voiture à vapeur.	Steam car.
Voiture à voyageurs.	Passenger vehicle.
Voiture automobile.	Motor car.
Voiture de livraison.	Delivery van.
Voiture de tourisme.	Touring car.
Voiture électrique.	Electric car.
Voiture sans contrôle.	Unattended car.
Voiturette.	Small automobile ; run-about.
Volant.	Flywheel.
Volt.	Volt.
Voltage.	Voltage.
Voltmètre.	Voltmeter.
Volume.	Bulk ; volume.
Voyage.	Travel.
Vue.	View.
Vulcaniser.	To vulcanise.
Vulcaniseur.	Vulcaniser.
Watt.	Watt.
Watt-heure.	Watt-hour.
Zinc.	Zinc.
Zinc en tôle.	Zinc-plate.
Zinquer.	To zinc.

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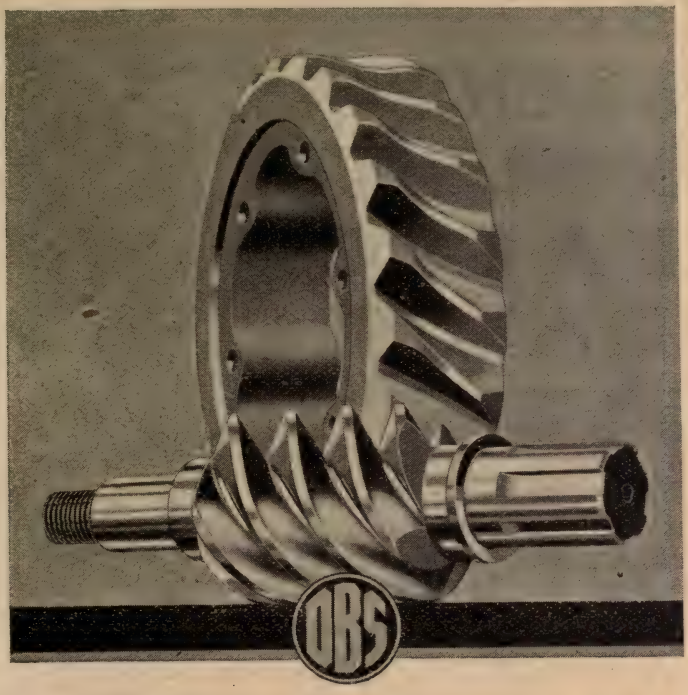

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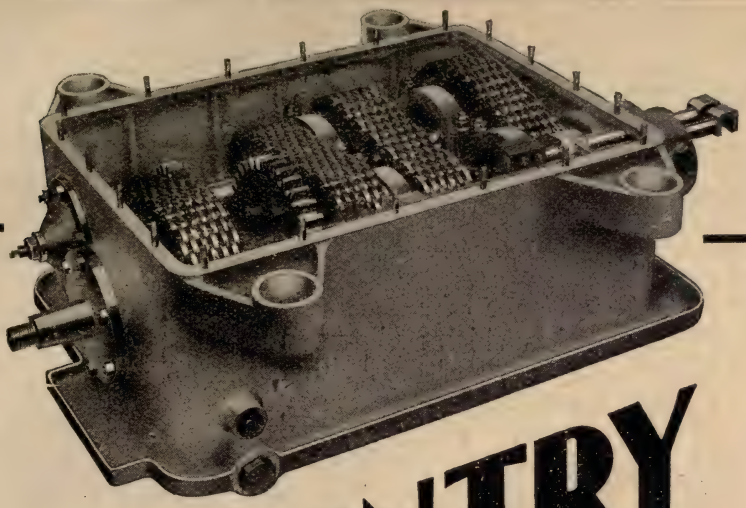

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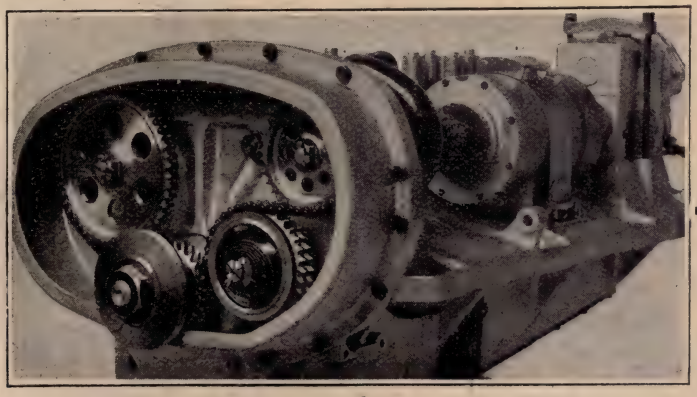

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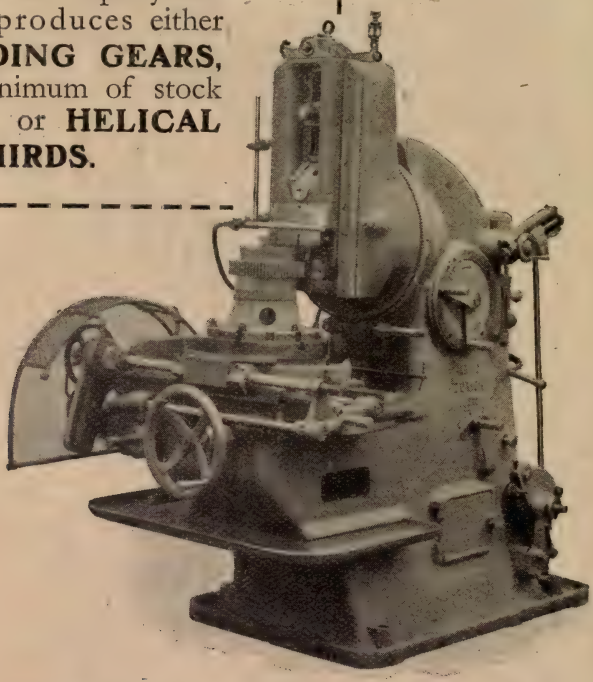

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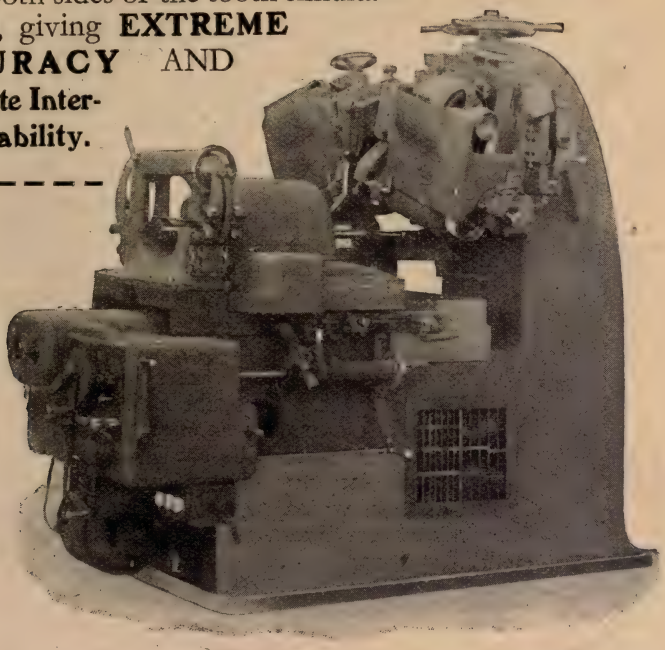

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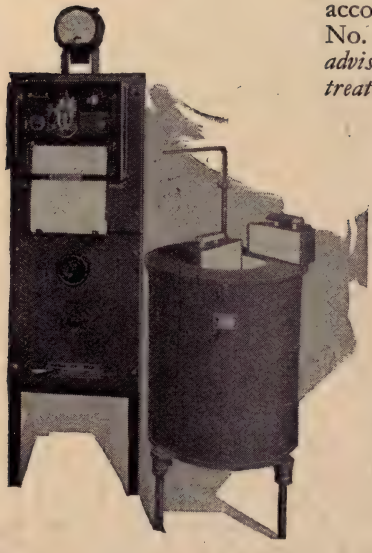

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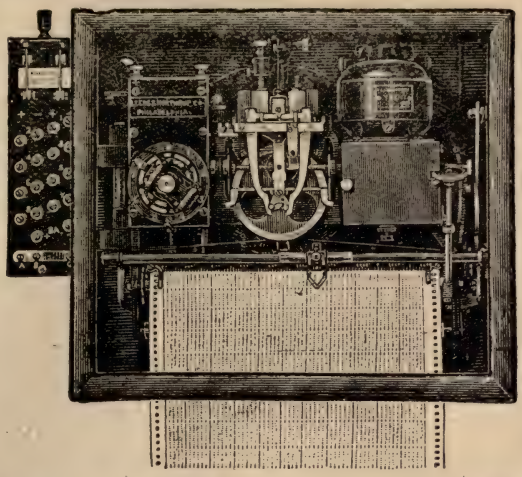

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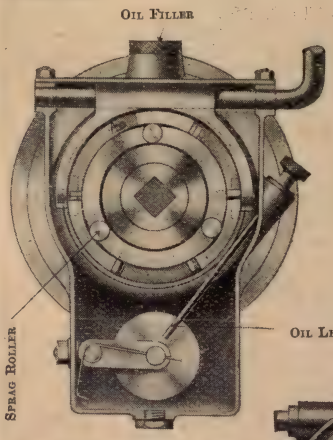

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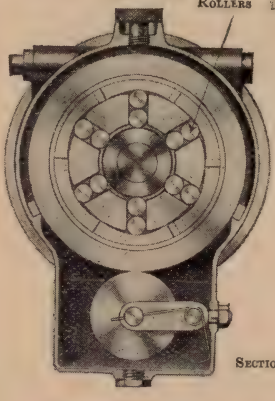

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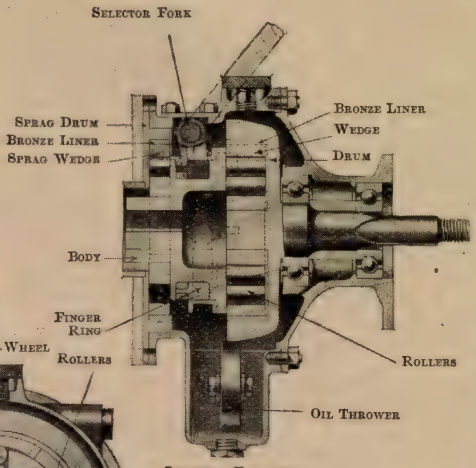

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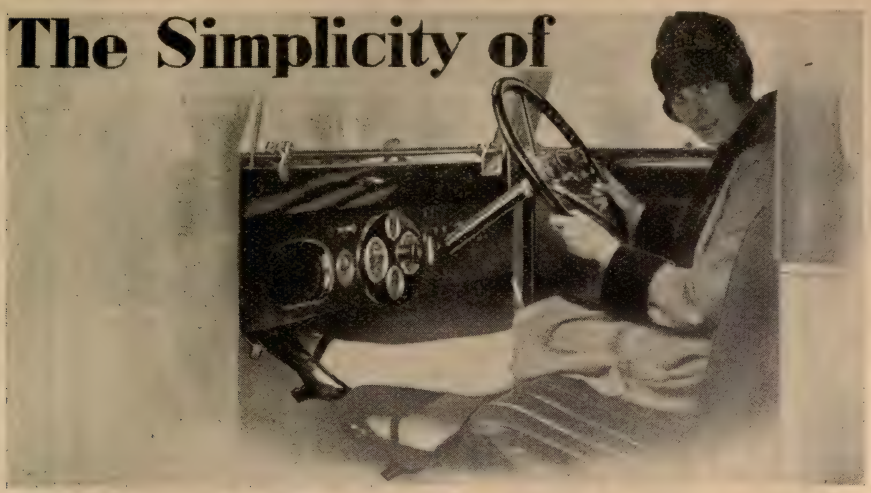

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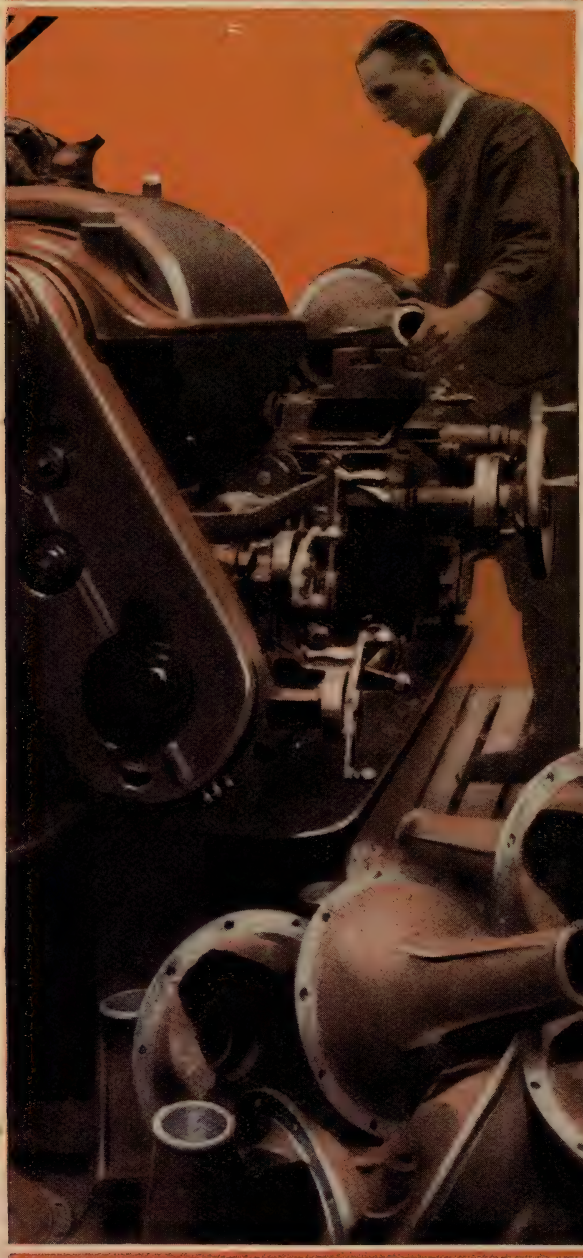

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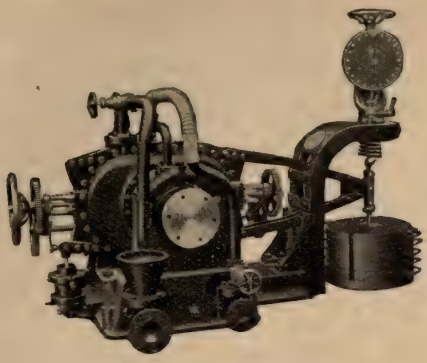

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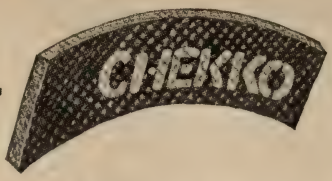

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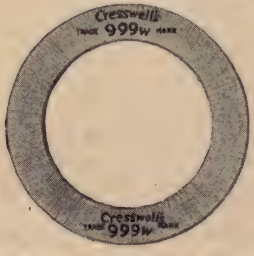

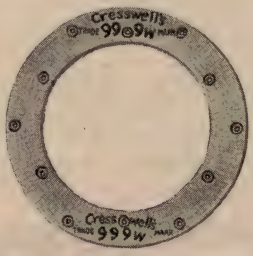

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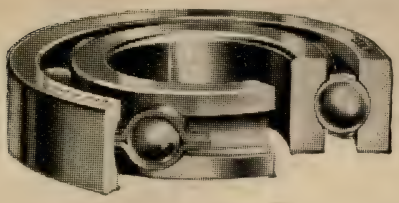
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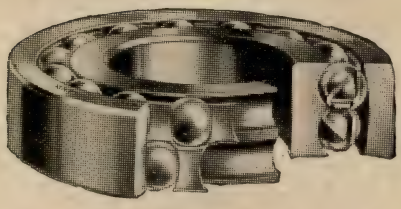
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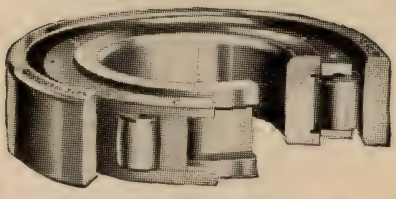
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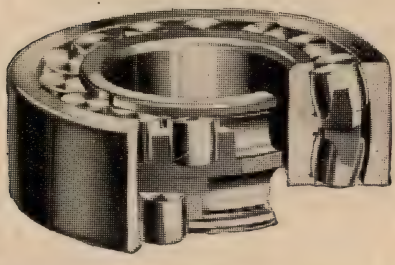
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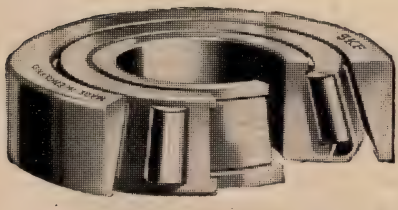
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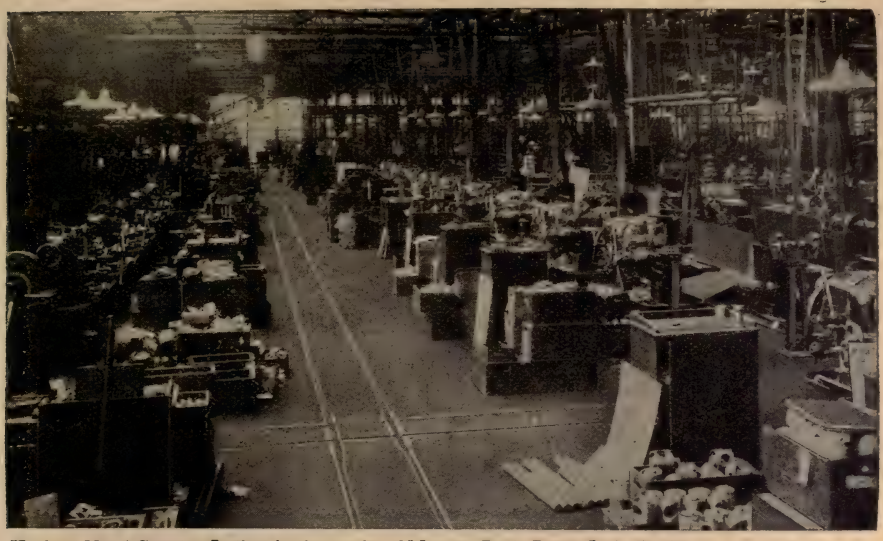

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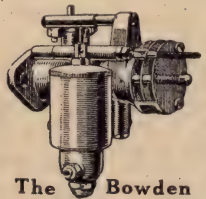

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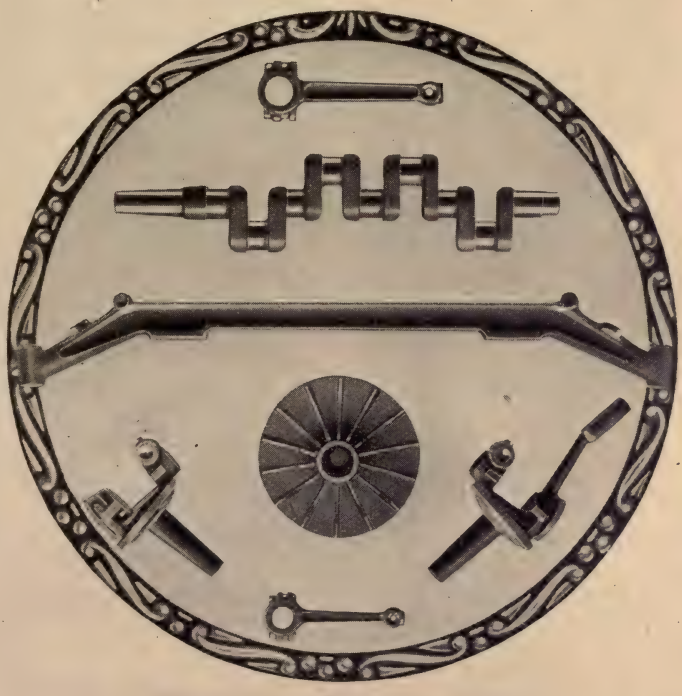

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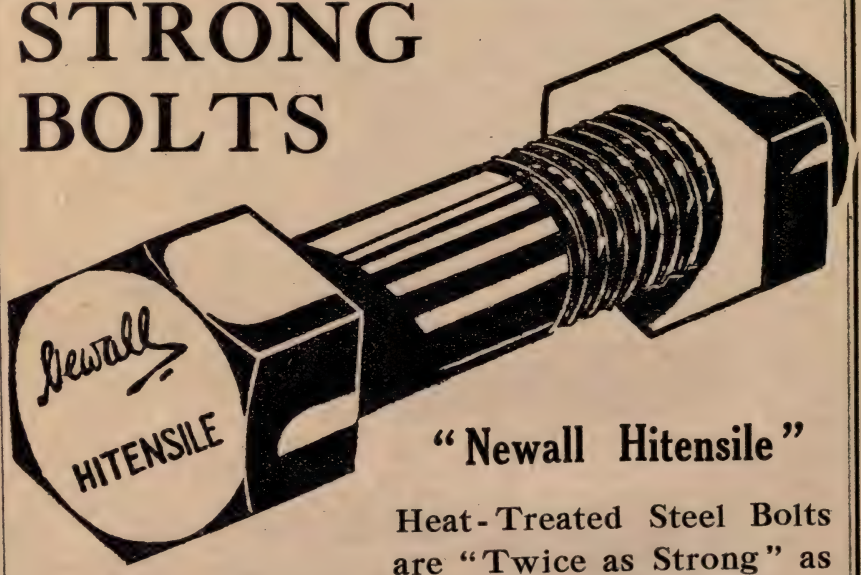

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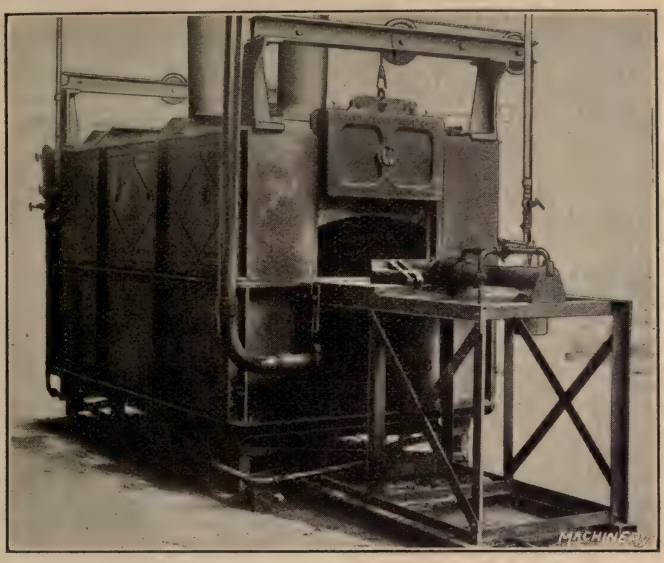

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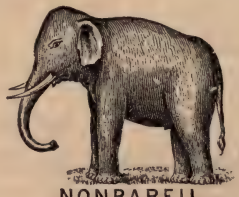
TRADE  MARK

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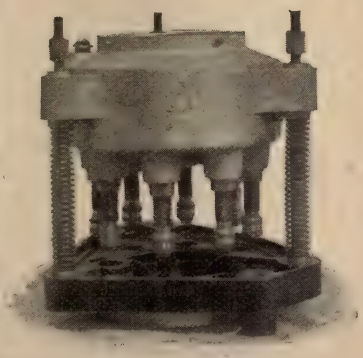

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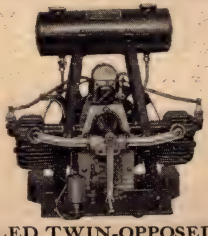

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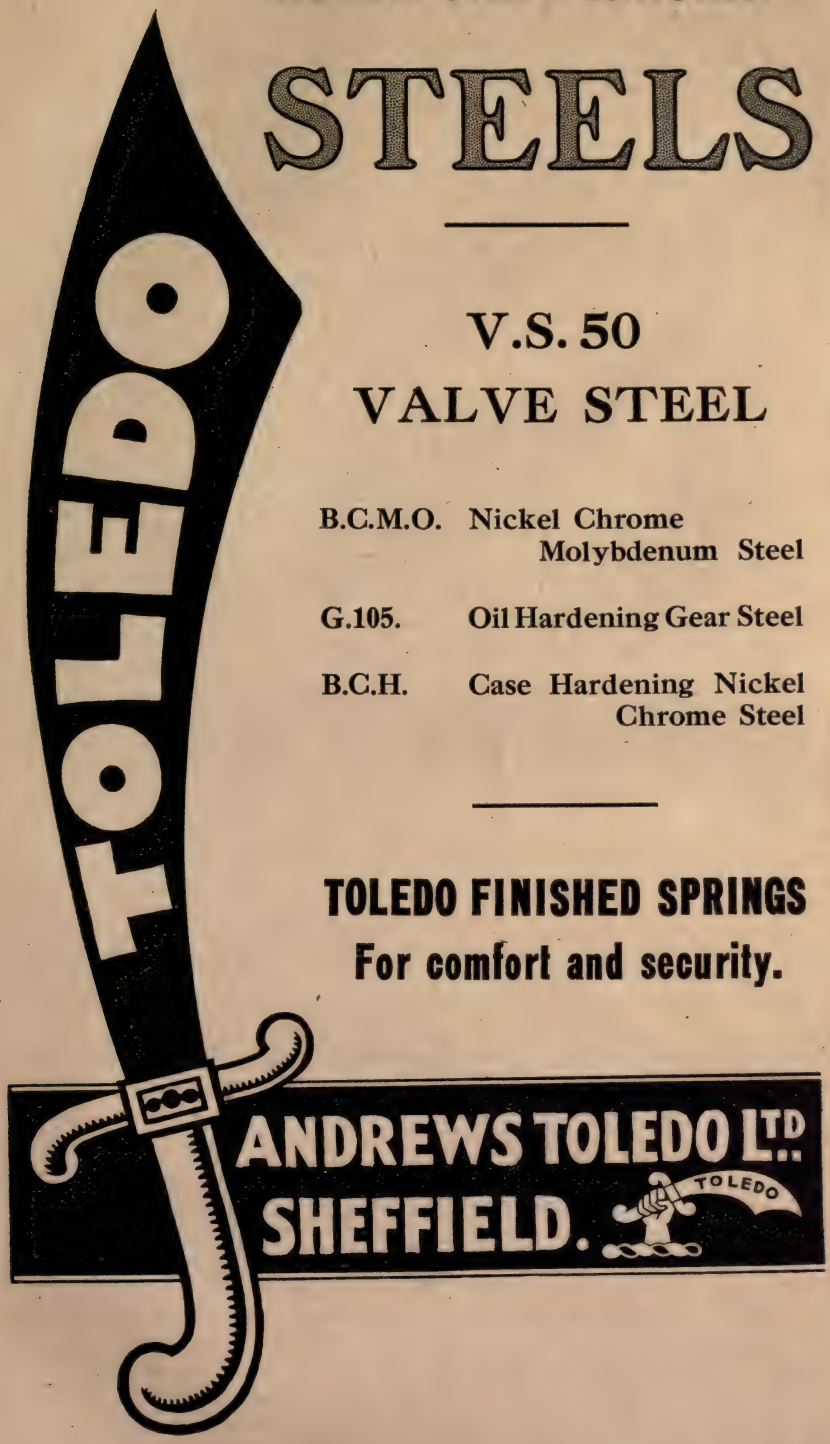

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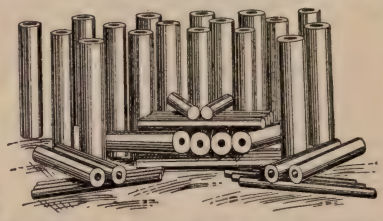

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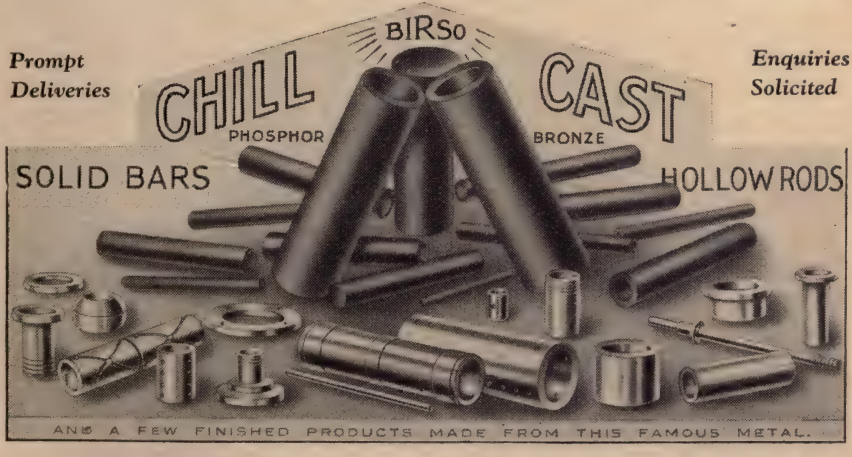

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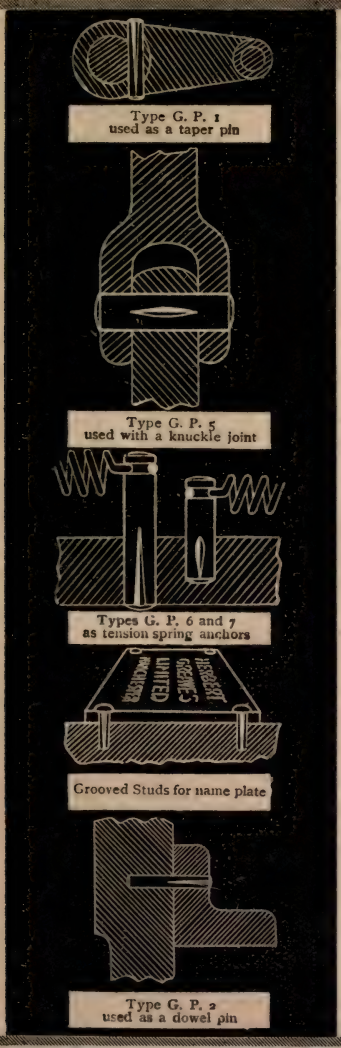

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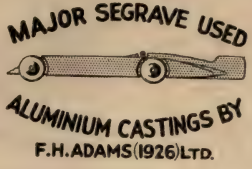

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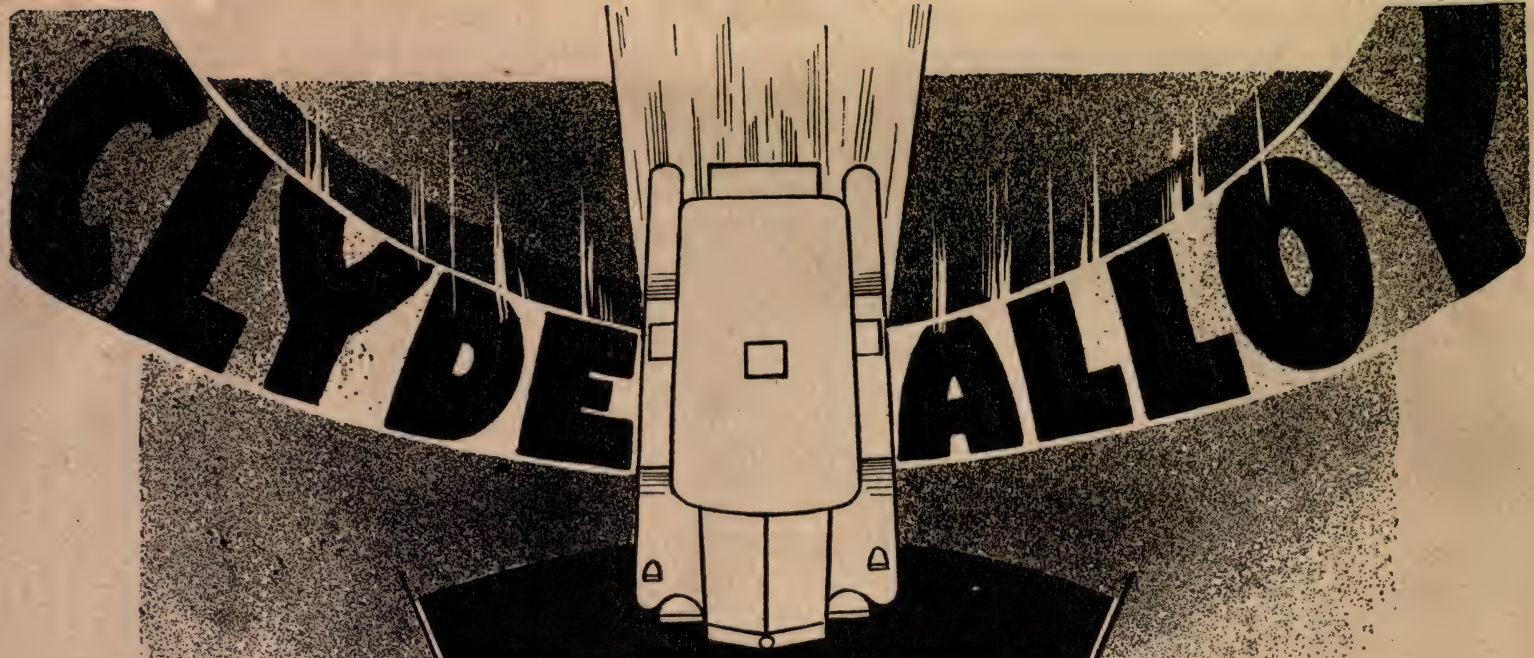

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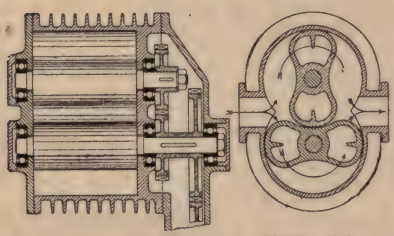

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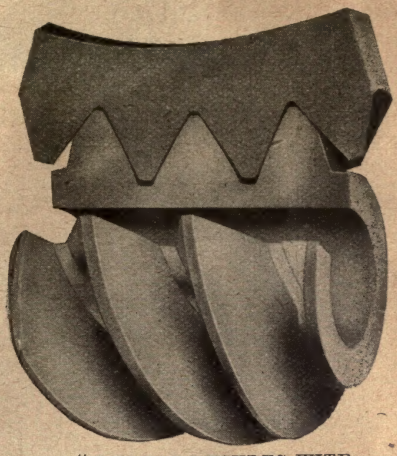

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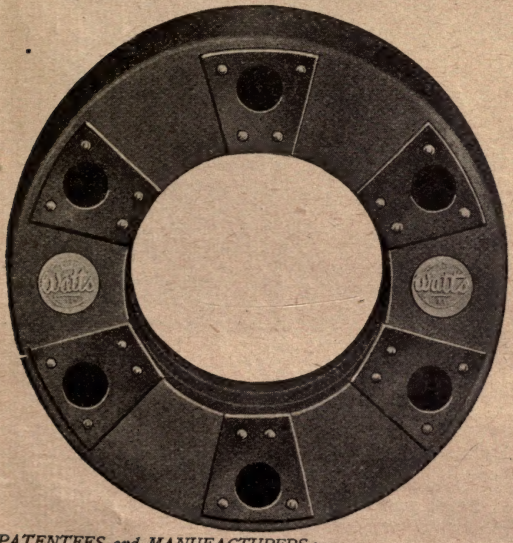

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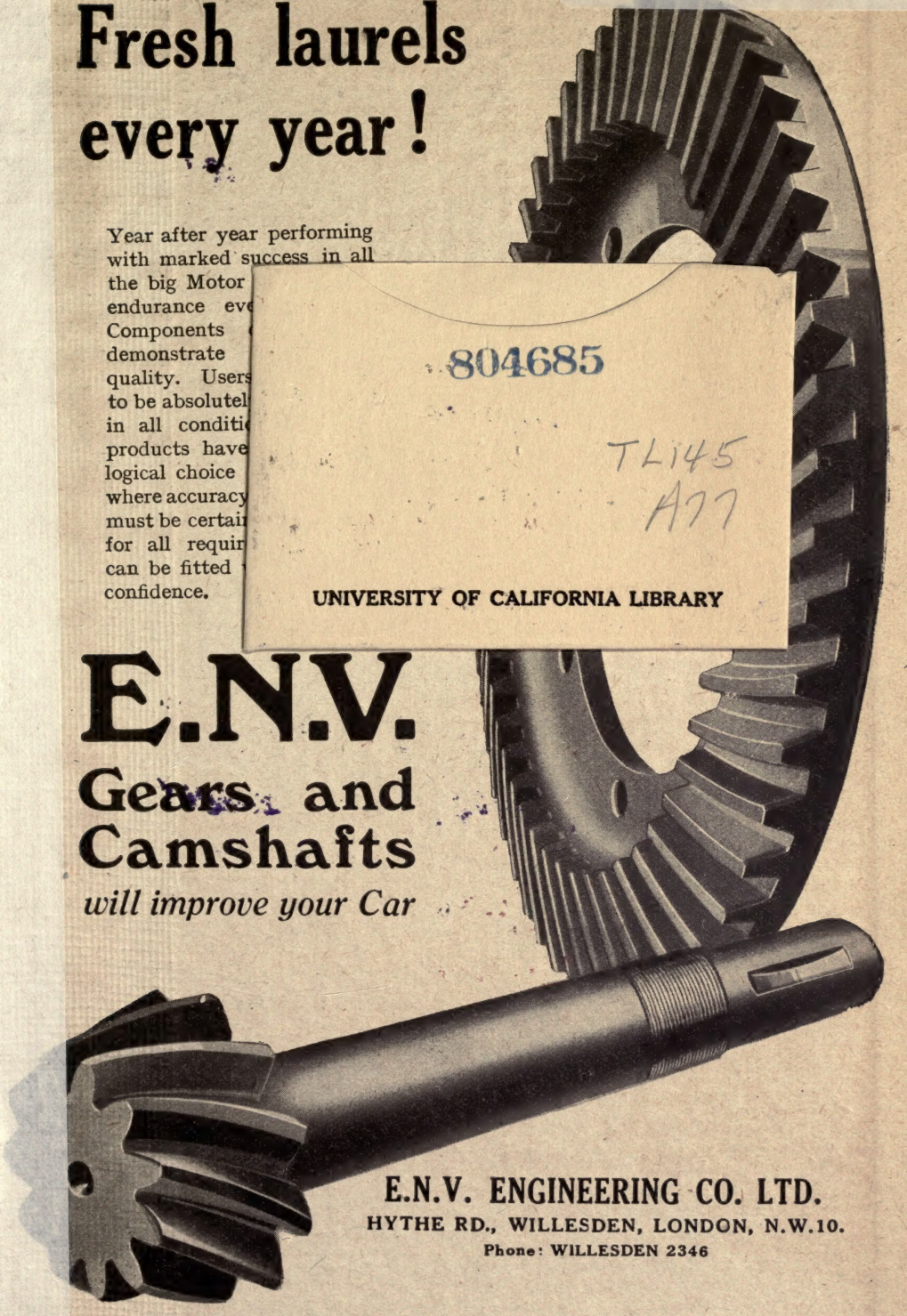

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