AERONAUTICAL ENGINES.

Paper read by A. GRAHAM CLARK before the Institution of Automobile Engineers.

THE problems involved in the design and construction of engines used for aeronautical purposes are such as should make a direct appeal to the automobile engineer for solution, not alone on account of the commercial possibilities of the situation, but because the practical and scientific difficulties experienced are somewhat akin to those which have been overcome in the evolution of modern car engines, and because the production of a satisfactory engine would go far to eliminate one of the chief sources of danger. This is especially so as regards the members of this Institution in view of the comments of the judges in the military aereoplane competition of this year, to the effect that the British engines entered in the competition had "not yet proved themselves capable of equalling the performances of the best foreign high-powered engines." Unfortunately, with comparatively few exceptions, motor car manufacturers have not given the subject the serious attention it deserves, but have, in some cases, endeavoured to obtain a high power/weight ratio by reducing the dimensions of the engine parts of their standard productions, especially those of the cylinder and the crank-case. It cannot be too strongly emphasised that the conditions of service are not less arduous than those under which the ordinary car engine is employed, and, therefore, any sacrifice of strength or rigidity should not be countenanced for one moment. Going even further, it might be asserted that it is not at all improbable that the aeronautical engine of the future will be adapted for use on automobiles, although, it must be confessed, the trend of aero engine design in many quarters at the present day would appear to be opposed to any such prospect.

Before considering the requirements which, from one cause or another, it is either essential or desirable that aeronautical engines should conform to, a few of the outstanding features embodied in current designs will be examined. To facilitate this, as well as to render much descriptive work unnecessary, Table I (page 1175), has been prepared, giving the construction of and materials employed for the principal parts of a number of engines; where the engines produced by any particular manufacturer vary, the data given relate to the type of engine constituting his principal production. The table is instructive as showing the extensive use which is now made of high tensile strength steels for crank- and cam-shafts and for connecting-rods, and of aluminium for the crank-case. With but one exception (a 35-h.p. rotary valve-engine by the Frontier Iron Works of U.S.A.) the engines are of the poppet valve type, and these, in the majority of designs, are placed in the head, and are operated by means of rocking-levers and push-rods.

Table II (pp. 1176–7) gives the principal dimensions, &c., of various engines, and, in compiling this, wherever it has been possible to ascertain the b.h.p. actually developed at any speed of revolution, the data have been employed in calculating the brake mean effective pressure in preference to taking the maker's horse-power at normal

Aeronautical Engines. By A. GRAHAM CLARK. TABLE III.—**Performances of various Aeronautical Engines.**

Name.	Country of Origin.	Number of Cylinders.	Bore and Stroke. In or Mm.	Type.	Form of Cooling.	b.h.p.	Revs.	mep lb. per sq. in.	Fuel Consumption per b.h.p. hour.	Brake Thermal Efficiency.	Oil Consumption per b.h.p. hour.	Engine Weight. Complete.	Engine Weight. Fly-wheel.	Engine Weight. Total.	Radiator and Piping.	Water.	Total Weight Power Unit.	At 1,200 Revs. per Min. b.h.p.	Weight per b.h.p.	Fuel Consumption per b.h.p. for 5 hrs	Oil Consumption b.h.p. for 5 hrs.	Weight per b.h.p. for 5 hrs. run.
									lb.	Per cent.	lb.	lb.	lb.	lb.	lb.	lb.	lb.		lb.	lb.	lb.	lb.
Albatross	Am.	6	$4\frac{1}{2}\times5$	Radial	Air	50	1,230	67·5	0·86	15·91	0·26	250	None	250	—	—	250	48·8	5·13	4·3	1·3	10·73
Anzani	F.	3	105×120	,,	,,	30	1,300	94·7	0·632	21·65	0·25	115	None	115	—	—	121	27·3	4·43	3·16	1·25	8·84
	F.	6	105×120	,,	,,	60	1,300	94·7	0·526	26·01	0·18	167	None	167	—	—	200	54·6	3·67	2·63	0·9	7·20
Austro-Daimler	A.	6	130×175	Vertical	Water	120	1,200	91·9	0·61	22·43	0·044	420	None	420	50	45	515	118·4	4·35	3·05	0·22	7·62
Barri and Marre	F.	4	112×100	,,	,, Air cooled head.	30	1,400	69·6	0·77	17·76	—	243	23	266	10	18	294	25·4	11·5	3·85	—	15·35
Chenu	F.	4	110×130	,,	Water	52·4	1,309	103·6	0·617	22·17	0·006	257	None	257	32	24	313	47·4	6·61	3·085	0·03	9·725
Chenu	F.	6	110×130	,,	,,	99·7	1,617	106·5	0·542	25·3	0·005	394	None	394	40	32	466	73·1	6·38	2·71	0·025	9·115
Curtiss	Am.	4	4×5	,,	,,	40	1,200	105·0	0·684	20·00	0·05	162	None	162	28	20	210	40	5·25	3·42	0·25	8·92
Daimler Mercedes	G.	6	120×140	,,	,,	100	1,350	99·8	0·53	25·81	0·033	420	None	420	50	40	510	87·7	5·81	2·65	0·165	8·625
Green	G.B.	4	140×146	,,	,,	62	1,155	77·5	0·59	23·18	0·11	265	37	302	41	32	375	64·4	5·82	2·95	0·55	9·32
Gyro	Am.	7	4·3×4·75	Rotary	Air	50	1,150	71·4	0·72	19·0	0·17	160	None	160	—	—	160	52·2	3·06	3·6	0·85	7·51
Hall Scott	Am.	8	4×5	V 90°	Water	83	1,500	87·2	0·61	22·43	0·106	290	None	290	36	32	358	66·4	5·4	3·05	0·53	8·98
Kirkham	Am.	6	$4\frac{1}{8}\times4\frac{3}{4}$	Vertical	,,	54·5	1,300	87·2	0·58	23·59	0·06	235	None	235	32	26	293	50·3	5·83	2·9	0·3	9·03
Maximotor	Am.	4	$4\frac{1}{2}\times5$	,,	,,	50	1,200	103·5	0·54	25·33	0·08	210	None	210	28	25	263	50·0	5·26	2·7	0·4	8·36
R.E.P.	F.	5	110×160	Semi-Radial	Air	60	1,100	91·9	0·595	22·99	0·1	330	None	330	—	—	330	64·6	5·11	2·975	0·5	8·585
Renault*	F.	8	96×120	V 90°	,,	78	1,800	72·6	0·64	21·37	0·045	397	None	397	—	—	397	102·6	3·865	3·2	0·225	7·29
Salmson	F.	9	120×140	Radial	Water	110	1,280	78·2	0·61	22·43	0·059	352	None	352	25	35	412	103·1	4·0	3·05	0·295	7·345
Wright	Am.	4	$4\frac{3}{8}\times4$	Vertical	,, Air cooled head	39	1,600	80·2	0·75	18·24	0·041	167	23	190	24·8	18·3	233·1	29·25	7·98	3·75	0·205	11·953
Wolseley	G.B.	8	5×7	V 90°	Water	126	1,150	78·9	0·54	25·33	0·044	635	66	695	60	50	80·5	131·5	6·12	2·7	0·22	9·04

* Propeller driven off camshaft. *Note.*—Data in italics have been assumed from average values. Data in heavy type obtained from official tests.