ABSTRACTS.

AERONAUTICAL ENGINEERING.

Aeroplane Engine Design.

This is a comprehensive review of recent developments in design and modern practice in regard to constructional methods and materials. The aeroplane engine is passing from the stage of invention to that of design. It is a light structure of high tensile steel parts, including seamless tubing, forged and welded parts. Certain components, such as the piston, exhaust valve, and guides, are designed for heat flow rather than mechanical stresses, and certain other components, such as the ports and crank-case, may be of any convenient material.

In order to secure low engine weight per horse-power, the mean effective pressure and the engine speed should both be as high as possible. For long flights, the weight of fuel and lubricating oil is a more serious consideration than the weight of the engine. The engine weight may be 4 or 5 lb. per h.p., and the weight of fuel and oil may be ½ lb. per h.p.-hr. The standard type of engine is now the water-cooled, four-stroke, fixed cylinder type with 6 or 8 cylinders in line, or 8, 12, or 16 cylinders in V-setting. The weight of metal in a water-cooled engine is about 1½ times that in an air-cooled engine, but the fuel consumption is about twice as great in the latter type owing to the lower compression permissible in the hotter cylinders. There is room for much improvement in the design of carburettors which will yield a dry, homogeneous gas mixture under accurate control.

The rate of flame propagation with reference to piston speed is an important factor at the piston speeds now used. Combustion is hastened by central ignition or by multiple ignition. An air meter must be used to determine the cam forms and valve timing producing highest mean effective pressure at high speeds.

The cylinder arrangement does not affect the weight of cylinder, piston, and connecting rod. Frame and shaft weight per cylinder is reduced by multiplication of cylinders, and circumferential multiplication is lighter than longitudinal multiplication. Only V-engines and engines with cylinders in line are now used; in the latter type, the weight per cylinder is reduced by using up to 6 cylinders in line. Large cylinder diameter and short stroke favour light construction.

Various cylinder constructions are reviewed, and their merits are discussed. The cylinders of the Hispano-Swiss engine are threaded externally and screwed into a double-walled aluminium casting, which contains the ports and water-jacket. Single-piece steel forgings with welded sheet metal jackets are satisfactory, but costly. The desirability of large valve-diameter influences the cylinder head design. Block arrangement of cylinders and jackets imposes undesirable restraint on the cylinders as regards thermal expansion and contraction.

The author deals with developments in pistons, valves, valve gears, frames, etc., and with the reasons for these developments. He makes also a thermal study of valves, pistons, and crank cases. (C. E. Lucke, "American Society of Mechanical Engineers Journal," May, 1917.)

The Cleveland Aero Engine.

The Cleveland aero engine is a decided departure from the usual design. It is of the horizontal "barrel" type, the axes of the cylinders being grouped round and parallel to the axis of the main drive. Each cylinder drives a single throw crankshaft on which is a bevel pinion meshing with a large bevel wheel on the propeller shaft which rotates at half the speed of the crankshafts. The simplicity of this design enables most of the engine parts to be so standardised that they may be used in the assembly and repair of any size engine from 100 to 600 h.p.

The engine is of the four-stroke cycle type. Model 4, 150 h.p., has six cylinders 5in. by 6in., each provided with two inlet and two exhaust valves. The barrels of the cylinders are of steel tubing with water jackets and sparking plug bosses welded on. The combination cylinder head and manifold are an aluminium casting. The pistons are of aluminium alloy and have three rings each.

Ball bearings are used throughout and lubrication is secured by running oil on to the large bevel wheel which throws the oil about, thus lubricating other parts.

Ignition may be either by two magnetos, a magneto and a battery, or two batteries.

There is no crankcase casting proper, only a light sheet metal case being required. The design lends itself well to a streamlining of the aeroplane body. ("Aviation," New York, Feb. 15, 1918.)

The D.F.W. Biplane Brought Down During a Raid on Paris.

The German aeroplane which was forced to land during the night of Jan. 30-31, 1918, was a D.F.W. biplane of the well-known general utility type designated by the letter "C." The design of the machine is well-known to the Allies, as it appeared at the front during the spring of 1917.* What is of special interest is the fact that a machine of such a type took part in one of the recent raids on Paris, confirming the opinion that German raiding squadrons do not consist solely of large machines such as the "Gotha" or "Friedrichshafen," but include a few machines of the general utility type, which, besides acting as bombers, will be able to go to the aid of the slower and less easily manœuvred large machines.

The machine under discussion did not have its under-surface painted black, but it was "camouflaged," chiefly in brown and green. It has been noticed that while certain twin-engined machines captured earlier were painted black on their under-surface, others, captured more recently, were "camouflaged" in black, dark blue and light green. ("L'Aerophile," Feb. 1-15, 1918.)

The Location of Seaplane Floats.

A method of calculation for the location of seaplane floats is considered in some detail in this article, which is written by Mr. R. N. Wing, of the Curtis Aeroplane and Motor Corporation.

As the method adopted is the same whether single or twin floats are used, the special case of a single main float is considered in general by means of the following procedure:—

(1) A determination of the weight and C.G. of the machine with full load excepting the main float and float bracing.

(2) An estimation of the weight of the float and bracing, and the resulting full load weight of the complete machine.

(3) The design of the float for the required buoyancy and the calculation of an assumed 3° load water line and the centre of buoyancy line for the full-load weight.

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* The above remarks are true so far as they relate to night bombing raids in France. It should be observed, however, that while the air endurance, with normal bomb load, is sufficient for an attack on Paris, it is barely sufficient for a raid on London, although an L.V.G., Type DII, made such a raid in daylight last year.

(4) A determination of the vertical position of the float with regard to the rest of the machine.

(5) A determination of the horizontal or fore and aft position of the float.

A typical numerical case is worked out for a seaplane, weighing 1,900 lb., with its centre of gravity located at a distance of 66ft.* aft of the face of the radiator, and 2in. above the line of the propeller axis. The propeller is assumed to have a diameter of 8ft. ("Aviation," New York, Mar. 1, 1918.)

The "Continental" Two-Seater Pusher Biplane.

This is a distinctly original design produced by the Continental Aircraft Corporation of New York City. It has a span of 36ft. and an overall length of 22ft. The lift loading is 7 lbs. per sq. ft., and the gliding angle about 1 in 9. The engine is a 110 h.p. Hall-Scott, model A.5, and drives a three-bladed airscrew.

The outriggers supporting the tail comprise two steel booms secured to triangular steel frames, covered with fabric, which replace the usual inner rear interplane struts. The booms are suitably trussed to the upper and lower wings. A monocoque construction is adopted for the nacelle, and the engine is mounted on heavy veneer panels slotted around the crankcase. A trapdoor allows the engine to be lowered to the ground when its removal is desired. The pilot, who occupies the rear seat, is provided with a starting crank.

There is an undercarriage with two skids and four Ackerman wheels, connected to the body by six streamlined struts. The wheels are mounted on rubber spring axles. Tusks are provided at the rear ends of the skids for use as brakes when landing.

This machine has covered 60 miles in 45 minutes (80 miles per hour) at an average height of 5,000ft. No information as to weights is given. ("Aviation," Feb. 1, 1918.)

The "Hannover" Biplane.

The "Hannover" aeroplane, which is made by the Hannoversche Wagon Fabrik, is a two-seater tractor biplane of new design which has recently been brought down at the Front.

The lower wings are smaller in span and chord than the upper wings, and their tips are more rounded. The upper wings are swept back at the tips in a manner reminiscent of the recent D.F.W. machine, and each wing carries a balanced aileron. The upper wings are supported by two pairs of struts on the fuselage, and there is only one additional pair of struts on each side of the fuselage. The fuselage is in 3-ply wood, and is very short. The tail is similar in general design to the pre-war Dorand, it is a biplane, one elevator being above the fuselage and the other below it. The engine is an Opel-Argus of 180 h.p. The machine is equipped with a fixed machine-gun firing through the airscrew and a second one mounted on a movable turret at the rear; there is a camera and bomb-dropping device. ("L'Aerophile," Dec. 1-15, 1917, and Jan. 1-15, 1918.)

NOTE.—The following additional particulars regarding the Hannoversche Wagon Fabrik have been obtained from an aeroplane brought down on the British front in France recently:—

Wings.

The upper wing is 12in. above the top of the fuselage, and since the centre section is cut forward to the back of the rear spar, an excellent field of view is provided.

* It is suggested that the distance of the C.G. aft of the radiator face is incorrectly given and that it may be 0.66 feet.

The fastening of the butts of the wing-spars is of uncommon design. The wing is placed in position by being pushed in towards the fuselage over metal eyes or balls mounted on the longerons. It is then moved rearwards a distance of half an inch, and the neck of metal balls on the longerons and on the centre section is engaged by the edges of the metal box on the wing spars. A vertical pin is pushed through the metal box passing behind the ball of the fuselage fitting to prevent the wing moving forward, thus keeping the ball fitting locked in the box.

All wings are camouflaged yellow, green, pink, and blue in soft colours and in small angular areas.

Upper Wings.

	ft.	in.
Extreme overall length of machine	25	6½
Span (of which 8ft. 8in. is centre section) ...	38	3
Chord	5	11
Chord Dimensions.		
Leading edge to centre of front spar		10
Spar centres	2	7½
Centre rear spar to trailing edge	2	5½
Lower Wing.		
Span	36	10
Chord Dimensions.		
Leading edge of centre of main spar		7⅞
Spar centres	1	9¾
Centre of rear spar to trailing edge	1	9⅞
Gap	5	3

The *Angle of Incidence* on the wings is—

Bottom wing	5½° at fuselage.
	5° at struts.
Top wing	5° its whole length.

Ailerons.

Ailerons are fitted on the top wings only, and the aileron surface is partially balanced, roughly 1 sq. ft. of the surface being in front of the hinge line.

Empennage.

The empennage has double superimposed surfaces of the following dimensions, approximately :—

	ft.	in.		ft.	in.
Each bottom plane	3	4	×	4	1
Upper surface	6	7	×	1	5½
Gap	3	3			
Upper elevator (overall)	6	7	×	1	4
Lower elevator (overall)	6	11	×	3	8

Other dimensions are as follows :—

	ft.	in.
Rudder (depth)	3	9
Rudder (fore and aft width) ...	1	10

Tailskid.

The tailskid is not provided with swivel mounting, but has a solid metal shoe with a convex underside.

Radiator.

The radiators are placed in top centre section, and have an area of 16in. × 27in.

A metal ring is in position on the underside of the radiators within reach of the pilot. This is apparently intended to carry a semi-circular disc to act as a radiator shutter.

Armament.

The armament consists of 1 Spandau gun forward, firing through the propeller, and a second gun on a ring mounting for the gunner.

The Spandau gun receives sufficient heat from its proximity to the exhaust manifold, but leads and push-in sockets are provided for electrically heating clothing and gun for the observer.

Camera.

Provision is made for the use of a camera through a hole in the bottom of the fuselage, which is covered by a sliding panel, operated by wires and pulleys, when the camera is not used.

General.

The fuselage is 4ft. 7in. deep at the gunner's cockpit, and 3ft. 2in. wide.

"Rumpler" Biplane C.4.

This machine is a two-seater tractor biplane of reconnaissance type. Its performance compares well with that of a scout machine as regards maximum horizontal flight speed and its climb is given as about 16,000ft. in 34 minutes.

The following are the principal dimensions:—Span of wings: Upper, 41.4ft.; lower, 40.1ft. Length of fuselage, 27.6ft. Maximum height of machine, 10.7ft.

The wings are swept back 3°, and have an upward dihedral of 2° or $2\frac{3}{4}°$ and a forward stagger of 2ft. Their plan forms are trapezoidal, the tips of the upper wing being raked so that the leading edge is the shorter, and those of the lower wings simply rounded, so that the maximum span occurs at the front spar. The chord at the root of the upper wing is 5.6ft. and of the lower wing 4.3ft. The angle between the thrust axis and the wing chord is about 5° in some examples, and varies from root to tip in others. Ailerons are fitted to the upper wings only, and are each of a length a little less than a quarter of the span; in width they vary from less than 20in. at the inner end to 25in. at the tip. The gap between the wings measured from spar to spar is 6ft. 1in. The total wing area is 360 sq. ft.; upper, 215 sq. ft., and lower, 145 sq. ft.

The tailplane has a nearly semicircular leading edge, and the elevators are slightly balanced and of area about two-thirds that of the fixed tail. The triangular fin and unbalanced rudder are similar to those of the Rumpler C III. The control and stabilising surfaces at the tail have a framework constructed of steel tube, as is the usual practice in German aeroplanes.

The airscrew is a Heine 10.4ft. diameter, and carries a conical fairing in front. The capacity of the petrol tanks is sufficient for a flight of about four hours. The six exhaust pipes are united into a single streamline tube discharging above the upper wings. A honeycomb radiator is attached to the two forward body struts, and is fitted with shutters to regulate the cooling. The undercarriage is of the usual type. The pilot occupies the front cockpit, and the rear cockpit carries a machine-gun turret. Arrangements are made for reconnaissance photography and for bomb-dropping. ("L'Aerophile," Jan. 1-15, 1918.)

The Design of Air Turbines.

Air turbines have come into increasing use for aircraft in the last few years owing to the greatly extended use of radio apparatus, searchlights, stabiliser servo-motors, etc., which render the provision for generating considerable quantities of electrical power independently of the engine absolutely necessary.

The method of design discussed in this article is based on the well-known

https://doi.org/10.1017/S2398187300147711 Published online by Cambridge University Press

airscrew theory of Drzewiecki and Lanchester in which the airscrew blade is considered as made up of elementary sections each functioning as an aerofoil, and the properties of the aerofoil being obtained from wind tunnel tests. Thus the procedure in the design of air turbines is very similar to that ordinarily adopted for airscrews.

An example of the design of a six-bladed air turbine is given, for which an efficiency of 81 per cent. is calculated. It is pointed out that in considering the overall efficiency of the air turbine as a generating device this efficiency of 81 per cent. should be multiplied by the efficiency of the airscrew of the aeroplane, that is, by about 0.75, making an overall efficiency of about 60 per cent.

Air turbines may be constructed in either wood or metal; if the former, the method is a direct adaptation from airscrew practice; if the latter, castings of light alloy are generally employed. ("Aviation," Feb. 1, 1918.)

Physical Properties of Aeroplane Woods.

This article is based on wood tests conducted at the Forest Products Laboratory, Madison, Wisc., and refers principally to the three most common woods used in aeroplane construction, viz., spruce, ash, and white pine. In searching for a wood that is light, has a high modulus of rupture and of elasticity, and is moderately hard, spruce has been found to give the most satisfactory results for stressed members, while white pine, having a low specific gravity, is much inferior because of its comparative softness. The moduli of rupture and elasticity are also slightly lower than that of spruce. In the case of struts, where the elastic modulus is the decisive factor, spruce is again superior. A comparison of ash and spruce, from a standpoint of flexural strengths, favours the former for the same weight, and indicates that ash would be superior for wing spars, but, unfortunately, the increase in deflection of the ash spar over the spruce spar of the same strength for the same load is about 39 per cent., so that the efficiency of an ash beam is lower, and dangers due to deformation of the wing structure increased. The final conclusion is thus in favour of spruce.

The article states that the importance of variations in strength according to different positions of the wood in the tree have been over estimated, and are mainly due to variations in specific gravity and moisture content. Tests on 26 species of woods at 15 per cent. moisture conducted at the laboratory give the following results:—

Compression parallel to grain (1 lb. per sq. in.) $= 10^4 \times$ sp. grav.
Modulus of rupture (1 lb. per sq. in.) $= 2 \times 10^4 \times$ sp. grav.
Modulus of elasticity (1,000 lbs. per sq. in.) $= 2{,}800 \times$ sp. grav.

Curves are given showing that the effect of increasing the moisture content is to decrease rapidly the moduli of elasticity of rupture, and the compression parallel to the grain up to the fibre saturation point, after which they remain constant. It is suggested that all wood tests for strength and elasticity should include determinations of the moisture content and specific gravity. The following details are given regarding the mechanical tests conducted at the Forests Products Laboratory:—

Static Bending.—The test specimen used is 2in. × 2in. × 30in. and is loaded at the centre having a span of 28in. The load is applied at a constant rate, simultaneous readings of load and deflection being taken.

Compression Parallel to Grain.—The test piece is 2in. × 2in. × 8in. and is compressed in the direction of its length. Deformation is measured between two collars 6in. apart attached to the specimen.

Compression Perpendicular to Grain.—The test piece is 2in. × 2in. × 6in. long and is laid upon its side. The pressure is applied through a suitable hard metal plate 2in. wide laid across the centre of the piece and at right angles to its length. But one-third of the surface is directly subjected to compression.

Hardness.—Hardness is tested by measuring the load required to embed a 0.444in. ball to one-half its diameter in the wood.

Shearing Strength Parallel to Grain.—The shearing test is made by applying force to a 2in. x 2in. lip projecting from the side of a block. (G. H. Congdon, "Aviation," Mar. 15, 1918.)

NOTE.—The reference above to the effect of moisture in test specimens is of interest and capable of wider extension to other materials than timber which are affected by the quantity of moisture present in the test piece, as much more comparative values are obtained. This principle has been recognised in the testing of fabrics with advantage.

AERIAL TRANSPORT.

Italy's Plans for Postal Aeroplane Routes.

This article, published in the New York periodical "Aviation," is based on an announcement made by Signor Delmati, Director-General of the Italian Post Office, in the "Rivista dei Trasporti Aeri," that Italy now proposes to set up an aerial mail service between the Mother Country and her North African colonies, and on the views expressed by Signor Caproni, the well-known constructor of large multiple-engined aeroplanes, in an interview. The announcement is of particular interest in view of the proposed creation by the U.S. Post Office Department of a postal airplane route between New York and Washington.

It would appear that the experience gained by the establishment last summer of an experimental seaplane service between Continental Italy and Sardinia has been sufficiently encouraged to justify this further enterprise on the part of the Italian Post Office Department.

In considering the future development of public air services regard must be paid to the limitations which at present exist, such as, for instance, the relatively small cargo which can be carried by even the largest aeroplane, and the limitations imposed on the reliability of the service by the vagaries of weather conditions, these applying especially to the northern countries of Europe, where fogs are prevalent during long periods of the year. Thus for a certain time the coming public air services may be expected to be limited to linking up localities which possess no other modern means of transport or which are so far distant from one another that the creation of an air line will serve materially to reduce the time of travel.

The geographical and climatic conditions applying to Italy and her North African colonies, coupled with her capability of designing and manufacturing large aeroplanes, place her in a particularly favourable position for taking the lead in establishing commercial air routes. From Turin to Syracuse by train takes 36 hours; from Syracuse to Tripoli by steamship takes 27 hours, there being a pre-war service of four trips per week. It is estimated that with an air service the time could be reduced to about one-third, including the time required for stoppage at ports of call. In order to carry the normal pre-war mail of 4,000 kg. per week from Italy to Lybia a daily air service with aeroplanes having a cargo capacity of 600 kg. would be sufficient. A similar aeroplane mail service could well be set up between Italy and Cyrenaica; the amount of mail in this case approximated to that carried to and from Tripoli, but only one trip a week was made. In addition, there is a strong case for making interconnection by aeroplane routes between the principal cities of Tripolitania and Cyrenaica, because the shifting sands of Lybia make the construction of railroads a very expensive and hazardous undertaking. ("Aviation," New York, Feb. 15, 1918.)

METEOROLOGY.

Stratification of the Atmosphere.

This article, "Considerazioni sulla Tecnica dell'Esplorazione Atmosferica," continued from the previous number, discusses the changes in the velocity and the direction of the wind at different altitudes, as obtained from the records of numerous pilot balloon ascents. A table gives the results obtained from three ascents on May 14, 1917, up to an altitude of 2,700 metres. One of these shows a variation in velocity from less than 2 metres per second at low altitudes to a velocity greater than 30 metres per second at a height of 2,500 metres, accompanied by a change of direction of nearly 90°. The observations were taken by the use of a single theodolite.

The writer (Dr. Giuseppe Crestani) points out that the changes in the wind from one strata to the next are often irregular, but are, nevertheless, on the whole, continuous, and he refers to the well-known lack of local uniformity throughout the atmosphere, especially as regards horizontal gusts and vertical up and down currents.

A conclusion is drawn that there is a real stratification of atmosphere which is separated primarily into two distinct parts. The lower portion, which is arbitrarily limited to a height of one kilometre, is largely affected by the topographical configuration of the surface of the earth, and has a diurnal period. On the other hand, the conditions in the upper strata are determined by barometric and thermometric conditions, and especially by the general distribution of the isobars. ("La Rivista Italiana di Aeronautica," Feb. 28, 1918.)

RECENT PUBLICATION.

"Textbook of Naval Aeronautics," by Henry Woodhouse. Introduction by Rear-Admiral Bradley A. Fiske, U.S. Navy. New York: The Century Co., 1917. $6.00. Illus. 277 pp. 4to.

Deals with, amongst other subjects, aerial strategy and tactics, aerial attacks on ships at sea, torpedo planes, attacking ships with aircraft guns, aircraft mother-ships, submarine hunting by aircraft, locating submerged mines, naval anti-aircraft defences, administration of naval aeronautic stations, United States and British orders, rules and regulations, training of aviators, aerial navigation over water, aeroplane guns and aerial gunnery, spotting the fall of shots, bomb-dropping from aircraft, aerial photography, radio-telegraphy, night flying, instruments for aerial navigation, U.S. Navy aeronautics, naval militia aeronautics, aerial coast patrol, evolution of the seaplane and the flying boat, naval dirigibles, construction and operation of kite balloons, evolutions of the aero-motor, aeronautics in relation to naval architecture, aerodynamics, identification marks.