ABSTRACTS.

300 h.p. De Haviland Aeroplane.

This article explains in great detail the construction of the D.H. 4, 300 h.p. Rolls-Royce, giving the exact dimensions and materials of most of the parts. Particular attention is drawn to the system of dual control, which, it maintains, is a feature of all English two-seaters.

Photographs of the machine in various positions are given and detailed drawings of the wing fuselage body structure and the contour of the wing section. (" Deutsche Luftfahrer Zeitschrift," June 22, 1918.)

German Aeroplanes.

This article consists in essence of a series of very good photographs of the following German machines, showing in most cases not merely the general build, but the detailed external construction of many parts.

Fokker monoplane.
Fokker biplanes, D.1, D.2, D.3, D.4, D.5.
Fokker triplane, D.R.I.
Rumpler biplane, G.
L.V.G., C.IV.
Albatros, D., C.10, C.III., G.
Ago, C.I., C.4.
Gotha, G.2.
Aviatik, C.III.
L.F.G., C.II., D.I.
Friedrichshafen, G.II.
D.F.W., C.V.
Siemens, D.I.
A.E.G., C.I., G.3.
Halberstadt, D.

Some of these photographs are so clear and accurate that the main dimensions of the machines can easily be determined. (" Motor," May-June, 1918.)

Air Propulsion.

This paper describes experiments with propellers, asserting that the accepted screw theory of air propulsion does not accord with the facts and should be replaced by a theory of reflection or batting action which explains the fact, experimentally established, that air is impelled by a propeller at a speed approaching twice the screw advance for small-blade angles. Thrust is shown to be due in greater degree to velocity and less to blade disc area than is commonly supposed. A method of predicting the complete flying performance of a propeller from a single static test of a model is indicated.

According to the current theory, it is stated, air is driven by a propeller with a velocity never exceeding the product of the propeller's pitch and its revolutions. It was a surprise therefore to find experimentally that air may be driven back at a velocity nearly twice as great as this product indicates. This " super-speed " effect is not generally noticed in the ordinary propeller owing to the mingling of high-speed air with a quantity of inert air lying between the propeller blades. Experiments were made on a propeller having very wide blades sweeping the entire 360° of disc area. It had an experimental mean pitch of 2.53 ft., and gave a wind on static test of 3.33 ft. per revolution, regardless of the rotational speed of the propeller. The super-speed ratio, 3.33/2.52, is 1.32. It is explained by the theory that the particles of air are driven back by precise reflection or batting action from the blade surface. The geometry of the motion is given for static and wind tunnel or flying conditions, and it is shown that the super-speed ratio is in each case given by $2 \cos^2 a$ where a is the angle which the blade makes with the plane of rotation. This factor varies from nearly 2 for low-pitch angles found near the blade-tip to 1 for a 45° angle. Normal values for super-speed would lie usually

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between 1.5 and 1.6. In the case of the propeller, which has been cited, the calculated super-speed ratio comes out as 1.31, as against the experimental value, *1.32. Similar close agreement was found by other confirmatory tests.*

Investigation of the air-flow from a static propeller by means of light ribbons showed that the air moves in a direction strictly perpendicular to the blade angle, the condition demanded by the reflection theory, but not by screw action. Further, the ribbons indicated that the stream contracts slightly as it leaves the propeller, whereas "with the squeezing action of a screw it would be expected that the air would be expanding rather than contracting."

An experiment giving a convincing demonstration of super-speed is described, in which two propellers are tested in tandem in a wind tunnel. With the forward propeller or blower giving a wind of 44 ft./sec. and the rear propeller driven at just over idling speed (revs. × pitch equal to 48 ft./sec.), an anemometer showed a wind speed behind the rear propeller of 50 ft./sec. Shutting down the blower while keeping the revolutions of the rear propeller constant caused the wind speed to rise to 75 ft./sec., instead of remaining constant as demanded by the screw theory.

The proper interpretation of super-speed should render it possible to predict the flying performance of a propeller from static tests. The following formula is given as a preliminary empirical approximation:—

$$T = T_0 - T_0'$$

where T is the flying thrust at forward speed V and revs. n.

T_0 is the static thrust at revolutions n.

T_0' is the static thrust at propeller speed V/p where p is the propeller pitch.

That is, T_0' is taken statically at what is idling speed in the wind. Since static thrust varies as n^2, a single static thrust at any speed enable both T_0 and T_0' to be derived. With this formula the flying thrust at 30 per cent. slip is found to be 51 per cent. of the static thrust at speed n. (Morgan Brookes, "Aviation," New York, June 1, 1918.)

Calculation of Stresses in Aeroplanes.

Fuselage Stresses.

The analysis of the wind forces acting on a fuselage of the girder type and the resulting distribution of stresses in the members is carried through in a particular case. The tail portions of the fuselage are regarded as constituting a cantilever projecting from the centre of support, and the maximum normal wind forces on the tail 'plane and elevator are estimated from a knowledge of the angle of inclination of each part, its dimension and the maximum wind speed of the machine. These forces are based on Eiffel's formula:—

$$P = 0.0033\ AV^2$$

where P = Normal pressure in lbs./sq. ft.

A = Area of surface in sq. ft.

V = Velocity of wind in miles/hour.

These wind forces, in addition to the weights of the various members, are assumed distributed among the top junctions of the vertical struts with the longerons, half the load being borne by each vertical face, the horizontal and vertical sides not interfering. The stresses are calculated by two methods: (1) Graphically, by an application of Bow's Notation in the usual manner; (2) analytically, by equating the sum of the external moments about a junction to the left of a vertical section through a member to the moment of the face in that member. By choosing a number of suitable points about which to take moments all the forces may be found.

The dimensions of the wooden members are then checked by using the formula:

$$\frac{P}{A} = \frac{b}{l+c}\left(\frac{l}{k}\right)^2$$

where P = Breaking load in lbs.
A = Area of cross-section in sq. ins.
l = Length in inches.
k = Least radius of gyration in inches.

b and c being constants such that:—

For spruce $b = 5{,}600$
For ash $b = 6{,}250$

c depends on l/k according to the table.

	Value of l/c.	
l/k.	Spruce.	Ash.
60	11,000	10,000
80	10,000	9,000
120	8,000	7,000
160	6,500	5,000
200	5,000	4,000
240	4,000	3,000
280	—	2,800

(S. E. Slocum, "Aerial Age Weekly," June 10, 1918.)

Electric Dynamometer.

A description is given of the general method of testing an aero engine by means of an electric dynamometer, whose power is absorbed either by external electric resistances, or by pumping current against the pressure in the mains. The various points which have to be watched both in the apparatus itself and in the working of it are considered. The operation of a typical control panel for a 400 h.p. electric cradle dynamometer is described and a cut of the panel given.

The close and accurate readings possible with electric dynamometers have saved many a new engine on its first test by giving a timely warning of impending trouble. When making a long run at a given speed, the operator should watch his scales closely. If the torque and speed drop off and do not come back again the engine requires attention. ("Aviation," New York, June 1, 1918.)

Swiss Aeroplane Sheds.

An advertisement by the Hetzer Wood Construction Co., Zurich, showing elevations and sections of aeroplane sheds at the Swiss Government Flying Ground at Dubendorf. The construction is entirely of wood, and the design is patented. The firm states that they have built sheds already covering an area of about 160,000 sq. metres. ("Schweizerische Bauzeitung," July 13, 1918.)

The General Movements of the Atmosphere.

The atmosphere is subject to certain general movements which extend over periods more or less prolonged and proceed in definitely ascertained directions. These movements comprise wide zones of activity. The charts prepared by the Signal Office at Washington embrace the whole hemisphere, and show that the areas of high and low pressure, which characterise during each season the general air-circulation, undergo displacements and transformations that exert influences alternately in opposite directions, and produce effects duly recorded in the different Meteorological Offices.

The complexity of these movements and the frequent changes in their duration render their general study a matter of extreme difficulty, but the author has found it possible, by treating each chart as an instantaneous photograph, and by providing the necessary intermediate points to prepare cinematograph films which give a record of these movements and indicate the various phases. Numbers of these charts have been connected together in this way, and the high pressure areas have been rendered more visible by colouring them of a grey tint. By this means he has already produced three cinematographic films, the first of which comprises the surface of Europe and Asia, and shows that this mode of attacking the problem is possible, but that "the phenomena" are here a little complicated by the presence of two neighbouring maximum areas over Siberia and the Azores. In the case of the other two films, the one of Europe and the other of North America, the results are very clear. It becomes evident that in a general way the depressions that occur in succession, first towards the North on the 60th parallel, and then to the South on the 30th parallel, swag in such a manner that their trajectory rises and falls alternately, and that the atmosphere over the region thus examined undergoes a species of respiratory action, with alternate elevation and depression. Some of the features of this phenomena are explained, and the modes of interpreting them are discussed. As the outcome of his studies, the author maintains that the formation of the storm periods can be foretold with great certainty, as they follow very definite laws. Both the sun and moon have great influence upon the atmosphere, as already shown by M. Poincaré, and the moon, in the vicinity of the 30th parallel, controls the movements of vast regions of the atmosphere. It becomes possible by the plan above described to predict the condition of the atmosphere on any given meridian and to deduce the probable weather for the course of the day with the changes brought about by high or low atmospheric pressure at any selected point. ("Comptes Rendus," July 22, 1918.)

Vincent-Multiplex Compass.

This is a description of the Vincent-Multiplex compass, which it is claimed combines within a small box all instruments necessary to the aviator, the navigator and the explorer for the determination of the magnetic declination and for the solution of astronomical, geodetic and topographical problems required for determining position and directing the course of travel. It is further claimed that the problem of steering craft overseas and in the air may be solved with a precision hitherto unknown.

The improved compass is furnished with the usual accessories. There are provided a reference line or directrix under a glass plate which may be rotated, a movable index card with sights for the measurement of angles and azimuths, and a style for the solution of time problems. The whole compass is suspended on gimbals inside a box which is pivoted on a slab. The box carries on one of its faces a needle and a dial, and on its bottom a second needle which moves over degree graduations on the slab.

The method of using the compass over sea and land is described. ("L'Aerophile," May, 1918.)

French Avion-Renault Biplane.

This is a description of the French A.R. (Avion-Renault) biplane. It is stated that this machine presents the following characteristics:—

Wing Members.—Upper wing, continuous span 13.32 m.; lower wing, upward dihedral 16 cm., sweep back 10 cm., span 13.25 m. Depth of wing in both cases, 2.02 m. Perpendicular distance separating wings 2 m.; for each centre of forward spar was 30 cm. from leading edge, and centre of rear spar 82 cm. forward of trailing edge. Ribs, 33 cm. apart. Upper wing given backward stagger 54 cm. measured close to body; this offers clear upward field of view to the pilot; the observer is placed, it is said, exceptionally far back; but the upper wing is cut away just above, and the lower wing cut centrally to a semi-circle as far as the rear spar. Total wing area 44.75 m², exclusive of flaps. Two pairs outer struts and two inner pairs, the latter reinforced and sewing to support the body. Four additional steel members are introduced below to take up the propeller thrust. All struts of wood, streamlined to 120/38 mm. at the centre, and 90/28 mm. at the extremities. Ailerons attached to rear spar of upper wing, extending on either side from tip as far as line of inner struts.

Body.—Forward section approximately square, 800 mm. broad, with slightly cambered top-side; tapering back, and supporting a rudder-post of height 500 mm. Total body length 8 m.

It is pointed out that no appreciable additional damping area is added. The reputation of the machine in regard to longitudinal stability is attributed to wing section. Elevator area 4.2 m².

Engine, etc.—Water-cooled, 8-cylinder, in V formation. Four magnetos, allowing of double ignition, each magneto operating in 4 cylinders. Main petrol 180 l. capacity, auxiliary tank 8 l. Main aluminium radiator fitted to body nose connected to subsidiary cooler below the body.

Armament.—Observer's machine gun; pilot's machine gun operating through propeller; four small bombs.

Weight unloaded given as 894 kg. Useful load 300 kg., including crew of two, armament with ammunition and photographic apparatus. Fuel carried, 138 kg. petrol, 22 kg. oil, with 32 kg. cooling water; this gives total load 1,386 kg., leading to specific wing loading 29 kg./m², on the assumption that one half of the aileron area contributes to support.

No figures are available for speed and climbing performances. ("Oesterreichische Flug-Zeitschrift," No. 7-8, April, 1918.)

Acrobatic Flying.

A personal claim that "stunt" or acrobatic flying increases the confidence and enthusiasm of an airman introduces a list of different "stunts" in vogue at present; a diagram of each is given, together with instructions for performing them.

The ordinary loop and a series of loops are first dealt with, and it is pointed out that loops should be made when going into the wind. Two ways of getting into and out of tail spins are described.

The Immelmann Turn is next shown—the aeroplane performs half a spin about its axis when taking the loop, thus flying in its initial direction at the top. The "Upside Down Glide" (also shown) is very similar to the Immelmann Turn, the difference being that before regaining its original attitude it glides some distance upside down. Greater success will be obtained if the glide is made against the wind.

The "Barrel or Roll Over" also commences in the same way as the Immelmann Turn, but on the aeroplane reaching the top of its path, the operations are reversed, and the machine spins through 180° about its axis, its attitude remaining the same at the end of the "stunt" as it was at its commencement in the loop.

Finally the Reverse Loop is shown. It starts in the same way as the loop, but at the commencement of the descent from the top the aeroplane spins about an axis perpendicular to its length (*i.e.*, yawed) through 180°, thus enabling the pilot on completing his manœuvre to fly in a direction opposite to his original direction. (Lieut. C. W. Keene, "Aerial Age," June 24, 1918.)

Motion of the Air through the Airscrew.

The investigation is based on a diagram of the slip stream of a four-bladed pusher airscrew given by C. Schmid in the "Zeitschrift f. Flugtechnik u. Motorluftschiffahrt," 1915. This diagram gives the magnitude and direction of the velocity of the air at points in six planes perpendicular to the axis of the airscrew, three on either side of the airscrew. The velocity vectors are resolved into two components, axial and radial, the former (parallel to the airscrew axis) being assumed to be constant for any particular one of the six planes. The observations in the neighbourhood of the boss, and on the edge of the slip stream, are neglected.

The origin of co-ordinates is taken at the centre of the boss, and the positive direction of the x axis is on the intake side. If P be the force due to the rotation of the airscrew acting on a mass m of the air, c the velocity in any plane, $x=$constant (the suffix s denoting the value at $x=0$), and E the kinetic energy of the mass m, then

$$P = -\frac{dE}{dx} = mk\frac{c^2}{2g} = \frac{KE}{g} \text{ whence } \log\frac{c}{c_s} = -\frac{k_x}{2g}$$

or if D be the diameter of the slipstream,

$$\log\frac{D_s}{D} = -\frac{K}{4g}x \qquad . \quad . \quad . \quad . \quad . \qquad (a)$$

since $c_s D_s^2 = cD^2$
where K is a quantity defined as the "viscosity factor" of the air. A table gives at each point at which observations were taken the value of K calculated from the slipstream diagram by means of the equation (a). A mean value K_m of K is taken for each of the six planes, and final mean value is obtained by plotting xKm against x and taking the slope of the curve. The values given are 25.4 and 48.9 for the wake and intake sides respectively. (H. Bandisch, "Oesterreichische Flug-Zeitschrift," Nos. 9-10, May, 1918.)