ABSTRACTS.

Curtiss R-4-L Mailplane.

This machine, equipped with one Liberty engine, contains a mail compartment of between 33 and 35 cubic feet, with a carrying capacity of about 625 lbs. of mail. Its flying speed ranges from 100 to 135 m.p.h., and its landing speed is approximately 50 m.p.h. The wing span is 48 ft. ("Aviation," January 1, 1919.)

Standard Single-Seater Mailplane.

The machine weighs fully loaded 2,450 lbs., with overhang, and has a normal mail carrying capacity of 180 lbs. The wing loading is 7.12 lbs. per sq. ft., and the power loading 14.1 lbs. per h.p.

A detailed itemisation of the general characteristics follows:—

Main Dimensions.

Overall length	26 ft. 7 in.
Overall height	10 ft. 10 $^{3}/_{16}$ in.
Wing action employed	R.A.F. 15.
Area of upper wing	150.9 sq. ft.
Area of lower wing	138.1 sq. ft.
Total wing area, including ailerons	337 sq. ft.
Span upper wing	31 ft. 4 in.
Chord upper wing	6 ft.
Aspect ratio, upper wing	5.2 ft.
Span lower wing	31 ft. 4 in.
Chord lower wing	6 ft.
Aspect ratio, lower wing	5.2 ft.
Gap	5 ft. 6 in.
Stagger	5 ft.
Sweepback, in degrees	5 deg.
Dihedral	3 per cent.
Decalage, in degrees	0
Angle of lower wing chord to propeller axis...	2½ deg.
Height of axis of propeller above ground with:—	
1. Machine resting on ground	6 ft.
2. Propeller axis in line of flight	5 ft.
Angle between line from base of wheel to C.G. with a vertical line when machine is horizontal	14 deg.
Angle between line joining wheel base and skid to a horizontal line	11 deg. 30 min.
Stabiliser setting to lower wing chord ...	0 deg.

Areas of Control System.

Aileron area, lower wing	24 sq. ft., unbalanced.
Aileron area, upper wing...	24 sq. ft., unbalanced.
Aileron of stabiliser	23.7 sq. ft.
Area of elevators	22 sq. ft., unbalanced.
Area of fixed fin	4.6 sq. ft.
Area of rudder	10.1 sq. ft., unbalanced.

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Summation of Weights.

Group.	Weight.	Percentage of gross weight.
Power plant...	778.5 lbs.	32.4
Fuel and oil...	390 ,,	16.2
Passengers and miscellaneous equipment	264.3 ,,	11.0
Mail ...	180 ,,	7.5
Body structure	288.1 ,,	12
Tail surfaces with bracing	75.5 ,,	3.2
Wing structure	324 ,,	13.5
Chassis	100 ,,	4.2
	2,400 ,,	100

Equipped with Overhang Section.

Area, main planes ...	382.4 sq. ft.
Area, upper plane with aileron ...	220.3 ,,
Area, lower plane with aileron ...	162.1 ,,
Area, upper aileron (2) ...	28 ,,
Area, lower aileron (2) ...	24 ,,

The machine is fitted with one Hispano-Suiza engine developing 170 h.p. at 1,700 r.p.m., climbs 5,300 ft. in 10 minutes, 10,000 in 24 minutes, and has a maximum speed near ground of 100 m.p.h. Its maximum endurance is 3 hours, or approximately 280 miles. ("Aviation," January 1, 1919.)

Curtiss Model K 12-Cylinder Engine.

This engine, of the fixed cylinder type, consists of twelve cylinders arranged in two groups of six at an angle of 60 deg. The bore is $4\frac{1}{2}$ in., stroke 6 in., and displacement 95.4 cu. in., or 1.56 litres per cylinder. In general it is of aluminium construction, with inserted steel sleeves; four interchangeable valves per cylinder, two intake and two exhaust; overhead camshafts driven by bevel gearing, and a single reduction by herring-bone gear to the propeller shaft.

The cylinder sleeves consist of high carbon steel hydraulic forgings, rough machined all over, and heat treated. The cylinder head proper is an aluminium casting, which, when assembled with six sleeves, forms a complete unit for one side of the engine. The casting contains internal threads to hold the cylinder sleeves together.

The pistons are cast in aluminium alloy and contain three rings per piston.

The connecting rods are of alloy steel drop forgings, heat treated, and finished all over.

The crankshaft is a 35-45 carbon chrome nickel steel drop forging—rough machined, heat treated, and finished machined. It is supported on five bearings, one at the front end, one between each group of four cylinders, and two at the rear end, one on each side of the crankshaft reduction gear. The main bearings are all $2\frac{1}{2}$ in. diameter and respectively 2—2—2—$2\frac{3}{4}$—$1\frac{5}{8}$ in. long starting from front. The crank-pins are $2\frac{1}{2}$ in. diameter, $2\frac{1}{8}$ in. long, and drilled out, as are the main bearings, $1\frac{7}{8}$ in. In order to balance the long cheeks between pins 1—2 and 5—6, steel counter-weights, carried on aluminium spacers, are attached to these arms.

Mounted above the crankshaft at a distance of eight inches is the propeller shaft supported on two journals—front $1\frac{3}{4}$ in., rear 4 in. long. The reduction gear rotates between these journals, and is fastened to a flange on the propeller shaft and driven by 7/16 alloy steel bolts.

The crankcase is an aluminium casting carrying the crankshaft, propeller shaft, and reduction gear; it extends up to form water jackets for the cylinders, the cylinder heads and sleeves being bolted to a flange at the top of the crankcase. The upper part is bored out with six holes in each side, a recess in the bottom of each hole being fitted with a cork ring or gasket. The cylinder sleeves are inserted into these holes, and the flanges at the bottom of the sleeves compress the cork ring into the recess, and in so doing ensure a watertight joint between the water jacket and the crankcase proper. A gasket is placed between the flanges at the top of the crankcase and the lower surface of the cylinder head, the head being securely bolted to this flange, which completes the whole water system.

The bearings of the crankcase are bushed with phosphor bronze bushings, lined with tin babbitt.

The lower half of the crankcase is flanged and bolted to the upper crankcase at the centre line of crankshaft. It contains the oil pump, oil pump drive shaft, oil temperature regulator and oil reservoir. The reservoir is closed by a sheet of aluminium, held on a flange; this partition forms the oil sumps at either end, and prevents the oil from flooding the crankcase when the engine is in positions out of the normal.

The lubrication consists of a complete force feed system with auxiliary pumps to remove oil from above the oil pan deck. The pump unit is situated in the bottom of the lower crankcase, and is driven through a horizontal shaft from the vertical accessory shaft. A long account is given of the whole system.

At the top of the gear housing, and at an angle of 45° with the centre line are mounted the camshaft drive shafts. The camshafts are mounted on the top of the cylinder heads, one shaft over the exhaust valves and another over the intake.

The clear valve opening is $1\frac{5}{8}$ in. diameter, while the seat is 1/16 in. wide. The valves seat directly in the steel cylinder head and are each held down by two concentric alloy steel coil springs.

The front end of the engine is mounted with an aluminium casting which contains the vertical shafts driving the various accessories, viz., the water pump, the gasoline pump, the magnetos, and the tachometer, and acts as a housing for many parts.

The cooling is by centrifugal pump coupled to the lower extension of the vertical shaft.

The ignition is by high tension magneto, two two-spark six-cylinder magnetos being used. These are driven through elastic block couplings through gearing from the vertical shaft.

The engine is equipped with two 52 mm. duplex Ball Aero carburettors. Each carburettor furnishes gas to three cylinders through a fan-shaped manifold. This is water-jacketed to assist in vaporising the gasoline. ("Aviation," January 1, 1919.)

Christmas "Bullet."

This machine, designed by Dr. Christmas, of the Cantilever Aero Co., New York City, is reported to have made a speed of 170 miles an hour with the engine at three-quarter throttle. It has a Liberty "Six" engine, rated at 185 h.p. at 1,400 r.p.m., and is stated to be the first successful machine having no wires or struts between the planes.

The upper wing has a span of 28 ft. and a chord of 5 ft. The lower plane is 12 ft. in span with a chord of $2\frac{1}{2}$ ft. The wings are flexible, and during flight they bow, giving the appearance of birds' wings. The trailing edge is flexible also, and as the speed of the machine increases the wing flattens. In encountering shocks in the air and in combating severe winds, the flexibility of the wings makes the machine less subject to the racking effect felt in more rigid machines.

A photograph accompanies the article and shows the machine to be a single-seater tractor with a deep body, whose maximum depth is equal to the gap between the planes. There is a rectangular nose radiator and the airscrew is two-bladed.

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The Cantilever Aero Company is stated to be making plans for the construction of a trans-Atlantic aeroplane of 180 ft. span, equipped with four 760 h.p. engines. A land model is to be used, and it is hoped that the machine will be the first to make the trip in a continuous flight. (" Aerial Age Weekly," December 30, 1918.)

Liberty Starter.

The Liberty starter is a four-cylinder radial two-cycle air motor and compressor, with a bore of 2¼ in. and a stroke of 2¼ in., with a 9 to 1 reduction gear for use as a starter. The valve construction is a semi-rotary of the Corliss type, having a universal joint action to the rocker shaft.

All the parts are idle except when brought into action as a pump with direct drive or as a starter with reduction gear. For the former service it compresses the air pressure in the tank and automatically disengages when the pressure reaches 230 lbs.

Illustrations give the elevation and sections showing the overall dimensions to be 12 in. square and 8 in. long. Its weight is only 30 lbs., which is said to be a low figure when the fact that it will start the largest engines in service has been taken into account. (" Aerial Age Weekly," December 30, 1918.)

Liberty Motor.

Through the courtesy of the Engine Production Division of the Bureau of Aircraft Production, Mr. Douglas Wardrop presents a series of excellent photographs and diagrammatic illustrations of the Liberty Twelve, including a number of the smaller engine parts. A complete list of general data giving the dimensions of the valves, pistons, and cylinders has been added, together with a detailed description of the cooling, oiling, ignition and carburettor systems, etc. (" Aerial Age Weekly," December 16 and 23, 1918.)

Hispano-Suiza Aviation Motor.

The Hispano motor has been developed in a large number of sizes and types for military aviation purposes. They are built with eight cylinders forming a 90° V in each case. This angular setting results in a uniform turning couple about the crankshaft, the power impulses being equally spaced from one another at 90°. The motor is unbalanced in a horizontal plane only, but the unbalancing is too small to affect the actual operation. The motors have been built in both direct and geared down types and operated at various speeds, as shown in the table.

Type.	Normal h.p.	Normal r.p.m.	Max. h.p.	Max. r.
150	150	1,450	200	2,000
180	180	1,540	250	2,240
200	200	1,870	210	2,200
220	220	1,970	238	2,200
400	400	1,870	500	2,240
450	450	1,970	476	2,200

The cylinders are machined from hollow steel forgings of 0.40 carbon steel, and weigh when rough about 40 lbs. for the smaller motors, the finished weight being about 11 lbs. The pistons are aluminium alloy sand castings thoroughly well ribbed to assist in cooling. The piston head is flat with an average thickness of 7 mm. The gudgeon pins are composed of chrome nickel steel, while the connecting rods of the fork type are made of the famous B.N.D. chrome nickel steel. The rods are 227 mm. centres, somewhat less that 2 piston strokes. Short connecting rods are the rule in aviation motors, since they enable the latter to be maintained compact and light, although the secondary unbalanced forces in the motor are thereby increased. At the top of the cylinders are placed the valves,

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arranged in a single line parallel to the axis of the motor, a single camshaft operating all the valves and each group of cylinders. The crankcase is composed of aluminium and is cast in two halves split horizontally through the plane of the crankshaft axis, and the upper half is a very light shallow casting rendered possible by the use of short piston stroke and short connecting rods. To provide pressure on the fuel tanks, a low pressure pump is built into the camshaft housing cover, and is operated by one of the cams. The oil consumption varies according to the type of motor as indicated below.

Type.	Litres per hr.	Gals. per hr.
150 h.p.	2	0.528
180 h.p.	3	0.793
200 h.p.	4	1.057
220 h.p.	5	1.321

Ignition is provided by two spark plugs per cylinder, set to fire synchronously, the current is supplied and distributed by two independent high tension magnetos, cross-wired to the spark plugs so that should one unit be put out of operation the motor will continue to fire on all eight cylinders. The motor is provided with a single centrifugal water pump having a single inlet and two discharge pipes.

In contrast with the German method of pumping water through the top of the jackets only, it is led into the bottom of the aluminium jackets and out at the top. In order to obtain the best motor performance at each altitude, the carburettors are equipped with a hand-operated barometric control, by means of which the mixture can be maintained at the best proportions of air to fuel. Actually this is done by varying the pressure in the float chamber, and so reducing the effective head on the gasoline nozzle. ("Aerial Age Weekly," December 23, 1918.)

New American Diesel Motor.

There is a short illustrated note of the Hood type of motor, which in its latest form is a small single-cylinder of 2 h.p. The cylinder compression is not so high as the usual Diesel type, reaching only to 390-450 lbs. per sq. in., corresponding to a temperature of 400° F.

Very little 'nformation is given of this motor beyond stating that it can be run at speeds from 160 to 1,600 r.p.m., and has a brake efficiency of 25-30 per cent.; but it is of interest to note that an American firm has taken out a licence for its manufacture, but whether in a single or four-cylinder form is not stated. ("Automobilwelt-Flugwelt," December 1, 1918.)

Double-Piston Motors.

This article discusses several types of double-piston internal combust'on engines, including the Junker aircraft motors. Reference is first made to the Gobron four-cylinder motor, built with the cylinders in pairs so arranged that the downward acting pair of pistons are attached to the same p'n in opposite phase to the other pair and on opposite sides of them. The Sears, Evans, and Messpa designs are next described, the last being an engine driving on to two separate crankshafts. In the Junker tandem type the consecutive cylinders are arranged with a step of 90° in the crankshaft, so that the engine has no dead centre.

For flight motors of the double-piston type designed by the Junker firm an increased efficiency of 20 per cent. in fuel economy over the ordinary single-piston engine is claimed. (Diefeld, "Motor," November-December, 1918.)

Calculations on the Strength of Wing Spars.

In this contribution the wing spar is treated as a beam of uniform flexural rigidity supported at a number of intermediate points, laterally loaded uniformly in each bay, and under end thrust, differing from bay to bay. The method follows that adopted by English mathematicians during the war in treating the same problem, although certain developments are missing in the German treatment. An extended form of the equation of three moments is obtained, one for each set of three consecutive supports. There are thus sufficient equations to determine the bending moments at each support on the assumption that the bending moments at the ends are known. These equations form a linear system whose coefficients are simple functions of the dimensions, properties and loading of the spar. It is shown that crippling will occur when the bending moments become infinite. This condition is easily written down as a determinant, from which the critical end thrust can be found. The analysis shows that when the spar is supported intermedially at a number of points the load to cause failure may be greater than the normal Euler's load. A number of special cases are worked out in detail. (H. Miller, " Zeitschrift für Flugtechnik und Motor-luftschiffahrt," September, 1918.)

Graphical Method to Determine Optimum Angles of Flight.

The author presupposes a diagram for the aerofoil given showing the variation of K, the resistance of coefficient, against K_y, the lift coefficient, with angles of attack.

The total resistance of the machine is then

$$W = W_x + W'_x = K_x F_v{}^2 + kfv^2$$

where W_x = resistance of wing

W'_x = parasitic resistance.

If G is the total weight of the aeroplane,

$$G = KyFv^2$$

from which it follows that

$$W = \frac{K_x}{K_y} G + \frac{kfG}{FK_y}$$

For minimum resistance $\dfrac{dw}{dK_y} = 0$ and accordingly

$$K_y K'_x = K_x + kf/F.$$

The second term on the right hand side being practically constant, the two curves $K_y K'_x$ and $K_x + kf/F$ are easily constituted from the original diagram, their point of intersection determining the optimum angle.

In the same manner the h.p. required

$$L = vW = G\sqrt{\frac{G}{F}}\sqrt{\frac{1}{K_y}}\left(\frac{K_x}{K_y} + \frac{kf}{F} \cdot \frac{1}{K_y}\right)$$

The optimum position is now obtained from $dL/dK_y = 0$, that is,

$$K_y K'_x = \frac{3}{2}\left(K_x + \frac{kf}{F}\right)$$

practically the same curves as before, and once again the inter-section gives the required position. (A. Fischer, " Zeitschrift für Flugtechnik und Motor-luftschiffahrt," July, 1918.)

Improved Climbing and Frictional Resistance.

This article states that when the wings of an aeroplane are being covered the fabric on the lower surface is sprinkled lightly with sand. Although the friction is thereby increased, the climbing power is considerably improved. This result is

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associated with the production of innumerable small eddies all in close proximity to each other on the undersurface of the wing, forming a species of air cushion. A fact closely associated with this is the phenomenon that when a machine flies directly into a head wind it climbs better than when flying in still air with the same relative speed. The author considers that this effect is directly connected with the eddying air encountered by the machine.

Experiments are being conducted to test the effects of roughening different parts of the surface of propellers and streamline bodies, and these have so far given satisfactory results. They have shown that roughening the undersurface of the wing is favourable to the production of a cushion of supporting eddies. (Von Burberg, "Zeitschrift für Flugtechnik und Motor-luftschiffahrt," July, 1918.)

Aeroplane Photography.

This article deals with the commercial application of aeroplane photography to surveying purposes, such as mapping out high roads, railroads, estates, or any other topographic work. Not only is attention confined to map making, but also to contour surveys. An account is given of the methods of using aeroplanes for this work, and also of many practical details of a mechanical nature that occur in the automatic and controlling systems of the camera. The latter it is stated must be completely automatic and suspended in gimbals within the body of the machine so as to be free from air currents and capable of being maintained in a vertical position. The vertical position can be controlled by means of a gyroscope, mechanically undesirable, or by gravity with suitable air cushions to prevent oscillations. (A. Brock and L. J. R. Holst, "Aviation," January 1, 1919.)

Parachutes for Aeroplanes.

Mrs. Louis Bennet has offered a prize of $500 to the Aero Club of America for the development of a parachute which will be to aviators what the life preserver is to seamen. If the competition shows that efficient means are to hand for this purpose, and fool-proof methods of using it are decided upon, it is expected that carrying parachutes on aeroplanes will be made compulsory. The problems which have to be faced in this connection are set out as under.

(1) To determine a method of attachment for the parachute which can be operated for any attitude of the machine.

(2) Almost instantaneous attachment and action is necessary since the pilot may have merely a few seconds to think and act.

(3) The parachute must open quickly, must not drop too fast, nor oscillate too much in descending. The average parachute opens after a drop of about 120 ft., and then descends at a speed of, approximately, 20 ft. per second.

(4) Safety is not to be found in weight, which itself is an aerodynamic disadvantage.

A parachute of Japanese silk about 18 ft. in diameter capable of sustaining a man weighing 150 lbs. will not weigh more than 15 lbs. Large parachutes tend to take up oscillations and side-slip badly, while, on the other hand, if the parachute be too small it will descend too rapidly.

Pioneers like Baldwin and Stevens contend that control can be exercised over the direction of the fall by pulling the attachment ropes, thus forming a type of sail.

By pulling the ropes on two sides simultaneously, and thus decreasing the span, the speed of drop may be increased, and adverse air currents avoided. The nature of the harness connecting the pilot to the parachute is exceedingly important, in order that he may detach himself immediately upon touching the ground to avoid injury by dragging, in the event of there being a strong wind. It is anticipated that success along these lines will ensure the use of parachutes in dropping mails and packages from aircraft, and thus avoid landing. It is well known that the Allies used parachutes during their latest advance to supply the most forward troops with ammunition. ("Aerial Age Weekly," January 6, 1919.)

Aerial Expedition to Explore Arctic Regions.

The Aero Club of America, of which Rear-Admiral Robert E. Peary is a member, has decided to back Capt. Robert A. Bartlett, the famous explorer, in equipping and sending to the Polar regions an expedition which will have as its aim the stupendous task of exploring and surveying the unknown Polar regions as well as exploring the depths of the Polar basin and the upper air of the Arctic regions.

It is hoped that the expedition will leave the United States in June, 1919, to take advantage of the period of comparatively warm weather which exists in the Arctic regions for six weeks of the summer, in July and August, when the temperature seldom falls below 60° F.

The plans are to have a ship to go to Etah, about 600 miles from the North Pole, in June, carrying a large seaplane or land machine for the flight over the Pole, as well as several smaller machines for scouting flights. At Etah a base would be established, and, while waiting for the ice to break up farther north to permit the ship to go as far as Cape Columbia, the small seaplanes would fly to Cape Columbia and establish a base there for the large plane which would fly from there over the Pole to Cape Chelyuskin on the Siberian side, and for exploration over longer distances.

It is hoped that results of inestimable value to science will be obtained from the expedition. Exploration which by the old methods would take about 200 years to do, it will now be possible to accomplish in about twenty years. At the present time only one-seventh of the earth's surface has been accurately mapped, two-thirds have been mapped from rough sketches only, and the remainder has not been surveyed at all.

There are hopes that discoveries of valuable minerals may be made and turned to account. It is known that mica and other minerals in great demand are to be found in the sub-Arctic regions, but to what extent cannot be said without further exploration. ("Aerial Age Weekly," December 30, 1918.)

Portable Airship Sheds.

The sheds described are made on the "Ermus" system, which is the subject of a German patent. The author points out the difficulties of housing an airship in a fixed shed, of which the opening may be in the worst possible aspect for a given condition of wind. He also criticises the rotary type of shed on the score of great initial cost. The new system permits of easy removal of the entire shed to another site, or to construct it upon the same site again with its axial line in a different direction. The skeleton framework consists of duplicate parts each comprising a lattice girder, to the centre of which is pivoted a strut of suitable length. Suitable foundation blocks of concrete are laid, each one having a suitable socket to receive the pin end of the articulated framework. Assuming the lattice girder with its strut folded together is lying upon the ground with the pin end of the strut in its proper position, then the extreme end of the girder, which is provided with a roller, is moved inwards, and when the strut is vertical the girder forms the roof principal at an angle of 45° to the horizontal. With the corresponding opposite principal in position, it forms a ridge roof, completing with the ground surface a triangular cross section. In order to permit of easy alteration to a different direction of its axis, say to any one of eight different points of the compass, it is sufficient to put in the requisite number of concrete foundation blocks with their suitable sockets. ("Deutsche Bauzeitung Supplement," December 4, 1918.)

Retractable Aeroplane Chassis.

An advertisement by the Martin Aeroplane Company shows an under-carriage which may be drawn up when in flight so as to be almost completely enclosed in the body of the aeroplane. From the figure accompanying the advertisement the under-carriage is seen to be in general appearance of the simple "vee" type. In an extract from a report by Mr. L. V. Kerber on one of the latest U.S. Army aeroplane designs of machine with retractable chassis the following particulars are given :—

At 100 miles per hour :—

Total resistance of extended chassis	59.6	Units not stated.
Total resistance of retracted chassis	11.0	
By retracting the chassis the total resistance is decreased 48.6/488.6	10 per cent.	
By retracting the chassis the maximum horizontal velocity is increased 145/137 — 1	6 ,,	

("Aerial Age Weekly," January 13, 1919.)

Instability of American Aeroplanes.

Investigations have been made at the Massachusetts Institute of Technology, Boston, on the dynamical stability of American aeroplanes, together with wind tunnel experiments in aerodynamics. The article is intended to summarise the reports of the investigations, omitting names of manufacturers, who, it is anticipated, will take advantage of the defects reported and remedies offered. ("Scientific American," February 8, 1919.)

Theory of Sprung Tail Skids on Aeroplanes.

It is claimed at the outset that attaching springs to the tail skid of an aeroplane is more important than it is usually considered. The skid is attached to the fuselage by means of a pin joint at a point near its centre and the upper end connected with the body by a spring. The oscillations set up when the lower end of the skid comes into contact with the ground on landing are examined from a theoretical point of view. It is supposed for simplicity that the landing wheels are rigidly attached to the ground, the aeroplane being free to move about the axle.

Let O be the point of intersection of the axle and the plane of symmetry, S the C.G., A a point on the fuselage vertically above the lower end of the skid. Also :—

$r = OS$.
r_s = the horizontal distance from O to A.
ϕ = the inclination of OS to the horizontal.
P = the reaction between the skid and the ground.
T = the moment of inertia of the machine about the axle of A.
G = the weight of the machine.

H and H' are the distances during oscillations above and below A_0. Suffixes 0 and 1 are used to denote the values of the quantities when the machine is in its *zero position* (*i.e.*, when the skid just touches the ground, but does not bear the weight of the machine) and in its position of equilibrium respectively.

The equation of motion about the axle is

$$Gr\cos\phi - Pr_s = -T\frac{d^2\phi}{dt^2}$$

Consider the first oscillation between the zero position and the lowest point reached by A.

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If $x = \phi_0 - \phi$ and K a constant depending on the spring,

$$P = P_0 + Kr_s x,$$

and it is found on integrating the equation of motion that

$$x/x_1 = 1 + C \sin a (t + t_0)$$

where

$$a = \sqrt{\frac{Gr \cos \phi_0 - P_0 rs}{Tx_1}}$$

and

$$C = \sqrt{1 + \frac{2Gh}{x_1 (G_r \cos \phi_0 - P_0 r_s)}}$$

where h is the vertical displacement of S corresponding to a rotation x.

These equations give the maximum value of x, and hence

$$P_{max} = P_1 + (P_1 - P_0) C.$$

Now $Gh = P_1 H$ approximately, and since the work done by gravity from zero to equilibrium positions is equal to the work done by the spring for the same motion.

$$G_r \cos \phi_0 x_1 = \frac{P_1 + P_0}{2} H'_1, \text{ also } r_s x_1 = H'_1.$$

After substitution, the final expressions for P_{max} are obtained, viz. :—

$$P_{max} = P_1 + \sqrt{(P_1 - P_0)^2 + 4P_1 Hk}$$

so that the maximum value of P that is likely to occur can be found if P_1, P_0, H, and K be known. In particular, if $P_0 = O$ and $H = 0$, *i.e.*, if there be no previous tension in the spring and the tail of the machine drops only from the zero position,

$$P_{max} = 2P_1.$$

The equation loses its meaning, of course, if the tail of the machine cannot fall through a distance H_{max} without touching the ground.

Now, substitute $P_0 = P_{max} - KH'_{max}$ in the above equation for P_{max} and solve for H, then

$$H = \frac{2H'_{max} (P_{max} - P_1) - kH'^2_{max}}{4P_1}$$

H_{max} will, of course, have to lie between limits defined in the design of the machine.

The article includes the solution of a few numerical examples where also the length of the skid is considered, and concludes with a remark on the friction between the skid and the ground. ("Oesterreichische Flug-Zeitschrift," December, 1918.)

Liberty Aeronautic Fuel.

The Liberty fuel is the outcome of research made in the United States with the object of developing a method of producing an artificial gasoline substitute. The article gives the results of tests made on the fuel at the Bureau of Standards to determine (*a*) those physical characteristics of the fuel which have bearing on its use in aeroplane engines; (*b*) the comparative performance of engines when using the Liberty fuel and aviation gasoline. The specifications referring to the manufacture of the Liberty fuel were not communicated to the Bureau of Standards, but it is understood that they are in the possession of the General Engineering Depot of the War Department.

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The physical characteristics which were determined were (1) the total (high) and net (low) heating valves, (2) the specific gravities, (3) the distillation temperature characteristics. In addition a cooling test was made which showed that a considerable amount of crystallisation took place when the Liberty fuel was cooled to — 10° C. (+14° F.).

The comparative engine tests were made with a 150 h.p., type A, Hispano-Suiza engine with compression ratio 5.3. The results of the tests indicate that Liberty fuel compared with a gasoline, fulfilling the export specification for aviation gasoline, will develop about 3 per cent. greater horse-power when consuming 10 per cent. greater weight of fuel per horse-power hour. The thermal efficiency of the engine when using Liberty fuel is, however, about 2 per cent. greater than it is when using the export grade of gasoline. The sparking plugs used in the runs on Liberty fuel showed a slightly greater carbon deposit than the plugs used in the run with export gasoline.

A series of runs was made to determine if the use of Liberty fuel would dilute the lubricating oil more than standard export gasoline, but the results of these tests are not yet available. ("Aviation," January 15, 1919.)

Climb Meter.

A short note on a climb meter developed by B. Russell Shaw is given in "Aviation" (New York), January 15, 1919, accompanied by a sketch of the instrument, but without an explanation of its governing principle. The instrument consists of a small streamline tank mounted on the under side of the aeroplane body and connected by tubing to a glass tube mounted on the dashboard and containing liquid, variation of level of which indicates climb. The instrument registers zero within five seconds after a level flight is started at any altitude, and this reading is not affected by opening or closing the throttle of the engine. ("Aviation," January 15, 1919.)

Use of Aeroplanes in Forest Patrol Work.

Of the total area of the United States approximately 24 per cent. is forested. Statistics secured during the past three years (1915-1917 inclusive) indicate that the average annual damage caused by forest fires amounts to approximately ten million dollars, and that there are upward of 28,000 forest fires annually in the United States.

The chief object of forest patrol work is protection against fire. For this purpose the present method of detecting fires is by means of a system of well selected look-out peaks. The writer, Henry S. Glaves, Chief of the U.S.A. Forest Service, is of opinion—although no experiments have as yet actually been carried out—that the method of detection of fires could be greatly improved by the use of aeroplanes. Several disadvantages of the present method are given and the advantages of aircraft for the purpose are brought forward. As a means of prompt detection of fires in rolling or flat country it is doubtful if aircraft patrol could be excelled, and it is probable that by adopting aircraft patrol the numbers of men required could be reduced.

Besides their use for fire detection, aircraft would be very useful for scouting on large fires. It is the duty of a fire scout to determine each day how the fire is progressing in order that it may be fought to the best advantage, and in country where getting about from one place to another is difficult the use of aircraft would be especially advantageous.

It is suggested that aeroplanes might be employed for the speedy transportation of fire fighters from point to point, and, further, that aeroplanes of the bombing type might even be of use in fighting fires by the dropping of fire-extinguishing bombs. ("Aviation," January 15, 1919.)

The Farman "Aerobus."

Some particulars are given of this new aeroplane, which is apparently to make regular trips between Paris and London. On trial flights it carried on each trip 12 to 14 persons. This machine is a transformation of the Goliath type F60, which was designed as a bombing plane.

The characteristics of the new machine are:—

Span	28 m.
Bearing surface	168 m.^{2}
Weight, empty	2,000 kg.
Useful weight	2,000 ,,
Weight of fuel	520 ,,
Weight, ready for flight	4,520 ,,

It is engined by two Salmon Z. motors developing 500 h.p. in all. The speed for "commercial" purposes is 160 km. per hour.

The machine can rise in four minutes to 500 metres and in ten minutes to 1,000 metres. It should be possible to attain still higher altitudes, as it has reached 2,000 metres in twenty-five minutes carrying 3,000 kg.

The Farman aerobus, which leaves the ground in ten seconds over a distance of less than 50 metres, can land smoothly, when travelling at 60 km. per hour, and in a few minutes.

The machine is properly equipped inside for the convenience and comfort of the passengers. ("La Nature," February 22, 1919.)

Halberstadt Biplane C.L. II.

The first model of this machine appeared at the beginning of 1918. The type has been used for all purposes—fighting, reconnaissance and bombardment.

The principal dimensions, loading, etc., are as follow:—

Span of upper wing, 35 ft. 4 in., lower 34 ft. 10 in.; chord of wings, upper 5 ft. 2½ in., lower 4 ft. 3½ in.; gap about 4 ft. 3 in.; stagger, 2 ft. 2 in. positive. Total length, 24 ft.; lifting surface, 323 sq. ft.; total weight, 2,540 lbs. The engine is a 160 h.p. new model Mercédès.

The two planes are nearly equal, and staggered positively; the upper wings are swept back a little, and the lower have a dihedral of $1\frac{1}{3}°$. The structure of the wings is entirely of wood, with the exception of the balanced ailerons on the upper wings, the framework of which is composed of 10 mm. steel tube. In both planes the trailing edges are rigid. The spars are of pine, and separated in each plane by about half the chord length; the front spars are in each case very near the leading edge. The central portion is covered with 3-ply, and is cut away considerably above the pilot's seat. A petrol tank and a radiator are lodged in the thickness of this portion of the wings. The lower wings are very much twisted at the tips.

There are two pairs of wing struts, one on each side of the fuselage, and they are of faired steel tube. They are reinforced internally by a double tube at their ends. At the points of attachment of the struts the spars are reinforced by four plates of ash, and are furnished with metal collars carrying ball and socket joints for fixing strut and cable ends.

The cabane is divergent, and consists of six struts, slightly inclined forward. Two of these are attached to the front spar, and the other four form a pair of inverted V's with the apexes at the rear spar.

The tail recalls that of the Albatross, but the fixed plane is less deep and has a less rounded leading edge. The structure is metallic, and the 30 mm. tube forming the leading edge is placed between two strips of ply wood. The elevators are not balanced, but the rudder is. The latter is situated with the fixed fin entirely above the fuselage, and the elevators extend some distance beyond the trailing edge of the rudder.

The fuselage is of ply wood, and terminates in a horizontal knife edge. It is of light construction, and well faired. The sides and base are flat, and the top rounded. At the forward end the covering consists of two sheets of light alloy joined at top and bottom of the fuselage.

There is one elongated cockpit for pilot and machine gunner. Under the pilot's seat is the main petrol tank. The machine gunner is in the rear and is rather cramped. The turntable is raised above the top of the body, thus ensuring an excellent field of fire.

The under-carriage is provided with two pairs of steel tubes, each forming a V; the tubes are widely separated. The shock absorbers may be either rubber or steel springs.

The Halberstadt C.L. II. has a good reputation among German fliers, but probably more on account of its good manœuvrability than of its performance. Its ceiling does not exceed 16,500 ft., and its speed is 103 m.p.h. on the ground against 85 m.p.h. at 13,000 ft. ("L'Aerophile," December 1-15, 1918.)

Duesenberg Model H. 850 h.p. Motor.

The Model Duesenberg motor, developing 850-900 h.p., built by the Duesenberg Motor Corporation, of Elizabeth, N.J., is the most ambitious aero engine development that has been attempted, and carried through successfully, in the United States. The motor is of the 16-cylinder, V type, with cylinders at an angle of 45 deg., and the weight of the power plant with gear drive is 1,575 lbs., without gear drive 1,390 lbs.—remarkably low weight ratio for a power plant of its size.

General Data.

Number and arrangement of cylinders: Sixteen V.
Included angle: 45°.
Bore: 6″.
Stroke: $7\frac{1}{2}$″.
Normal brake horse-power: 800 at 1,800 r.p.m.
Type of gear: Overhead camshaft and valve rockers.
Number of carburettors: Four Miller.
Number of valves per cylinder: One inlet and two exhaust.
Type of piston: Flat.
Material of piston: Magnalite.
Number of camshaft bearings: Four bronze and one ball bearing.
Cylinder centres: 7 inches.
Ignition: Battery and generator.

Many further particulars are given in the article, together with drawings and photographs of the engine and separate parts. ("Aerial Age Weekly," January 27, 1919.)

German Two-Seater Biplane L.V.G. C. VI.

This machine is one of the most recent that have been brought down on the French front, and may be considered an improved form of the L.V.G. C. V. There are no new features, but the improvements noticed in the latest German designs are embodied in the C. VI.

The principal dimensions and the weight of the C. VI. are rather less than those of the C. V., whilst the motor is still the 225 h.p. Benz, so that presumably there is an improvement in the performance.

The wings are unequal in span and chord, without sweepback, slightly staggered positively, and have a dihedral. The ailerons carried by the upper plane only are no longer balanced, and do not project beyond the maintips. There is a small fixed central portion which carries the radiator within its thickness. A petrol tank is lodged in the left-hand wing. The leading edge of the upper wing is shorter than the trailing edge, whilst the tips of the lower wings are approximately elliptical.

The six struts of the cabane are in two groups of three tubes, each forming an N inclined towards the rear. They are not inclined in the front view.

The tailplane is a little larger than in the C.V. Elevators and rudder are balanced, and the rudder is placed wholly above the tailplane.

The fuselage is of ply wood, and finishes in a vertical knife-edge. The sides and base are slightly convex, and the top is considerably rounded.

The mean duration of flight is about $3\frac{1}{4}$ hours. ("L'Aerophile," December 1-15, 1918.)

The Standard E1 Single-Seater.

The E1 single-seater built by the Standard Aero Corporation was designed as a secondary training machine. It is provided with either an 80 h.p. Le Rhone or a 104 h.p. Gnome engine, but in either case the dimensions of the machine remain the same. Slight differences in weights and performances result, depending upon which engine is used.

The R.A.F. 15 wing section is used. Dihedral 3 deg.; aspect ratio of both planes, 7; stagger, 13.02 in. Wings are set at an angle of 2 deg. to the propeller axis.

General Dimensions.

	Ft.
Span, upper plane	24
Span, lower plane	24
Chord, both planes	3.5
Gap between planes	4
Length over all	18.85
Height over all	9.08

Areas.

	Sq. ft.
Upper plane	81
Lower plane	72.3
Ailerons (two upper and two lower)	23.2
Total wing area with ailerons	153.3
Stabiliser	12
Elevator	12.7
Fin	2.6
Rudder	6.8

Summation of Weights.

(With Le Rhone Engine.)

	Weight in lbs.	Percentage of gross weight.
Power plant	434	36.4
Fuel and oil	140	11.8
Pilot and miscellaneous equipment	179	15.1
Armament	28	2.4
Body structure	141	11.9
Tail surfaces and bracing	36	3.1
Wing structure	156	13.1
Chassis	74	6.2
Total	1,188	100.0

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Summation of Weights.

(With Gnome Engine.)

	Weight in lbs.	Percentage of gross weight.
Power plant	467	36.6
Fuel and oil	196	15.4
Pilot and miscellaneous equipment	179	14.0
Armament	28	2.2
Body structure	141	11.1
Tail surface with bracing	36	2.8
Wing structure	156	12.2
Chassis	74	5.7
Total	1,277	100.0

Weight per h.p.: Le Rhone 14.5
Weight per sq. ft.: Le Rhone 7.6

The Le Rhone is a nine-cylinder, air-cooled rotary engine, developing 80 h.p. at 1,200 r.p.m. and 84 at 1,290. Bore and stroke $4^1/_{16}''$ by $5\frac{1}{2}''$.

The nine-cylinder rotary Gnome, manufactured by the General Vehicle Company, is known as type B-2. At 1,200 r.p.m. it delivers 104 h.p. Bore and stroke, 110 mm. by 150 mm.

Summary of Performances.

(With Le Rhone Engine.)

Height (feet).	Speed (m.p.h.).	Time of climb. min.	sec.	Rate of climb (ft. per min.).
Ground	100—103	0	0	705
5,000	—	8	0	705
5,500	95	—		—
8,500	90	16	30	—
10,000	85	22	20	200

Ceiling: 14,500 ft.
Stalling speed: 48 m.p.h.
Gliding angle: 1 : 7.
Maximum range: At 5,000 ft., 200 miles; 10,000 ft., 160 miles.

In the article detailed weights of parts are given, and it is illustrated with general arrangement drawings and photographs of the machine. ("Aerial Age Weekly," January 27, 1919.)

Formula for Approximating Propeller Diameter.

In this article a simple and effective formula is obtained for determining the diameter of a propeller giving an estimate of fair accuracy for any case in which the number of blades, the horse-power and r.p.m. of the engine, the flying speed and the maximum blade width are given. In deriving this formula it is assumed that the efficiency is the same for all propellers, so that the horse-power absorbed is proportional to the product of the thrust and the speed of flight. It is contended that practice shows that this assumption involves only comparatively small errors. On the Drzewiecki theory of design the thrust on an element is

$$T = K_y \times b \times dr \times V_r^2 \times \cos(A+G),$$

where K_y is the lift coefficient of the section; b the blade width; dr the length

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of the element; V_r the resultant velocity through the air; A the angle which the path of the element makes with the plane perpendicular to the propeller axis; and G the angle which the line of action of the resultant force on the element makes with the perpendicular to the path of the element. The value of b is directly proportional to the maximum blade width so long as the blade form remains unchanged. Therefore to allow for changes in section and in plan form arbitrary constants will require to be associated with Ky and b respectively. Assuming the propellers divided into the same number of elements, dr is proportional to the diameter and V_r to the product of the diameter and the number of r.p.m.

Cos $(A+G)$ is practically constant for all propellers. On these assumptions it is easily shown that the power absorbed can be written in the following form:—

$$P = \frac{K_1 K_2 B D^3 N^2 V n}{10{,}000{,}000{,}000}$$

D = propeller diameter (ft.).
B = maximum developed blade width (in.).
N = revolutions per minute (of propeller).
n = number of blades.
V = speed of flight (m.p.h.).
K_1 = coefficient of blade form (0.75—1.00).
K_2 = coefficient of section and angle (0.75—1.00).

For propellers of the usual blade form with a rounded tip, and the maximum width about three-quarters of the way out.

$$K_1 = 0.85 - 0.9.$$

K_2 has its maximum value for propellers with a cambered blade at a large angle of incidence (about 6 deg.), its minimum for sections of low-lift type set at a small angle (about 2 deg.).

K_2 also will lie between 0.85 and 0.9 for most propellers, so that it is not possible to make a very large error in the determination of these constants.

As an illustrative example, the diameter of a two-bladed propeller for the Liberty engine, developing 400 h.p. at 1,700 r.p.m. mounted on an airplane flying 125 m.p.h., may be found, assuming the maximum blade width to be 10 in.

$$400 = \frac{0.85 \times 0.9 \times 10 \times D^3 \times (1{,}700)^2 \times 2 \times 125}{10{,}000{,}000{,}000} = 0.553\, D^3$$

$$D = \sqrt{\frac{400}{\cdot 553}} = 9.0 \text{ ft.}$$

(E. P. Warner, "Aviation," February 15, 1919.)

Nomographic Charts for the Aerial Propeller.

There has recently come into use a means for the graphical solution of exponential formulæ, which is similar in principle to the "Polar Logarithmic Diagrams" devised by M. Eiffel, in that it depends on the reduction of an exponential to a linear form by the use of logarithms, and the employment of logarithmic scales. This device consists in the construction of diagrams called nomographic charts, or alignment charts, from which the required results may be obtained by simply connecting the points representing the given data by straight lines and then reading off the intercepts on the proper scale, the method being similar to that of using a slide rule.

Prof. Slocum describes with examples the method of applying nomographic charts to propeller calculations, assuming that the performance of a given type of propeller is given by an exponential formula based on actual results of tests. He states that the usual assumptions that the thrust varies as N^2D^4 and the horsepower as N^3D^5 may often give erroneous results, as was found by analysis of experimental results obtained by M. Eiffel and Capt. Dorand. ("Aerial Age Weekly," January 27, 1919.)

Plywood in Aeroplane Construction.

The first point upon which stress is laid in this article, describing the many uses to which plywood may with advantage be put, is that the idea of a number of sheets and fragments of thin wood stuck together by an adhesive such as ordinary glue, more or less soluble in water, or swelling and loosening on exposure to atmospheric humidity, should be dismissed from the mind when the material "plywood" is under consideration.

True plywood is a product resulting from a scientific process involving a correct and methodical sequence of operations all depending on each other. The elements of the original structure of the wood; the relations of the particular cementing material employed to the wood and to the atmospheric conditions of the moment; the temperature required to produce the chemical reactions between the wood and the cementing material, and within the cementing material itself; and the magnitude and duration of the pressure applied per unit area; all these form such a number of variables that no routine standardisation is practicable, and only the exercise of individual skill obtained under long experience, can produce a determinate result.

Laminated plywood formed into shapes under heat and high pressure with cementing materials which become insoluble in the course of the process, has been used in Russia for many years, notably in the works of the Russian Baltic Wagon Co., Ltd., who made the plywood fuselage of the Sikorsky aeroplane. From Russia the use of plywood extended to Germany in the products of the Deutsches Rohrplatten Gesellschaft; from which a knowledge of these special processes and equipment passed to the United States nearly twenty years ago. In Russia Capt. Kostovitch used plywood for dirigibles which in construction and design anticipated the most recent rigid plywood dirigibles built by the Schutte-Lanz Company in Germany. In Russia also the first complete plywood aeroplanes were made by Steglau in 1912, the use of plywood extending even to the wing covering.

In France, as early as 1909, sheet plywood was used by Levavasseur, and later, in 1912, Béchereau, of the Deperdussin Company, designed the fuselage now known as the "monocoque."

The Germans, who at first made fuselages of the truss type, covered in with linen after the prevailing French style, commenced about 1912—probably following on a visit of one of their investigators to Russia—to use plywood in fuselage construction, following not the method of Béchereau but a more correct method employing longerons and bulkheads.

England and France continued to use the linen-covered truss construction, and the designers of the United States in most cases followed the precedents thus created with little or no regard to what had been developed in Russia and Germany.

It is pointed out what rough usage the fuselage of the Albatross aeroplanes are able to withstand, and that the use of plywood on British and French machines is even yet unlike that of the better constructed German aeroplanes in that the plywood is generally nailed on as a mere covering, and not made an integral part of the structure.

Among the advantages of plywood as against the truss construction are the facts that no periodical truing up is required, and that the wood for plywood being so thin may be dried very quickly. The real problem in its successful use in aeroplane construction lies in the standardisation of parts for quantity production. (H. H. Suplee, "Aerial Age Weekly," January 20, 1919.)

Winds and the Trans-Atlantic Flight.

From meteorological data obtained both on the American and the European sides of the Atlantic it is possible to specify with moderate certainty the conditions that would confront a pilot attempting a trans-Atlantic flight, to indicate approximately what course should be followed, and which heights are the most favourable. In 1905-07 four expeditions were undertaken for the purpose of exploring the atmospheric conditions in the inter-tropical regions of the Atlantic. By measurement of the speed and direction of ascent of balloons from the deck of a yacht, the velocity and direction of the wind up to 30,000 ft. was determined between 10° and 30° north latitude, and 60° and 40° west longitude during the summer months. In all 715 observations were taken: 74 per cent. of the winds at sea level came from north-east, and this direction was more frequent than any other up to 10,000 ft. At 20,000 ft., east and south-west winds became most common, and at 30,000 ft. south-west winds were strong and frequent. The steady north-east Trade Wind blowing near the surface of the sea would be a distinct aid to a westward flight. These winds at sea level vary from 10 to 15 m.p.h., increasing to 25 m.p.h. at 20,000 ft.

From these data it is concluded that a very favourable course could be taken in the summer at a height of 3,300 ft., starting from Boston 'n an east-north-easterly direction. From 30° west certain Manchester observations could then serve as a guide, for these indicate that at this point favourable winds from the north-west are prevalent, thus encouraging a change in the course to one almost due east, with London as an objective. Observations show that fair weather and few storms prevail over this route in summer, and it is high enough to be above the fog. ("Aviation," February 15, 1919.)

"Planeurs Captifs" for Meteorological Work.

The author holds strongly that there is a great future for scientific kite flying for meteorological work, aerial photography, signalling, etc. Numerous societies existed in France before the war for the encouragement of kite flying, but the work of these in educating the public to the importance of the subject was interrupted by the outbreak of hostilities. It is proposed that an association should be formed embracing all such societies, and that there should be close co-operation between the different workers. Government assistance is desired especially in the provision of suitable grounds for the experiments in different parts of the country. The work must be carried out in a scientific manner, and all results of importance published. It is recommended that the name "kite" (cerf-volant) be dropped as being suggestive of a toy, and "Planeur Captif" adopted instead. The features which the apparatus should embody are sketched out. Thus the kites should be easily collapsible for storage, and yet rigid when erected. They must be stable in flight, and must act as a parachute if a sudden drop of wind occurs. They should fly in winds of from 5 to 25 m.s. In the scheme outlined for man lifting a pilot kite is first sent up and the train of lifting kites attached to the cable at intervals of 10 to 30 m. A basket travelling up the cable is used for the observer. the winch is preferably mounted on a lorry with separate motors for winding in the cable and driving the lorry. A dozen men have been found to be sufficient to manipulate a train of man-lifting kites. Sketches show several suggested forms of kite both of the monoplane and box types. Details of construction are also shown. ("L'Aerophile," January 15, 1919.)

Speed Measuring Instruments for Aeroplanes.

The conclusion of an article on speed measuring instruments for aeroplanes and airships first describes a double indicator which shows the revolutions per minute of both the right and left hand driving motors. The two speed cards are in one case and are clearly marked from four to sixteen hundred r.p.m. In this casing is fitted the magnetic coil which itself carries the indicators, so that all gearing is avoided, the movement of the indicator needle being limited to an angle of 90°. The needle for the L.H. motor moves underneath the needle of the R.H. motor, and the reading especially on the higher numbers is very clearly seen.

In spite of their simplicity these double speed indicators have not come into general use, their disadvantages being that if a speedometer has to be changed the whole apparatus must be taken to pieces.

The anemotachometer is another important instrument for aircraft, for measuring the actual or relative speed of the flying machine. It is made in the form of a cross, each arm of which carries a cup-shaped impeller which the wind drives. The rotation of the wind-driven impeller on its central spindle actuates a pendulum movement, the strokes of which are transmitted to the indicating dial. One of the greatest advantages of this instrument is that its action is always positive and is not affected by the density of the air through which the aeroplane is passing and, further, that the anemotachometer comes into action immediately the machine starts.

As this instrument has to be near the driver's seat, in large flying machines the same four-cup cruciform anemotachometer is used, but in this case the control is electrical and the flying speed is given by the voltmeter above the pilot's seat. This instrument has a second valuable use in that from it the pilot can judge the curvature of his course. Owing to the number of motors which are now included in the design of one aeroplane, steering has become very difficult, and it is often impossible for the pilot to know in foggy weather whether he is steering in a curve or straight forward. If two anemotachometers electrically connected to a central voltmeter are placed towards the extremity of each wing of the aeroplane, then the indications of both instruments will be the same if the machine is flying straight, but if flying in a curve the instrument on the inner or shorter radius of the curve will register a slower speed than the one on the outer radius. From the difference between these indicated speeds, the curvature can be seen from a properly prepared chart on the indicator dial.

The article is concluded by a description of various ways in which the anemotachometer may be used and different methods of the electrical wiring of the instrument, with various graphs and diagrams to illustrate the text. (Wilke, "Der Motorwagen," December 31, 1918.)

Helium for Airships.

One of the greatest achievements due to the pressure of war conditions, from the technical point of view, is the production of helium in quantities sufficient for airships. A rare gas discovered by Ramsay about twenty years ago, not more than 100 cubic feet had been obtained up to two years ago. Someone in the British Admiralty had imagination enough to propose the separation, on a large scale, of helium from natural gases in Canada, which gases contain about one-third of 1 per cent. of helium, and experiments were undertaken at the University of Toronto. The U.S. Bureau of Mines took the question in hand, and with such success that on the cessation of hostilities in Europe, there was, compressed and on the dock ready for floating, 147,000 cubic feet of nearly pure helium, and plants were under construction to produce at least 50,000 cubic feet a day at an estimated cost of not more than ten cents a cubic foot. The gas, which is non-inflammable, has about 92 per cent. of the lifting power of hydrogen. ("Engineering and Mining Journal," February 8, 1919.)

Commercial Employment of Rigid Airships.

The general public consider Zeppelins a failure, but are not aware of the important services airships rendered to the navy. The author describes the patrol duty carried out round the coasts of England and Scotland by airships. On

October 31, 1918, there were more than 100 such vessels in England. One had remained in the air 55 hours and another 61 hours. The British Navy has nine vessels of the Zeppelin type in use and others are being built. The American Congress has voted funds for six such vessels. In France it was decided to build six, but work upon the first has already been stopped. The author considers that airships and aeroplanes are not rivals, but that each has its special field of usefulness and travelling will be much more comfortable in the former than in the latter. He believes that airships will be largely employed for the conveyance of goods in districts where no railways exist. He looks forward to a regular traffic by airship from Europe and America, and regrets that the airship is at present neglected by the French naval authorities. ("Génie Civil," March 1, 1919.)

Aeronautics in the United States.

The author reviews the war developments of aeronautics and research relevant thereto in the United States. Helium has been made in balloon quantities, 147,000 cu. ft. being ready for shipment when hostilities ceased and plants being under construction to yield 50,000 cu. ft. per day at a cost not exceeding 10 cents per cu. ft. This gas has 92 per cent. of the buoyant effect of hydrogen and is non-inflammable. The meteorological service has made important discoveries bearing upon air currents at various altitudes and the possibilities of using airships for long distance flights. Arrangements have been made to take balloon records right across the Atlantic. A review is given of aero-radio development work, notably in connection with vacuum tubes, radio-telephony and direction finders. (G. O. Squier, "Electrical Review," Chicago, January 25, 1919.)

Newest Type of Zeppelin Cruiser.

All the latest improvements that the Germans had achieved were embodied in a Zeppelin which made a forced landing in France in October, 1917. Since that time no change has taken place in any essential feature. In length the airship is about 200 metres, the total height 24 metres, and its volume 57,000 cu. m. In form the central portion is cylindrical, and the two ends taper to a cone. Of the four gondolas one is placed well forward; this is divided into two compartments, in one of which there is the commander's cabin and the wireless telegraphic apparatus, while in the other the motor is fixed. Approximately amidships, side by side, are two other gondolas, each of which is also furnished with a motor. The fourth gondola, situated close to the tail, contains two motors, one of which is held in reserve for emergencies.

A triangular passage is built into the lower part of the envelope and is completely covered in. A ladder connects the gondolas directly to this passage. A wooden construction in the centre of this passage contains the fuel, the water ballast, the bombs, and several hammocks. A cylindrical chimney, constructed of a series of metal rings, connects this passage to a platform on the top side of the airship, where machine-guns and other light weapons are stationed. The four gondolas are well streamlined. The most forward of these is 10 metres long, 6 metres of which is taken up by the cabin of the commander. In height this chamber is 2½ metres and in breadth 2¼ metres. The motors develop approximately 1,200 h.p., while the diameter of the four propellers is 5 metres. The fuel tanks are of aluminium, and hold 300 litres of benzine.

The water ballast tanks have a capacity of 1,000 litres. The normal speed of this airship amounts to 100 kilometres per hour, while journeys of 30 hours' duration were undertaken without any difficulty. With a good climbing capacity the airship can attain heights of 5,500 to 6,000 metres.

The wireless telegraphic apparatus is built after the Telefunken system, and can transmit waves of lengths varying from 300 to 1,700 metres with the aid of antennæ 120 metres in length. ("Automobil-Welt," January 5, 1919.)

German Single-Seater Scout, Roland D.VI.

This machine appeared at the front in July, 1918. There are two forms, identical in every respect except that that D.VI.a has a 180 h.p. Mercédès engine and a weight empty of 1,440 lbs., whereas the D.VI.b has a 200 h.p. new model Benz engine and a weight empty of 1,475 lbs.

The fuselage is covered with strips of wood, tongued and grooved in a manner recalling canoe construction. There is a metal cowling forward for the motor. The tailplane is all in one piece, passing through the body. Balanced rudder and elevators are fitted. The fuselage has an elliptical section, shaped locally to form a short keel, to which the lower wings are attached.

In the lower part of the body and immediately behind the airscrew is a gilled oil cooler radiator.

The wing struts are wooden and tapered, a single pair to each wing attached to the spars by ball and socket joints.

The planes are staggered a little, and there is a dihedral on the lower wing only. The ailerons, fitted to the upper plane only, have a very narrow chord and are balanced by horns extending beyond the wing-tips. The Fokker D.VII. and all subsequent scouts have ailerons of this form.

The water radiator is in the upper plane. The new Benz engine has a new method of circulating the cooling water. The outlets for the jacket water are placed on the exhaust side of the cylinder head, and not in the centre at the top as formerly. This ensures better cooling of the exhaust valve. The lower system of communication between the jackets consists of a collector tube separated from the motor, to which the inlets of the various cylinders are attached independently by rubber tubes and flanged joints.

The construction of the machine is very ingenious but too frail in many parts. Thus the wing ribs have webs of linden, and flanges of ash. Linden or lime wood is not strong enough and reinforcing strips have to be nailed and glued on at several parts of the web. The spars are of northern red pine of good quality, and are made in box section. The finish is much improved as compared with previous German practice. ("L'Aerophile," January 1, 1919.)

Radio-Surgical Machine—"Aerochir."

This is a weight-carrying machine designed to carry a surgical outfit. It is the result of the collaboration of the engineer M. Nemirovsky and the doctor Tilmant, and is built to carry a pilot, a surgeon, and an X-ray operator as well as a complete surgical outfit. The speeds of machines for this purpose range from 60 to 100 m.p.h. A comparison of this rate of travel with that of wheeled traffic on congested military roads will indicate the immense value of the machines in war for the treatment of urgent cases. The scene of a sudden action leading to a large influx of wounded can be reached in less than two hours after warning has been received at the central station, if a post with two machines be provided for every 120 miles of front. In peace time also the machines should prove invaluable.

The "Aerochir" contains all the material necessary for six urgent operations to be performed immediately on arrival, and for sterilising this material for the performance of a subsequent 30 operations. There is a complete outfit of X-ray apparatus, the bulb being carefully protected by means of a fixed and padded box. The operating table is of specially light construction, entirely in sheet aluminium (which is permeable to the X-rays); it can also be used as a stretcher. The remaining surgical appliances are housed in aluminium boxes.

The total weight of the material carried by the "Aerochir" is about 800 lbs. All the trials have given full satisfaction. ("L'Aerophile," January 1-15, 1919.)

German Educational Work.

The paragraph on German educational work in aeronautics which appeared in the April number of this journal (Vol. XXIII., p. 203) is worthy of attention. Captain A. Graham Clark writes in reference to it as follows:—

The list of lectures is of more than ordinary interest as indicating the importance attributed by Germany to a strong aeronautical educational programme—despite the conditions imposed by the war. In the "Deutsche Luftfahrer Zeitschrift" for June, 1917, it was noted that the summer programme for 1917 was virtually only the same as in the preceding term. The summary of these lectures was as follows:—

UNIVERSITIES.

COLLEGE.	LECTURER.	TITLE OF LECTURE.
Berlin ...	Marcuse ...	Topographical geography with exercises in nautical geography and aeronautical astronomy.
Münster ...	Schewior ...	Outline of aeronautics.

TECHNICAL COLLEGES.

Aachen ...	von Karman..	Aerodynamics of flight.
Berlin ...	Kassner ...	The wind—its origin, measurement and application in relation to the construction of high buildings and harbours, to sea and airship navigation, and also to the construction of wind driven engines.
Berlin ...	v. Parseval ...	Aeroplanes.
Berlin ...	Schaffran ...	Researches with air and water propellers.
Brunswick ...	Schlink ...	Meteorology and aeronautics.
Danzig ...	Fottinger (subst. N.N.)	Propellers for water and aircraft—the design of propellers for water and aircraft.
Danzig ...	Rieppel (subst. Dr. Eng. Schneider)...	Engines for land, water and aircraft.
Darmstadt ...	Schleiermacher	Aerodynamics in relation to airship navigation.
Hannover ...	Precht ...	Airship navigation.
Hannover ...	Pröll ...	Aero-mechanics in their application to dirigible airships and aeroplanes.
Munich ...	Emden ...	Construction and navigation of the airships.
Stuttgart ...	A. Baumann...	Aeroplanes and their constructional details. Engines for land, water and aircraft.
Graz ...	Wittenbauer...	Technical Mechanic II. (hydrostatics, hydraulics, the mechanics of gases). Aeroplanes and airships in flight.
Vienna ...	Knoller ...	Airship navigation and the automobile.

All the above, with the exception of that at Münster, are included in the 1918 programme, but the whole syllabus has now been more widely extended on a much broader basis and the prominence which is now given to those subjects that are of high importance in commercial aeronautics should be particularly noted, as well as the attention devoted to propellers and to airships. The fact that such extension was deemed possible in 1918, when the syllabus remained practically unchanged in 1916 and 1917, is significant.