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REMARKS ON BUILDING OF LOW-POWERED AIRPLANES.

By Werner v. Langsdorff.

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REMARKS ON BUILDING OF LOW-POWERED AIRPLANES.*

By Werner v. Langsdorff.

The very successful flights with soaring airplanes or gliders, especially in Germany, have greatly influenced the development of the low-powered airplane. Its importance is so evident that attention needs to be called to but a few points. It will doubtless attain very great importance, as soon as it is sufficiently safe and cheap. The same as for all aircraft, its advantage over other means of transportation, by land or water, lies in its speed. Experiments have shown that speeds up to 100 km (62 mi) per hour are attainable by favorable construction. Even if the speed were only 60-80 km (37-50 mi) per hour, there would be a saving in time, since air lines average about 25% shorter than ground lines.

If the low-powered airplane is to be used advantageously by private individuals, the most important consideration is a smaller fuel consumption and, hence, a lower engine power. It is obvious that a comparatively weak engine will maintain a good soarer or glider in horizontal flight. Lulls in the wind and loss of altitude can be thus overcome. From experiments with gliders, it appears entirely possible, by utilizing ascending winds (on the weather side of mountains and those generated by

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the heat of the sun) and by employing engine flight intermittently, as required, to fly long distances over land.

For existing gliders, 5 to 8 HP would provide sufficient climbing power. Various structural difficulties present themselves, however. An ordinary propeller can, by no means, be considered ideal. The usual arrangement, with engine and propeller in front, offers no favorable solution of the problem, since the slipstream is strongly deflected by the fuselage, landing gear, etc. The strength of the engine depends on the power required for starting. If a low-powered airplane is to serve any but sport purposes, it must not be restricted to a few difficultly reached starting places, as has hitherto been the case with gliders. It must, instead, be possible to start from a small level field. If the engine has 5 to 8 HP with an unobstructed start, it is 20 to 40% stronger than is absolutely necessary for flying.

As a result of the great additional resistance created by the propeller and engine, a considerable increase in the sinking speed is to be expected, even though the added weight could be offset by lighter construction. Various expedients have been suggested for decreasing this resistance. With a revolving propeller, for instance, the resistance can be diminished by changing the pitch of the propeller blades or covering the propeller when at rest. Such a decrease in the resistance should not, however, be made at too great a cost in weight. It is

still problematical and needs to be tested experimentally, as to whether the increase in resistance and weight would leave it possible to make a flight without the continuous use of the engine, i.e., to attain actual soaring flight.

Flight by means of flapping wings has thus far been difficult to accomplish with rapid engines, on account of the inertia of the wings.

In the Dewoitine, Wren and Coupet types, the engine is placed at the front end of the fuselage and drives a small tractor propeller. In the German type of Budig, the engine is behind the pilot's seat and drives a pusher propeller. Martens installed in his monoplane "Strolch" (of the Prometheus Works, Hanover), which was successful in the fourth Rhön soaring contest, two auxiliary engines, one on each side of the fuselage.

These four airplane types were derived from gliders. The Dewoitine monoplane had already been flown in the first French soaring contest at Clermont Ferrand in 1922. It was able under Barbot, in the autumn of 1922, to make a gliding flight of 20 minutes from the plateau of Super-Bagueres (Pyrenees) with an altitude difference of 1200 meters. In 1923, it was flown by Barbot 8 hours, 36 minutes and 56 seconds in Biskra, Africa.

The Dewoitine monoplane has flexible wings without external brace-wires. For transportation, the wings can be folded back against the fuselage, without being entirely disconnected. Each wing has a hollow main spar and tapers outward. Its aspect

ratio is 1 : 10. It is steered by warping the ends of the wings, the rear two-thirds being flexible and the front third rigid.

The fuselage has a streamline form made by oval ribs connected by light spars. While on the glider, the front end of the fuselage consisted of a spherical cap of plywood, the latter was replaced by an engine on the low-powered airplane. The 7 to 10 HP Anzani engine was originally designed for motorcycles. It had two opposite cylinders and was air-cooled. The brake horse-powers were

7 HP	at	1250 R.P.M.
8 "	"	1350 "
9 "	"	1450 "
11.75 HP	at	1800 R.P.M.
12.75 "	"	2200 "

With wide-open throttle, the revolution speed was about 1350 R.P.M., hence 8 HP. The weight of the supporting structure is 35 kg (77.2 lb) or 4.375 kg (9.65 lb) per HP. The weight of the fuel is about 20 kg (44.1 lb) and the power plant 80 kg (176.4 lb). With a total weight of 250 kg (551.2 lb) the total load per HP is 31.25 kg (68.9 lb).

The engine is located in the front end of the fuselage and drives a two-bladed propeller. The fuselage is supported by an ordinary landing gear with rubber-tired wheels. The fuselage and wings are covered with fabric.

The airplane has the following characteristics:

Span	11.3 m	(37.07 ft)
Wing area	11.5 m ²	(123.78 sq ft)
Length	4.9 m	(16.08 ft)
Weight empty	115.0 kg	(253.5 lb)

Total weight	250.0 kg	(551.2 lb)
Weight per m ²	14.0 "	(30.9 lb)
" " HP	31.25 "	(68.9 lb)

The flight performances are said to have been satisfactory. Barbot reached an altitude of 500 m (1640 ft) in a 25-minute flight from Francavat to Toulouse. The start was made from a level field. Barbot made another flight from St. Inglevert (France) across the English Channel to Lympne (England) and back. The time going was 50 minutes; returning, 43 minutes. The consumption for both flights was 4.5 liters (1.2 gallons) gasoline and 0.7 kg (1.54 lb) oil. At 1500 R.P.M. near the ground, the speed was 90 km/hr (56 mi/hr). At 1200 R.P.M. it was 75 km/hr (47 mi/hr). The theoretical ceiling was 2000 m (6562 ft).

While Dewoitine's monoplane outwardly resembled a regular engine-driven airplane, the Wren monoplane closely resembled the well-known German high-wing type. The wings of the Wren are also without brace-wires. They rest directly on the rectangular, closed fuselage. The span is 11.3 m (37.07 ft). The wings have two spars and their leading edge is reinforced.

The pilot sits in the front end of the fuselage in a notch cut out of the leading edge of the wings. The engine is mounted in such a way that, with the small propeller diameter, there is room left for a special landing gear. Due to the smallness of the propeller diameter, the slipstream is greatly impeded. The fuel tank is inside the power-plant shelter.

The tail unit consists of a large rounded rudder behind a square fin and a divided elevator with balancing surfaces. The latter is braced by oblique rods. On the ground the tail is supported by a skid.

The landing gear axle is so high up in the fuselage that only a small part of the wheels project from the bottom of the fuselage to offer structural drag to the air flow. The A.B.C. motorcycle engine has two opposite cylinders of 398 cm³ (24.29 cu in) stroke volume. Its normal power is 3 HP, its mean flight output about 3.5 HP and its maximum output 7.5 HP. The propeller has a diameter of 1.12 m (3.67 ft) and a mean revolution speed of 2600 R.P.M.

In the very first experiments with this airplane, favorable results were obtained, as regards fuel consumption. The flight speed was about 60 km/hr (37.26 mi/hr). It had the following characteristics:

Span	11.2 m	(37.07 ft)
Length	7.0 m	(22.97 ft)
Dead load	95.0 kg	(209.44 lb)
Full load	163.0 kg	(359.35 lb)

The Budig biplane was derived from the Budig glider, which participated in the 1921 Rhön soaring contest. The lower wings have a slight dihedral and are shorter and narrower than the upper wings, which carry the ailerons. The cell is braced by V-struts and wires. The elevator is in front of the cell. It is likewise in the form of a biplane and is utilized for the automatic retention of longitudinal stability. The Budig stabil-

izing device, with a difference in the angle of inclination, is said to facilitate the utmost utilization of the horizontal wind fluctuations. It consists essentially of a steering surface, whose position automatically changes with fluctuations in the force of the wind.

Two rudders lie behind the cell, to which the tail is connected by four plywood girders. The landing gear consists of a pair of light wheels close under the lower wing on both sides of the short body. Supporting runners carry the front and rear stabilizing fins. The two-cylinder motorcycle engine is located in the back end and drives a two-bladed pusher propeller behind the cell, between the four tail girders. The B.M.W. engine gives 4 HP. Its weight per HP is 7 kg (15.4 lb). With this airplane Budig has made more than 250 flights over level land near Berlin.

Various other types have been experimented with in Germany and elsewhere. The incentive for this development was doubtless given by the results of soaring flights and especially by the performances of the German gliders. The first engine-driven airplanes, of Wright, Bleriot, Voisin, and especially, of Santos Dumont and Hans Grade, had low-powered engines. The better performances of the present low-powered airplanes are doubtless to be ascribed in part to the greater skill of the pilots, but more especially to aerodynamically improved construction. In the construction of recent engine-driven and engineless airplanes,

it has been endeavored to eliminate every form of structural drag. A very good solution, in this respect, is presented by the Wren monoplane of the English Electric Company, at Preston, designed by W. O. Manning, in which the landing gear has been abolished.

Airplanes with somewhat more powerful engines are usually built on the plan of large engine-driven airplanes. New types, with 20 to 50 HP engines, are being built in nearly all countries. The best known German types are built by Udet, Junkers, Dietrich Gobiet, Dornier, Eutler, Riesela-Mark, Sablatnig, "Bahnsbedarf" Company at Darmstadt, Ksoll and the "Flugtechnischer Verein" at Schwaben.

Other countries possess similar types, most of them aerodynamically poor, in the English "Avro-Baby," B.A.T. "Crew," French Caudron "C-67," Farman "Sport" and "David," Marcay's "Passe Partout," Bishop's "Estafette," "Sanchez-Besa," Italian "Breda," Nieuport-Macchi "M-16," Ricci "R-6" and "R-9," Russian "Dobkevitch," Polish "Gabriel," American "Gosport," "Heath," "Huntington," "Kite," "Mummert," "Slinger," etc. Of these airplanes, the "Avro-Baby" biplane has thus far given the best results. The Austrian W.K.F. monoplane, built shortly after the war, is worthy of mention, as also the Farman airplanes "Sport," "David" and "Meustique," with which engineless flights have been made. After removing the engines for this purpose, the seats were moved farther forward, the structure remaining otherwise unchanged.

Even in the construction of such sport airplanes, which can

no longer be regarded as gliders with auxiliary engines, the construction of gliders has manifestly had an influence. Examples of this are the Heinkel monoplane and especially the Caspar monoplane. In the latter the necessity for a special landing gear has been entirely avoided. The influence of the glider construction is also manifest in the wings. As a matter of fact, the favorite form of construction of gliders with a plywood nose (which, together with the front wing spar, forms a torsion-fast tube) can also be advantageously employed in engine-driven airplanes.

Of especial importance, naturally, is the ease with which a small airplane can be taken apart, thus saving the owner the great expense of building a regular hangar. For spans often exceeding 10 meters (32.8 ft) and a height of 2.5 m (8.2 ft) such a hangar would be very expensive. Gliders have long been made so they could be easily taken apart, for the sake of facilitating their transportation. This has ordinarily been restricted to disconnecting the wings from the fuselage. When directly adjoining the sides of the fuselage, the wings can be attached in such a way as to enable their being folded back against the fuselage. If external brace wires are eliminated, lateral struts are usually provided for two-part wings. If all external bracing is to be eliminated, the wing structure is usually built in three sections. The middle section can be located either above or below the fuselage, the end sections being removable. These sections can be attached by bolts in a very simple manner. On

low-powered airplanes, the very simplest methods of attaching should be employed, since only a few of the future possessors of such aircraft will have much technical knowledge. It is also important that but little time and assistance be required for taking them apart and putting them together. The user of a low-powered airplane should be able to get along without assistance. It is also important to avoid complexity in the construction of a low-powered engine. A low-powered airplane must be easy to operate for the average person, in order to be of practical importance.

Though less common, the fuselage can also be made separable. The rudders and stabilizing planes can be made removable, after the manner of the 1923 glider of the Dresden Airplane Construction Company. For use by non-technical people, the most practical methods of fastening are the ones in which the wing structure or fuselage can be swung about a fixed pivot. This method is employed, for instance, on the 1914 A.E.G. biplane, the 1918 Friedrichshafen airplane F.F.-64 for taking on board a ship, and the 1921 Dornier "Libelle." It is also important to make all parts so they cannot be easily damaged by the user or by a trespassing third party. It is therefore important for the seat to be inclosed and for the engine not to be easily accessible to meddling hands. In this respect, existing low-powered airplanes, as well as gliders, have not yet been perfected. The constructor is easily led, by the demand for light structures,

to build too light. Any airplane which, like the 1915 Fokker single-seater, requires numerous inscriptions of "Take hold here" and "Do not take hold here," does not seem very suitable for private use.

In this respect the employment of light metals as building material would seem desirable. It will surely be possible, however, with a suitable design, to build wooden airplanes answering these demands. Even the high weather-resisting properties of metal airplanes seem possible of attainment by wooden airplanes, by the use of suitable dopes and varnishes. One advantage of wooden airplanes doubtless consists in the greater ease of making repairs. It is surely of importance for the practical employment of low-powered airplanes, that they shall be capable of being easily and cheaply repaired.

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