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THE AÉRODYNAMICAL LABORATORY OF THE
VIENNA TECHNICAL HIGH SCHOOL.

By

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THE AERODYNAMICAL LABORATORY OF THE
VIENNA TECHNICAL HIGH SCHOOL.*

By

R. Katzmayer and L. Kirste.

This year the aerodynamical laboratory of the Vienna Technical High School celebrates its tenth anniversary. This laboratory was begun in 1911, with the construction of the small building in the second quadrangle of the school. The equipment of the laboratory is very interesting, though little known, in spite of the fact that a great deal of important work was done there during the war and that numberless problems will come up for solution in the coming time of peace, problems relating not only to the science of aviation and aerostatics, but also to many kindred subjects.

A detailed description of the laboratory and its equipment appeared in 1914.* Its equipment differs greatly from that of other laboratories and all the latest devices are used, both in the distribution of pressure in the various chambers and also in the measuring devices. Although the designer, Prof. Ing. Richard Knoller, was not able to make any preliminary experiments, he succeeded so well in his work that no modifications were needed, except a slight change in the electric installation.

* From "der Zeitschrift des Oesterr. Ingenieur und Architekten Vereines," No. 38/39, September, 1921.

**Zeitschrift für Flugtechnik und Motorluftschiffahrt, 1914, Nos. 7 and 8.

We will therefore give here only a very short explanation of the operation of the plant and deal principally with the question of what it has accomplished.

Its purpose is the determination of the action of an air stream on bodies of various kinds, more especially on airplane parts or their models or on bodies whose behavior in the air stream is being investigated from a purely theoretical standpoint. Tests have also been made on models of lattice girders, chimneys, etc.

The air stream, to which the models are exposed, flows vertically downward (Fig. 1). It flows from the upper chamber A, where the pressure is greater than that of the surrounding atmosphere, through the entrance cone B, and for a distance of about 1.5 m. through the test chamber (Fig. 2), in which the pressure is that of the surrounding atmosphere and which is therefore freely accessible. When the air stream has passed through the experiment chamber C, it is drawn into the diffuser D, which acts like the suction pipe of a turbine. In consequence of the widening of the cross-section, the velocity of flow is reduced and with it the kinetic energy of the stream, which is dissipated in the still air of the basement. The increase of energy in the diffuser increases the pressure in the basement to about half that in the upper chamber. From the basement E, the air is again sent into the upper chamber by four air propellers or fans F, placed in the corners of the

basement. By means of funnels G, of gradually increasing cross-section, the greater part of the kinetic energy is here converted into pressure. The fans are driven by four vertical shunt-wound motors. The voltage of the current can be varied by very fine degrees, almost without loss, between zero and 440, thus varying the revolution speed (r.p.m.) of the fans and enabling the regulation of the air stream between zero and almost $28 \text{ m/s} = 100 \text{ km/h}$, which corresponds to a maximum output of about 40 HP.

The way in which the model is held in the air stream and connected with the balances varies greatly according to its shape. The ordinary airplane wing model, the dimensions of which are $90 \times 15 \text{ cm}$, is held in position by two vertical wires (1 and 2) and two horizontal wires (3 and 4), as well as by a rod (5), of streamline section (Fig. 3).

The vertical wires run to a float balance S, containing mercury. Allowance is made for the weight of the model by means of a pressure-screw P, which forces into the hollow float or draws out of it by suction a measurable quantity of mercury. The reading is made directly in grams on the shank of the pressure-screw, whereby the weight of the model itself is eliminated by a single adjustment of the scale. The maximum allowable load is 5 kg., the sensitiveness of the balance about 0.5 gram.

The horizontal wires run to a balance with a loading W. The arrangement of the balance beam, which reminds us of the Roberval balance, allows the angle of attack of the model to be altered without affecting the reading of the balance. Too great oscillations are prevented by means of an oil damping device D. For wing sections, the horizontal forces, which really correspond to the lift, are a multiple of the vertical forces which represent the drag. If, therefore, we give a certain inclination to the horizontal wires, as shown in Fig. 3; they assume the resultant of the horizontal and vertical air forces, the vertical wires support only the weight of the model and the mercury gage stands at zero. The tangent to the angle of attack gives the ratio of drag to lift, which is the very important "gliding factor" in the science of aviation, and can be read directly on the hand-wheel H, which serves as an adjusting device. We will not here go into further details of the extremely ingenious measuring devices.

As already stated, the laboratory, as first designed, proved so satisfactory that only very slight alterations were necessary. Of these, the most important was the installation of a small auxiliary fan for supplying additional air to replace that which escapes through the porous walls, since, otherwise, any unusual extension of the experiment period would cause a noticeable diminution in pressure in the experiment chamber.

Originally the model wing was attached by six wires (diameter 0.5 mm.), but later it was found preferable to replace two of these wires by the previously mentioned rod.

Other small changes were gradually made in the weighing equipment as, for instance; the substitution of two needle valves for the cock controlling the flow of mercury, increasing the damping of the balances when testing very unstable models, etc.

As regards the experimental activity of the laboratory, it compares favorably with that of large laboratories in other countries. Experiments were first carried out on skin friction for various conditions of the surface. These were followed by tests on the lift and drag coefficients of typical wing sections. These tests demonstrated the great practical advantages of the direct determination of the gliding angle, and of the other special characteristics of the weighing devices.

Immediately after the beginning of the war, experiments were undertaken with extraordinary activity. First, a series of wind tunnel tests of cylinder sections were taken up, involving the study of the laws of air resistance. The practical data gained from these experiments gave the best cross-sections for aircraft struts, and the so-called "air flow sheath" which considerably reduces the resistance of a body of given form. Later, similar and very valuable tests were made on models of airplane fuselages and landing gears.

By far the most important work, however, was the testing of wing models. Polar diagrams were made of not less than 197 different wing sections, besides 70 so-called "thick" sections, such as occur in propeller blades. All these measurements were

made on wing models of standard size, 90 x 15 cm., while other wing models of widely differing shapes were used for determining the influence of round and sharp edges, camber, dihedral angles, incisions and notches.

One group consisted of experiments with biplanes and triplanes with different positions of the planes in relation to one another. Some very interesting data were obtained from experiments on the most favorable location for the various parts of an airplane with respect to one another, as, for instance, the installation of the radiator on the upper wing. The most important tests, however, were probably those on complete airplane models, in which the mutual influence of the fuselage, wings, landing gear and control surfaces was studied.

In all, twelve complete models were sent to the laboratory to be tested. These included both airplanes and seaplanes and were sent by the Navy and by private firms. By these tests it was proved that the slight turbulence present in the air stream had exactly the same effect as on a full-sized airplane, so that the data obtained from tests on a 1/15 model could be applied without correction to a full-sized airplane.

Alongside the tests on the mutual influence of the fuselage and a revolving propeller, tests were also made on the effect of the propeller stream on the control surfaces, especially those of unsymmetrical form.

The tunnel was also used for the systematic verification of

the speed of military airplanes.

There is also a model of a propeller-testing plant not directly connected with the laboratory. It has only a 1/10 HP motor. Its peculiar characteristic is that the propeller itself creates the desired air stream velocity, the so-called "flying speed." This is the model of a large propeller-testing laboratory, also designed by Prof. Knoller, at Fischamend, which had a 360 HP engine and which was recently torn down by the Interallied Control Commission, as having been used exclusively for military purposes.

A smaller laboratory for testing propellers up to a diameter of 800 mm., as well as a device for measuring the dynamic stability of airplane models can no longer be used, on account of the ending of the war.

With the advent of peace, the extraordinary experimental activity ceased. Experiments have, however, been resumed, in spite of the material difficulties in which most such establishments now find themselves. Inventors are again bringing new models of wings and propellers to be tested for their practical applicability. Very interesting were the tests of the model tandem triplane flying boat, intended for service on the Danube between Budapest and Vienna, as also the tests of the Handley Page slotted wings, regarding which there is a difference of opinion.

Special emphasis is, however, laid on the fact that the aerodynamical laboratory serves not only the purposes of aviation and theoretical aero-mechanics, but is equipped for many quite different lines of work, such as general hydrodynamics and thermodynamics, and especially for investigating wind stresses on buildings of all kinds.

This is surely a sufficiently extensive program for some time to come, and it is to be hoped that the difficulties hitherto encountered will no longer stand in the way of its execution.

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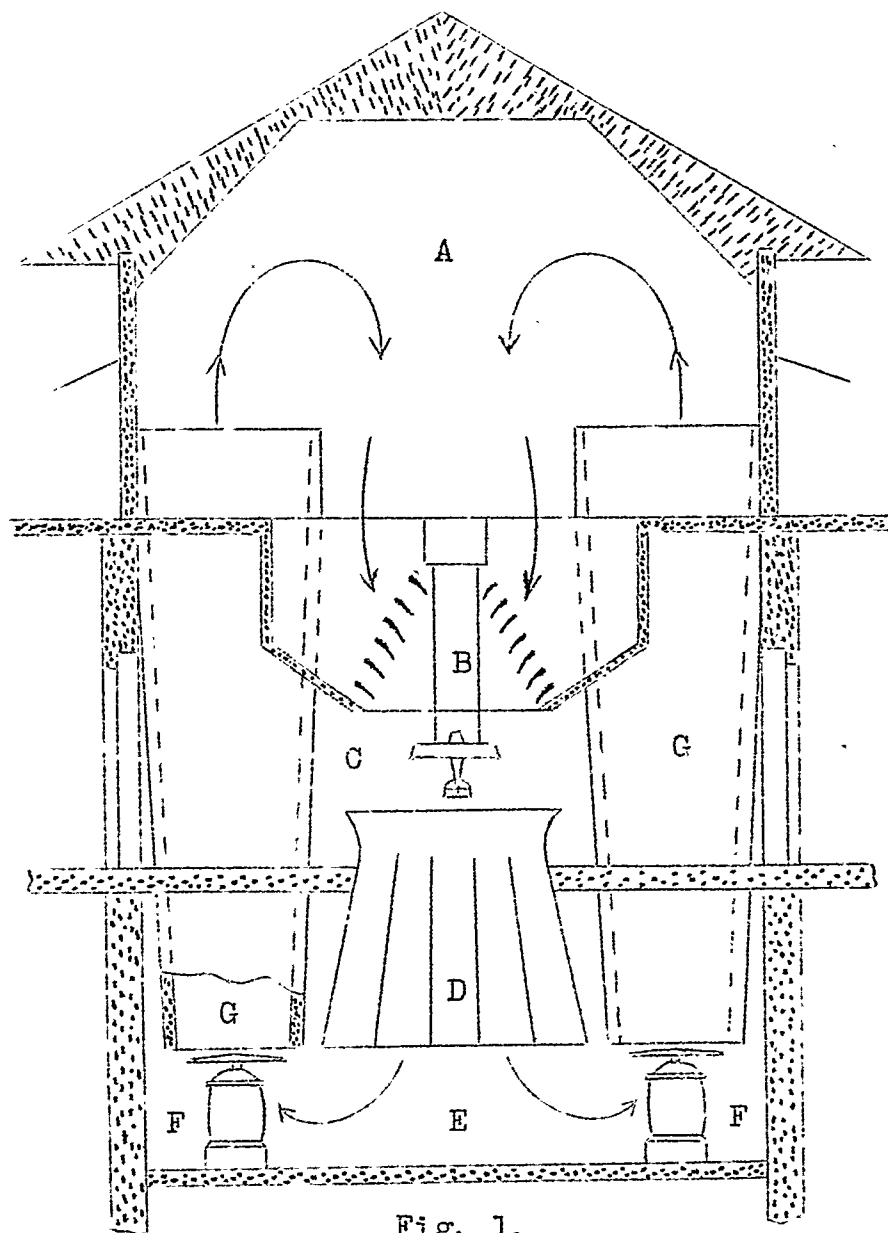


Fig. 1.

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