SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

AERONAUTICS

Some Full-Scale Experiments With Servo Rudders

SERVO RUDDERS have been fitted satisfactorily to many aircraft. To provide data for the design of servo rudders for larger aircraft and to cover the flap-type servo design, a program of tests was drawn up following a report on the general aerodynamics of servo rudders. Both types of servo were tested in the wind tunnel, the tests covering two different sizes of servo chord and various hinge positions. A report on the theory of "follow-up" in servo systems was next made.

It was then decided that flight tests on a flap-type servo rudder fitted to a large airplane were desirable in order to check the wind-tunnel tests, and these form the subject of the present report.

The cross-wind force coefficients and main rudder moments have been measured on an all-moving rudder fitted with hinged flap-type servo for a range of servo positions.

The maximum cross-wind force coefficient k_L obtainable with the rudder which was used in these experiments, and of which the aspect ratio was 2.4, is approximately 0.24 at an incidence of 14 deg. Shielding of the rudder by the tail causes a loss of rudder efficiency of 40 per cent on the calculated values. The center of pressure movement is large enough to be very important in large rudders with hinge positions set well back. The servo moments were extremely small. (J. E. Serby, from a press release of British Air Ministry, *Reports and Memoranda*, no. 1514, July 8, 1932, *d*)

Besler System of Steam Power for Aircraft

ON APRIL 12 a flight in a steam-driven machine was accomplished by Wm. Besler. The machine was a biplane originally built for a Curtiss engine, the Besler plant having been substituted for the latter. The installation included many parts taken from a Doble steam car which were unnecessarily heavy and in some cases too large for the purpose. No attempt was made to develop either extraordinary power or to make it extremely light.

The unit consists of a two-cylinder engine, which delivers approximately 150 hp at 1625 rpm. The weight is about 180 lb and no serious attempt was made to make the engine lighter. The boiler consists of a single tube approximately 500 ft long, and is built according to a patented design, the chief improvement over previous boilers being that the temperature remains constant regardless of the pressure, and the control is entirely automatic. The efficiency is very high.

The engine is fitted with a steam feedwater pump, the exhaust steam from this pump being used to preheat the feedwater entering the boiler. The power plant condenses about 99 per cent of the water used, and ten gallons are sufficient for an ordinary flight under reasonably cool weather conditions. To start the boiler, it is merely necessary to press a switch which starts an electric blower motor, causing air and fuel to be forced through the burner and into the boiler, where ignition is effected by a spark. From then on the automatic controls operate all the necessary functions, and the pilot has only to move the throttle and reverse lever, there being one position for forward and one for reverse. Apparently only a short flight was made. (*Discovery*, vol. 14, no. 163, July, 1933, pp. 220–221, 3 figs., *d*)

Peabody Mus. Mag

A Simplified Presentation of the Subject of the Spinning of Airplanes

IN THIS report, a broad view of the subject is taken, the argument being kept as short as possible, and some sacrifice in rigidity being made in the interest of clarity.

The report is not concerned with either the prevention of the involuntary spin, to which so much attention has been and is still being, directed, or the problem of recovering from such an undeveloped spin; but exclusively to the problem of preventing such a spin from developing into a flat spin.

The aerodynamic characteristic which makes it possible for an airplane to spin is essentially the same as that which gives rise to the well-known phenomenon of "autorotation," namely, the automatic rolling motion which may occur owing to the fall of the lift beyond the stall. Autorotation, however, as commonly understood, refers to the behavior of a model mounted symmetrically so that it is free to rotate about the axis parallel to the wind direction through its center of gravity. The term may conveniently be extended to include the rotary motion which may be possible when the model is free to rotate at a radius and also in unsymmetrical attitudes; that is, rotary motion combined with sideslip.

Using autorotation in this wider sense, the author does not know of any arrangement of fixed wings which will not, with an appropriate amount of sideslip, autorotate rapidly at any incidence between, say, 30 and 80 deg.

Existing experimental information therefore indicates that the prevention of the rapid flat spin is to be sought not in the use of wings which cannot autorotate at high rates, but in measures which will insure that the wings cannot remain in those attitudes in which rapid autorotation is possible. Such measures are the provision of sufficient effective fin and rudder area, or its equivalent in depth of body near the tail; and it is the main conclusion of the report that the flat spin can generally be eliminated in this way without going to an impracticably large fin and rudder. There are, however, a variety of other characteristics which may be either favorable or unfavorable to the flat spin, and when, for any reason, it is not convenient to provide sufficient fin effect to override these influences, they may turn the scale from safety to danger.

The most important of these secondary factors is the relative distribution of weight along wings and body, which may give rise to a yawing inertia couple of some magnitude. The way in which this couple is caused by the centrifugal forces acting on the various parts of the airplane is simply explained. The sense in which the couple acts in a spin, however, depends not only on the weight distribution but also on the autorotational properties of the wings; the explanation in detail of its interaction with these properties is somewhat complex and is given in an appendix. The important point to observe

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