Raoul Hafner's Blériot Lecture: A Comprehensive Survey

In Paris on Wednesday last, March 10th, the Royal Aeronautical Society's seventh Louis Blériot memorial lecture was due to be given by Mr. Raoul Hafner, A.F.R.Ae.S., Entitled 'The Domain of the Helicopter', the paper reviews the historical development and fundamental design-principles of rotating-wing aircraft, and analyses their configurations, performance and economy.

It appears certain that Mr. Hafner's lecture will be regarded as a most significant contribution to helicopter knowledge, and the reporting of it in this special issue of Flight is therefore most appropriate. Particular attention has been paid, in the abridged version which follows, to Mr. Hafner's considerations of rotor systems, of the three basic types of helicopter (in which a novel convertible helicopter is described) and of the helicopter in civil air transport.

After being introduced by Mr. Hafner, the lecture was to be read, in translated digest form, by M. Morian, chief engineer of the S.N.C.A.S.O. helicopter division.

It is noticeable that the author of the paper has been characteristically reticent about his own achievements in the field of helicopter design, which he first entered as long ago as 1927. In collaboration with J. B. Coats, he produced the R-1, which flew in Austria in 1930, and the R-2, which he brought to this country in 1953. Two years later the Hafner ARIII gyroplane appeared; though not a true helicopter, it introduced the now-established system of control by cyclic and collective pitch. His recent work with the Bristol Company—he joined them in 1944—is well known.

Historical Introduction.—The paper began by giving a short summary of the historical development of the helicopter. It first traced the development of human flight through the ages, and the successive emphasis laid on the three types of wing, flapping, fixed and rotating, with which it was thought this could be achieved. While Nature achieved success solely with the flapping wing, man successfully tried all three. Successful controlled flight, however, came with the application of the fixed wing. But flight, however, came with the application of the fixed wing. But this led progressively to the large, modern aircraft with its parallel with fixed-wing progress, and apparently initially with the rotating wing development had continued slowly in parallel with fixed-wing progress, and apparently initially with the rotating wing.

At its hub, the rigid rotor could possesses a limited number of applications of extreme load and frequent applications of medium load. It was thus necessary to observe two type of loading: a limited number of applications of extreme load and frequent applications of medium load. It was thus necessary to establish an envelope of ultimate load conditions where the material might be stressed close to the proof stress figure, and on the other hand to establish the so-called fatigue envelope, for which there was a much reduced safe stress level. The ultimate stresses arose generally from manoeuvre and gust loads, but as these were always coupled with inertia effects such as blade oscillations or torsional oscillations in the transmission, their evaluation was made somewhat difficult. Even more complex were the loading systems that produced the fatigue stresses, for these were due mainly to fluctuating air loads on the blades or torque fluctuations in the engine.

Besides the problem of stress in the rotor system, there were other problems of fatigue. These considerations in turn had pointed to the inadequacy of purely theoretical work alone and had, in consequence, led to a procedure of ground testing in which the flight conditions were simulated with as much accuracy as was possible.

Rotor Control.—The paper provided not only lift but also control of the helicopter. This must necessarily be so because the rotor blade is the only aerodynamic surface which maintained high speed in all flight conditions, including hovering, and was therefore capable of transferring aerodynamic force adequate for the purpose of control. We must, however, distinguish between the rigid and the articulated rotor. At its hub, the rigid rotor could render a force—the rotor thrust—as well as three independent moments. The rotor torque and two transverse moments. On the other hand, the articulated rotor could, apart from the rotor torque, produce three forces—the thrust and two transverse components. Rotation of the rotor axis produced in the rigid rotor a gyroscopic moment of sizable magnitude which was transmitted to the aircraft body. In the articulated rotor this gyroscopic moment was balanced by an aerodynamic moment, and no transverse moment was transmitted through the rotor hub. The total calculation of the forces on the rotor blades had been carried out to overcome many of the difficulties which beset the early helicopters and, since the successful performance of the autogyro demonstrated the value of articulation, it had been adopted almost universally in helicopter engineering. The following considerations of various forms of control applied therefore only to the articulated rotor.

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