CONVERTIBLE AIRCRAFT

was carrying 2,500 lb. weight, so that the rotors had only to develop 5,100 lb lift.

Capt. Liptrot now came to the second main category of convertible—that in which the aircraft was postulated as taking off with the fuselage vertical, the whole aircraft being rotated through 90 deg for high-speed flight. There were two classes in this category. The first considered by the lecturer had a permanent fixed wing to give necessary lift in horizontal flight, and the thrust of the rotor was used for vertical take-off. The second class where the rotor became the airscrew after conversion was that of designing a rotor which would be efficient both for vertical lift and for propulsion in high-speed flight. The lecturer pointed out that high efficiency in vertical flight was associated with high solidity, light power-loading and light disc-loading. The rotor must be jet-propelled, in which case the jets could be the propulsive efficiency demanded low solidity and small diameter. In other words, the rotor size for good helicopter performance was too large for high-speed efficiency, and much research appeared to be necessary in any event because of the pitch-moment introduced by the rotor. Zimmerman's low-aspect-ratio type. Here the aircraft was definitely unstable with rigid rotors. Articulated rotors gave a stable slope but the tail controls were not powerful enough in the high-speed condition. There were two classes in this category. The first considered by the lecturer had a separate power source would have to be provided for propulsion in high-speed flight. The lecturer pointed out that, whether or not the rotors were used for lift in horizontal flight, the lift and side forces would be present in greater or less degree whenever there was any pitch or yaw, and if the rotors and tail surfaces were not properly proportioned and located the aircraft might become unstable in the high-speed condition. On the other hand the tail surfaces would reduce the lift and side forces; that is to say, the lift and side moments, and for propulsion in high-speed flight. The lecturer pointed out that the lift and side moments would be present in greater or less degree whenever there was any pitch or yaw, and if the rotors and tail surfaces were not properly proportioned and located the aircraft might become unstable in the high-speed condition. One point which would have to be carefully considered was that, whether or not the rotors were used for lift in horizontal flight, the lift and side forces would be present in greater or less degree whenever there was any pitch or yaw, and if the rotors and tail surfaces were not properly proportioned and located the aircraft might become unstable in the high-speed condition. An interesting point was disclosed by N.A.C.A. tests on the Zimmerman low-aspect-ratio type. Here the aircraft was definitely unstable with rigid rotors. Articulated rotors gave a stable slope but the tail controls were not powerful enough in the high-speed condition.

Towed-airscREW Power

The lecturer then came to his third main category. He remarked that his survey of the usual configurations for convertible aircraft had shown that except, perhaps, Zimmerman's low-aspect-ratio type, the high-speed efficiency demanded large diameter, while in horizontal flight high propulsive efficiency demanded low solidity and small diameter. In other words, the rotor size for good helicopter performance was too large for high-speed efficiency, and much research appeared to be necessary in any event because of the pitch-moment introduced by the rotor. Zimmerman was to use an all-wing aircraft of aspect ratio close to unity, with two rotors bathing the whole wing in slipstream, so exploiting the high lift developed at high incidence by low-aspect-ratio aerfoils as well as the lift due to the slipstream at low forward speeds.

Capt. Liptrot next referred to a type of machine in which the rotor was stopped to become a fixed wing on conversion. In this case either a separate propulsive mean must be provided, or the rotor must be jet-propelled, in which case the jet could be the propulsive means.

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One point which would have to be carefully considered was that, whether or not the rotors were used for lift in horizontal flight, the lift and side forces would be present in greater or less degree whenever there was any pitch or yaw, and if the rotors and tail surfaces were not properly proportioned and located the aircraft might become unstable in the high-speed condition. An interesting point was disclosed by N.A.C.A. tests on the Zimmermann low-aspect-ratio type. Here the aircraft was definitely unstable with rigid rotors. Articulated rotors gave a stable slope but the tail controls were not powerful enough to trim at the very high angles of attack associated with high values of lift coefficient. The remedy was a large trailing-edge flap, as an alternative to the low-aspect-ratio wings. A flap was necessary in any event because of the pitch-moment induced by ground interference during landing and take-off.

More Research Necessary

Except for the N.A.C.A. research on the Zimmermann type, little had been done systematically to explore the many problems of the transition stage, and most inventors seem to have been preoccupied with their aircraft in the two operative configurations, assuming that the conversion could be effected instantaneously, as though one could, in fact, take off vertically. Of course they would have some pretty problems as regards stability in vertical flight, and they could never land vertically in the event of power-unit failure. In aviation, however, the impossible almost always becomes possible, or later, and perhaps the really high-performance convertible might come about in this way.

At this point the lecturer remarked that many aspects which he had had to leave out of his paper were, in fact, the very ones on which the eventual practical convertible must rest. He indicated two of them. The first concerned safe landing in the event of power-unit failure, which is imperative. This accentuated the problem of convertibility directly as the stage length. Mr. Shapiro had said recently that the fixed-wing counterpart of the helicopter was the auto-rotational glide with a low enough rate of descent.

In those cases where the rotors became the airscrew, there was a parallel problem to that of power failure in the helicopter proper. If power failed in horizontal flight the whole aircraft would be converted to the pitch-moment curves, but the tail controls were not powerful enough to trim at the very high angles of attack associated with high values of lift coefficient. The remedy was a large trailing-edge flap, as an alternative to the low-aspect-ratio wings. A flap was necessary in any event because of the pitch-moment induced by ground interference during landing and take-off.