A Production Air-cushion Transport Vehicle

BY THE TECHNICAL EDITOR

A LTHOUGH a count of heads suggests that Britten-Norman Ltd., of Bembridge Airport, Isle of Wight, are small fry in comparison with the other companies licensed by Hovercraft Development Ltd., they have already built two distinct types of air-cushion vehicles, and have with their second design achieved the first "over the counter" sale of such a machine. Moreover, potential customers for the CC-2 have for some time been given realistic delivery dates and prices, and production is in hand.

A note about Britten-Norman Ltd., and their associated company Crop Culture (Aerial) and its subsidiaries, was contained in *Flight* for June 24, 1960, as a suffix to a description of the original Cushioncraft CC-1. The name "Cushioncraft" will be used for all the company's air-cushion vehicles, and in the author's opinion is a more appropriate name than the commonly used "Hovercraft."

Britten-Norman and Crop Culture began to study air-cushion vehicles in 1959. From the outset they concentrated upon truly amphibious vehicles, in contrast to the other HDL firms, whose attentions have been focused upon purely marine craft. Prior to this, Crop Culture had operated aircraft for Elders and Fyffes Ltd, the famous banana shippers. Present arrangements for transporting bananas from the plantations to the hold of a ship are far from being the optimum, and Elders and Fyffes enquired whether it would be feasible to employ an air-cushion vehicle to undertake the entire operation without trans-shipment.

Britten-Norman, who at that time were not a licensee of Hovercraft Development Ltd, referred their client to the latter company, who suggested that an operational banana-carrier would require some five years' development and be a costly undertaking. Accordingly, Elders and Fyffes asked whether Britten-Norman could themselves produce such a vehicle. The Cushioncraft CC-1, described in the aforementioned issue, was the result. Although Elders and Fyffes made a contribution, most of the development was financed by Britten-Norman. Following upon their original philosophy of designing for operation over water, mud, sand and other surfaces, it was natural to choose the relatively low cushion pressure of about 12lb/sq ft and the considerable hover height of 12-15in. From the outset it was appreciated that structure weight should be held to a minimum, and the CC-1 was likewise made as simple and cheap as possible.

After fundamental research into stability and control at low cushion pressures, and investigations into several aerodynamic configurations, construction of the full-scale vehicle began late in 1959. It was circular in plan-form, and was lifted by a cushion generated by a peripheral rotor driven by a 170 h.p. Coventry Climax engine by means of a conventional car wheel and tyre pressing against a nylon-covered track inboard of the rotor blades. Propulsion and steering were effected by a pair of Hiller helicopter tail rotors driven by the same engine, and the flat upper surface of the craft around the engine compartment and cockpit was arranged as decking for the payload.

Registered as G-APYH, the Cushioncraft CC-1 was not used in the Cameroons as had been intended; but it worked successfully, and was of inestimable value as a research vehicle. Its best features were that the fan efficiency exceeded 90 per cent, and that aerodynamic losses were exceedingly low—in fact it would be hard to conceive an air-cushion configuration with lower duct losses. But the peripheral rotor was vulnerable to damage, and could have been wrecked had the craft suffered any severe collision. The twin rotors could not readily be modified to work in the optimum pitch range, and the top speed was therefore restricted to 25 m.p.h. For the same reason, accentuated by the gyroscopic moment of the rotor, the stability and control was never completely perfected, and a large swept fin was added early in the trials programme. Further drawbacks to the original design included the following: the drive to the fan and two propellers necessitated relatively heavy and complex gearboxes; on so small a craft the propellers constituted a hazard; it was difficult to design the craft so that it could be dismantled for handling and transport purposes; and the design had very limited development potential, owing to the fact that it would have been exceedingly difficult to produce a substantially larger peripheral rotor.

In June 1960, Britten-Norman started serious consideration of the Cushioncraft CC-2. There is little doubt that, without the experience gained with the CC-1, the design of the new Cushioncraft would have been much more difficult and less successful. Wherever possible, use was made of CC-1 knowledge; this was particularly important in view of the fact that at that time Britten-Norman were working entirely on their own, without access to information from Hovercraft Development Ltd. Nevertheless, the CC-2 has an entirely different configuration from the CC-1, employs a new species of lifting fan and has a structure which is almost unique.

Before any detailed design could begin it was essential to select an engine. In the CC-1 the designers chose a highly rated piston engine. The CC-2 could have had a diesel or spark-ignition automotive engine, an aircraft piston engine, or an aircraft or industrial gas turbine. In view of the number of possible choices, and the number of variables on which the choice was based, it is not practicable here to assess each type of powerplant separately, but the major variables can be listed. The CC-2 was intended not as a pure research vehicle, but as a craft which could become a commercial proposition. It was therefore essential to choose an engine which would give good service in all parts of the world. Overhaul and maintenance had to be simple and cheap, and make modest demands on labour and facilities. The installed weight of