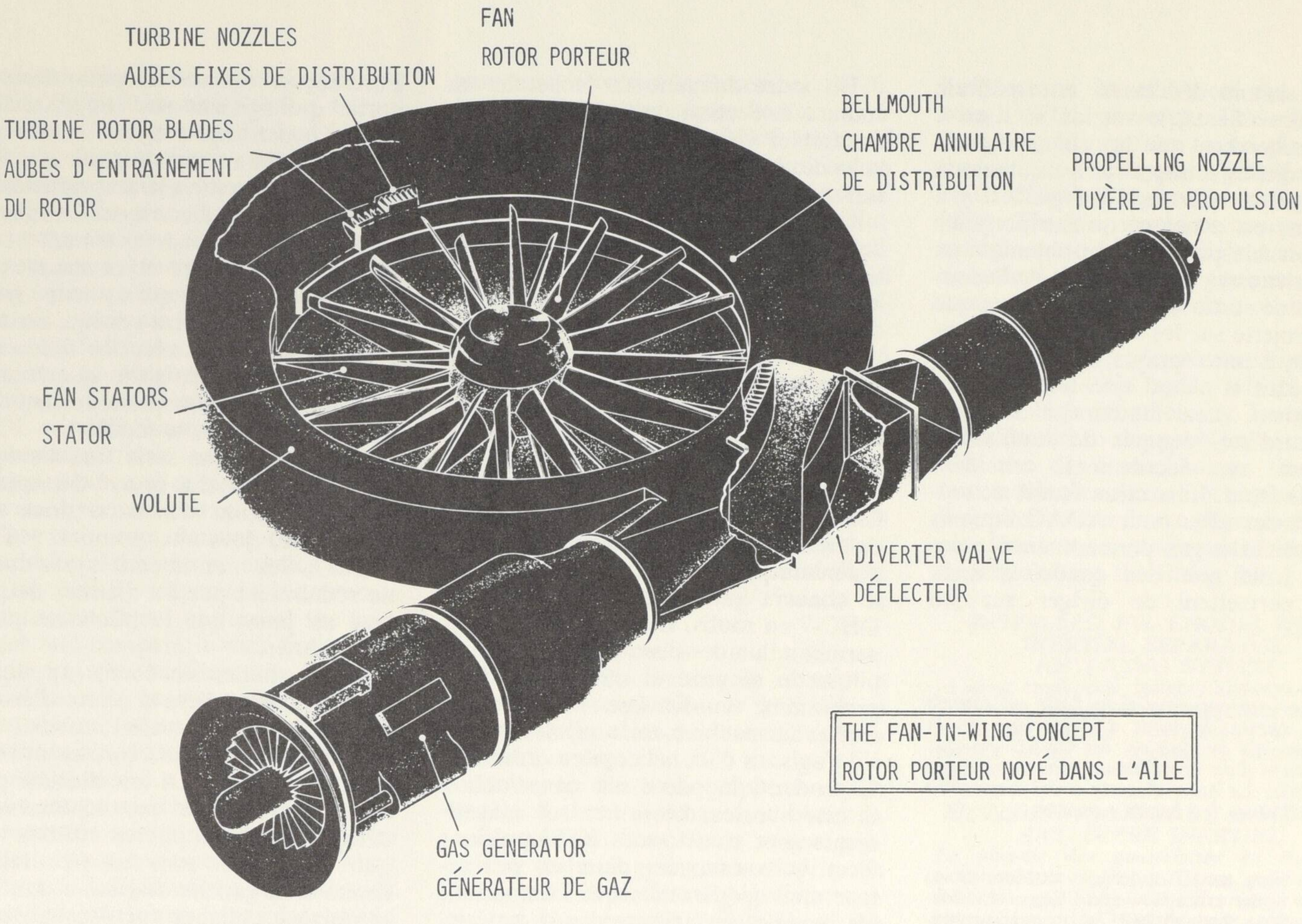

THE FAN-IN-WING CONCEPT
ROTOR PORTEUR NOYÉ DANS L'AILE

Current efforts are focused on the much more challenging problem of how the lifting fan behaves as the aircraft starts to move forward. There is a flow over the wings as well as through the wing due to the action of the fan. The fan is subjected to an extremely distorted air inflow which tends to deteriorate its aerodynamic performance. Additionally, the airflow loads the fan mechanically in a manner that produces high vibratory forces, which must be coped with in the fan design. In co-operation with NRC's Gas Dynamics Laboratory crossflow studies on a one-foot diameter fan-in-wing model have been undertaken in the propulsion tunnel.

Designed and operated for V/STOL propulsion research by the Gas Dynamics Laboratory, the tunnel has a 10-foot wide by 20-foot high by 40-foot long working section. This facility was constructed in 1962 specifically for the investigation of problems of safety, economy, noise and performance associated with V/STOL propulsion systems. Models representing possible full-scale engine arrangements are powered by an external source of compressed air (up to 50 pounds per second) and develop up to 1,000 pounds thrust. A 26-foot diameter fan subjects the model to a mainstream flow of about 200 miles per hour.

Several VTOL propulsion systems are currently under active study by the Gas Dynamics Laboratory. These include experimental studies conducted on a single engine system used to power both lift and forward propulsion (similar to the Pegasus engine used in the British VTOL fighter, the Harrier) and on separate lift engine systems designed specifically for low operating noise levels, e.g. Rolls Royce's RB 202 lift fan.

With the Harrier type engine, the engine intakes are always facing forward and thrust direction, either vertical or horizontal, is changed by exhausting the jets through rotatable nozzles. In the separate lift engine concept, the lift engines (fans) are installed in a near vertical attitude. On completion of the lifting function these engines are shut down and separate propulsion engines are used for forward drive. As with the fan-in-wing arrangement this lift engine receives a disturbed non-uniform air flow in the transition from hovering to wingborne flight.

A great deal of the work in this area of lifting performance has been done in the propulsion tunnel, initially with simple wooden models and later with powered models limited to single isolated thrusting fans. Tunnel personnel are now into the next stage — the study of crossflow effects on a tandem installation of three one-quarter-scale models of the RB 202 lift-fan. This study is expected to contribute materially to the first actual aircraft projects employing this engine.