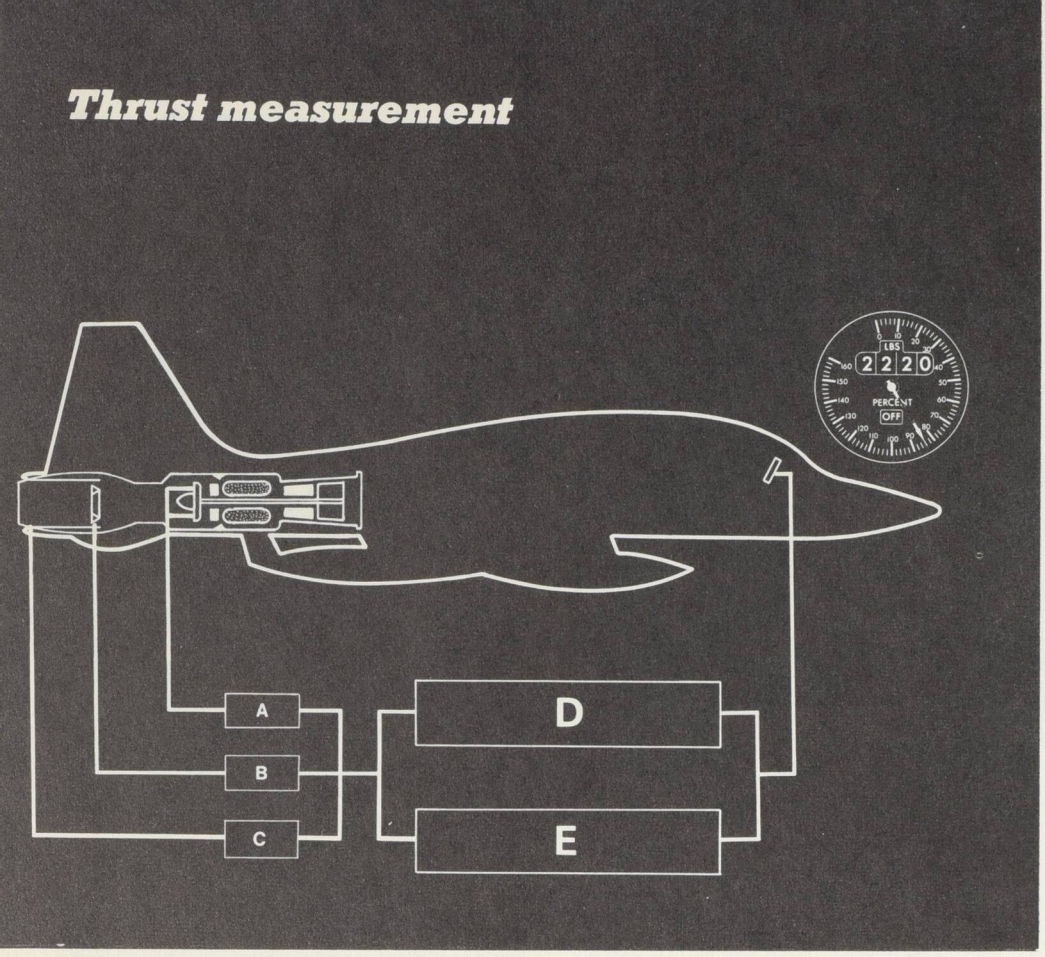
Thrust measurement



Pressure lines from the J85 jet engine run to three transducers (A, B and C). Electrical signals from the transducers are transmitted to the gross thrust and reference thrust computers (D and E). The computed thrust quantities are then displayed to the pilot on a dial in the cockpit of the aircraft. J85 engine powers the CF5 (right).

Les capteurs de pression montés sur le J85 sont reliés par des conduites aux trois transducteurs A, B et C, donnant des signaux électriques servant au calcul, en D et E, de de la poussée obtenue et de la poussée de référence dont les valeurs apparaissent sur un cadran du tableau de bord. Le CF5 (à droite) est équipé de deux réacteurs J85.

The system, which will be flight tested in the near future, will consist of gasflow sensors mounted on the aircraft engine and an airborne special purpose computer for calculating actual thrust of an engine. The calculation will appear on a cockpit indicator in front of the pilot. The computer also has to calculate the thrust which the engine should be capable of developing if properly operating.

Bryan Murphy, Project Engineer with Computing Devices of Canada Limited, says a completely successful thrust measuring system has never been developed. He says there has been a long standing need for such an instrument.

"The potential market could be extensive as every jet engine in service could be equipped," he says. "Initially, the application will be to straight afterburning or non-afterburning engines, but applications will be sought later for other engines such as fanjet or bypass engines."

One of the unique features of the thrust measuring system will be its ability to indicate engine "health." If a pilot of an aircraft demands maximum thrust of his engine, the thrust system will indicate to him not only the amount of thrust in pounds but also the relative thrust — the percentage of the thrust that the engine should be producing under the existing flight conditions. If the meter indicates that the engine is producing approximately 100 per cent relative thrust, the pilot has a healthy engine. However, if the meter indicates that the engine is achieving only 90 to 95 percent thrust when demanding full power, then the pilot has a damaged or deteriorating engine. The capability of the thrust computer to make this assessment, regardless of the flight mode or ambient conditions, constitutes a major improvement over any existing engine performance equipment.

The Engine Laboratory of the National Research Council of Canada is conducting engine tests on a Canadian-built (Orenda Limited) J85 turbojet engine loaned by the Department of National Defence. These tests have served to develop and check a method of calculating thrust.

Dr. E. P. Cockshutt, Head of the Engine Laboratory, says the initial instrumentation is for a turbojet engine equipped with an afterburner, an auxiliary burner attached to the tail pipe of a turbojet engine for injecting fuel into the hot exhaust gases from the engine and burning it to provide extra thrust.

"This is the most difficult application of a system for measuring thrust," he says. "We feel that if a system can be designed for an engine with an afterburner, systems for other engines will be less difficult to design."

The test engine is located in one of the Laboratory's test cells, which is constructed with 18-inch thick concrete walls for containment in the event of an engine failure. The cell is also equipped with extensive sound-proofing. The engine is operated remotely from a control room where laboratory-type instrumentation is located to examine the details of engine performance. The operation of the engine is monitored through the use of closed-circuit television equipment, which can be remotely focused and adjusted. While noise levels in the test cell are in a region which could cause immediate hearing damage and extreme pain to an unprotected observer, the four or five technicians and engineers conducting the research can carry on normal conversation in the control room. Most of the engine test work was done by G. G. Levy, an engineer with the Laboratory who died in 1970.

The thrust measuring concept will be built around the measurement of pressures at several points in the tailpipe of the J85 engine — a problem of some difficulty because the temperature of the gas stream can exceed 3,000 degrees Fahrenheit and the velocity of the stream can be more than 1,000 feet