Augmented Flow

An Interesting Method of Fluid-Flow Augmentation with Attractive Possibilities

A ROUMANIAN inventor, M. Henri Coanda, who has worked in Paris for many years (although he was with the Bristol Aeroplane Company before the 1914-18 war) has devised a new method of augmenting fluid flow which may have useful application in many fields. The theory is the subject of a recent report issued by the Combined Intelligence Objectives Sub-Committee.

Without going into the physics of fluid flow, the "Coanda Effect" can best be described as the phenomenon which occurs when a fluid stream is ejected at high speed from a slot, one wall of which is developed into one-half of a divergent passage. M. Coanda states that the stream is deflected from the axis of flow and follows the slope of the divergent wall whilst increasing in velocity and in mass by entraining additional air. This can be followed in the diagram Fig. 1. If a second portion of a divergent passage follows on the first, the airflow will again be turned through the angle of the deflection, and still further air will be induced to flow with the main stream. It is claimed that, with proper design of the divergent steps, it is possible to change the direction of a fluid stream through 180 deg with the outer side of the passage open. Optimum angles of the passages quoted by the inventor are approximately 31 deg for the first, 28 deg for the second, 25 deg for the third, etc., decreasing by about three degrees per stage.

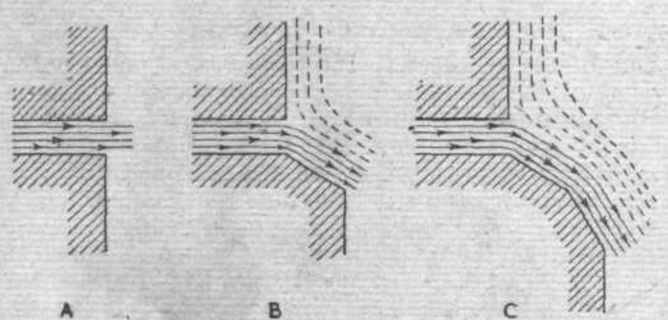

Fig. 1. Diagrammatic illustration of "Coanda Effect." A, high-speed fluid flow from slot. B, slot extended with one wall of divergent passage, and stream filaments following new slope whilst entraining additional flow. C, Second stage divergence with according change in flow path and greater induced flow.

Some attempts were made in the early experiments to apply this principle to the design of exhaust systems for piston engines as a means of improving the scavenging characteristics. This work was reported in a monograph entitled *l'Effet Coanda,* by A. R. Metral, of the Conservatoire Nationale des Arts et Metiers, published in 1939. More recent studies have been directed towards augmenting flow through nozzles in order to provide useful thrust; in addition some work has also been done on the design of a rotary pump for gases and liquids.

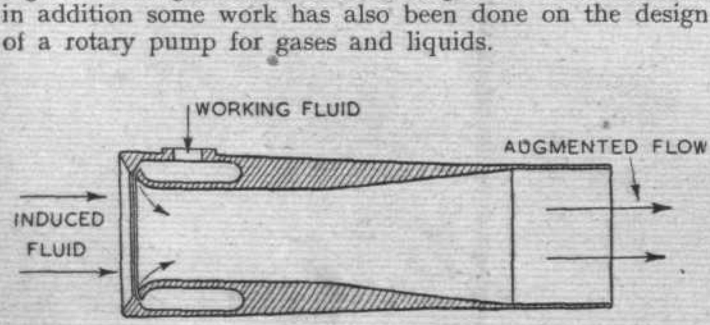

Fig. 2. Venturi nozzle with Coanda slot from annular "working fluid" chamber into entry mouth. Flow through slot induces axial flow and produces augmentation.

Two years after the fall of France—towards the end of 1942—M. Coanda received a contract from the Germans for the development of a propulsion system for ambulance snow sleds, ostensibly for use in Russia. This apparently prompted the research on thrust augmentors, although for some time the inventor had considered this to be an application of the principle. Experiments were made with venturi-type nozzles, as shown in Fig. 2, several nozzles with throat diameters varying between 20 mm and 100 mm being built and tested. After about a year the Germans stopped the work, but M. Coanda claims to have completed sufficient tests to prove the worth of his scheme. The full range of pressures and slot sizes has not been explored, but a few specific performance points have been obtained and some idea of size limitations established.

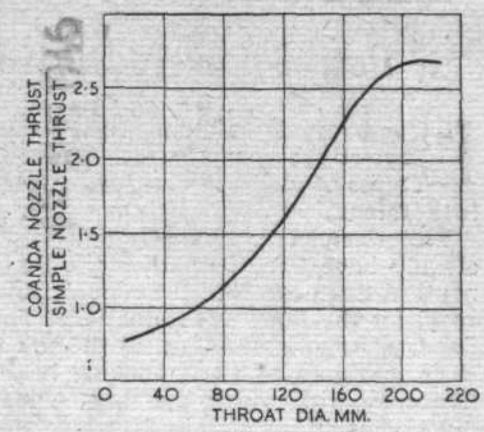

Fig. 3. Comparative thrust curve against nozzle size for Coanda and simple nozzles, illustrating that for thrust purposes Coanda nozzles are beneficial only between 80 mm. and 200 mm. throat diameters.

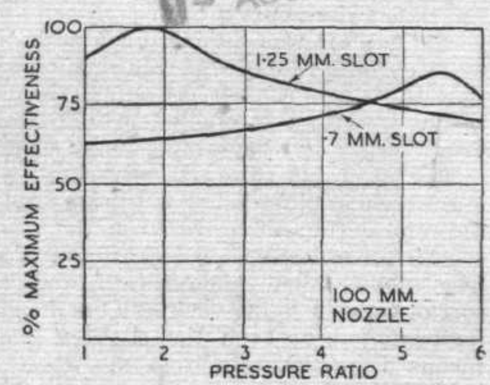

Fig. 4. Typical curves plotting effectiveness against pressure ratio for 100 mm. nozzle, using slot size as the parameter.

If a comparison is made between the thrust obtainable from a Coanda nozzle and that obtainable from a simple nozzle giving the same mass-flow at the same pressure as that of the primary fluid of the Coanda nozzle, the thrust obtainable with given sizes is shown by Fig. 3. It will be seen from this curve that, where thrust is desired, nothing is to be gained from the use of a Coanda nozzle in throat dimensions of less than 80 mm diameter. Further, the effect diminishes when the nozzle throat diameter exceeds 200 mm. There is an optimum size of slot for every throat diameter and pressure ratio—this being indicated in Fig. 4, which plots effectiveness against primary-fluid pressure-ratio, using slot size as the parameter. In the case of a 100 mm throat nozzle, a 1.25 mm slot was found to be the optimum when used with a pressure ratio of 1:1.75 atmosphere absolute. The ratio of primary to secondary airflow has been measured and found to be 1:21, at the optimum performance point of the 100 mm nozzle.

The only practicable application of the "Coanda Effect" that has so far been made was initiated by