AVON.

GAS FLOW TEMPERATURE, PRESSURE AND VELOCITY CHANGES.

The turbo-jet develops its thrust as a result of a continuous cycle of compression, combustion (addition of heat) expansion and exhaust, applied to the working substance. This is air contaminated by products of combustion after the fuel has been burnt in it.

Physical changes take place, and these are of importance as an indication of the way the cycle is working. As in a piston engine we should be interested in Pressures, Volumes and Temperatures at critical points in the 4 stroke cycle, so we are now interested in conditions at entry to and delivery from the compressor, before and after combustion, at entry to and discharge from the turbine, and at discharge from the propelling nozzle. As flow is continuous, volume changes show up as velocity changes.

The Compressor.

When ever a machine, such as a compressor, does work on the air flowing through it, we should expect to see a rise in pressure, or an increase in the velocity of the flow, or both. As it is a rise in pressure we are wanting, the increase in velocity should be small, and most of the work done on the air will produce a pressure rise. The accompanying rise in temperature is a measure of the amount of work done. Incidentally, if this rise is compared with the rise we ought theoretically to get for that pressure increase, we should be measuring the compressor efficiency.

The Combustion Chamber.

Now in the combustion process, if we prevent the pressure rising at all during this addition of heat energy to the air (as we can, by allowing for unrestricted flow expansion along the combustion chamber), all the heat energy added will go towards (1) an increase in the velocity and (2) an increase in its temperature. These two added together constitute the total 'head' of energy that our stream now possesses.

The Turbine.

In a sense this is the reverse of the compressor, for here the machine abstracts and makes use of the 'head' of energy and converts some of it into mechanical power. If the velocity of discharge at exit from the stages in the same as at entry the amount of energy abstracted will be in proportion to the drop in temperature. The gas can be thought of as yielding up its stock of internal energy in order to expand through the turbine, doing work on it and maintaining its own continuous flow.

The Jet.

Finally the gas flow at the propelling nozzle is controlled to give a maximum velocity.

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The above sequence is the broad picture of flow conditions. If we go into greater detail to examine what changes occur in those parts of the engine where the flow is being directed round corners, or smoothed from passages of larger to smaller cross-section and vice versa, we shall find velocity and pressure changes governed by:-

(a) Diffusion, in which flow from smaller to larger bore produces a decrease in velocity and increase in pressure (with corresponding temperature increase).

(b) Expansion, in which flow from larger to smaller bore produces an increase in velocity and fall in pressure, (with corresponding temperature decrease).

If these changes occur without any changes in the total (velocity and heat) energy, they are called adiabatic or isentropic, and the flow proceeds without loss. Obviously there will also be some loss due to frictional heat frittering away velocity energy. This is called polytropic change.

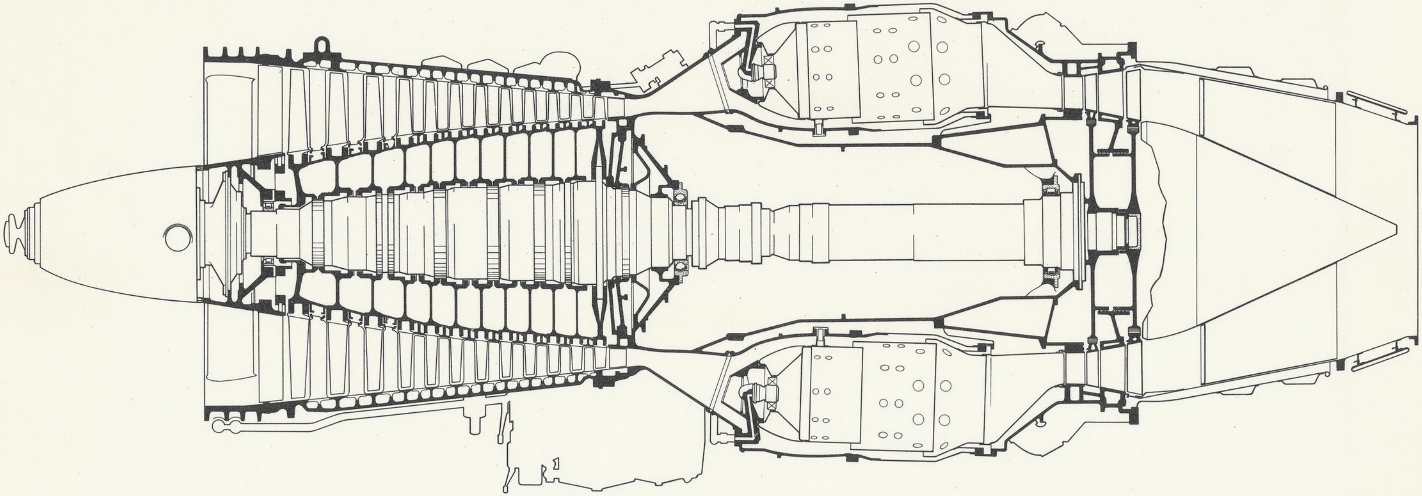
We can now trace the flow through an actual engine working under a given set of conditions.

The figures shown on the curves are static test bed conditions at maximum R.P.M. at sea-level and show the following, using Avon Mk.1. figures for example.

(a) Temperature in degrees Centrigrade (°C).

(b) Pressures in pounds per square inch absolute (p.s.i.)

(c) Velocities in feet per second (ft/sec.)



AVON - GAS FLOW DIAGRAM

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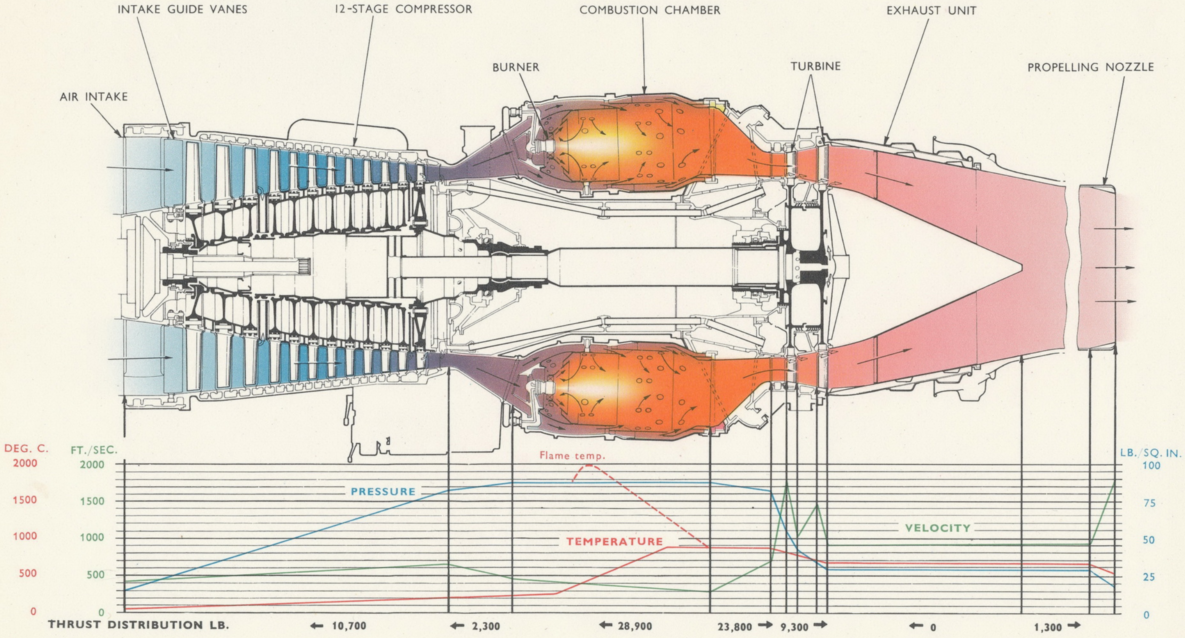

← EFFECTIVE FORWARD THRUST 7,500 LB.

TYPICAL GAS FLOW - AVON

1.9.55

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