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pressure by at least 25 deg C, and in addition there was loss of thrust due to the drag of the tube grill. Alternatively a hollow-bladed windmill in the air intake, fed with hot gas, was likely to give the required mixing with much less drag.

For surface-heating, electrical and hot-gas means had to be considered. For the centrifugal compressor the surfaces that needed heating were the intake nose and intake walls, and possibly the stone guard and inlet vanes. The axial compressor would require heat at the nose, the stone guard, and most probably the first two stages of the compressor, both static and rotating blades. The use of hot air was, therefore, confined to the nose cowling on both types. Both electrical and hot-gas methods were likely to be used for surface-heating light sections. A scheme of eddy-current heating was being tried out at present.

With double-sided impellers there was an appreciable rise of temperature in the plenum chamber. With the single-sided temperature rise was much smaller.

For anti-icing both types, the intake nose and surfaces should be heated, but what further measures were required depended upon the need or otherwise for a stone guard.

The electrical means of surface-heating was to be preferred for the axial compressor if the system could be developed to provide the power requirement, the surface-heating of the intake walls and struts being provided by circulation of hot gases from the engine.

Much the same considerations applied in the case of turbines driving airscrews.

There were two types of direct air intake: behind the airscrew, and the type in which the intake was formed in a hollow rotating spinner so that the nose was forward of the airscrew. The latter was more complicated and more difficult to anti-ice, but was more efficient as an air intake. Fig. 1 shows a scheme for an intake spinner on a single airscrew. The root fairings are used for conveying the hot gases across the intake. They have themselves to be heated, and are also used on the trailing edge for discharging hot gas into the air stream. Contra-rotating airscrews introduced further complications.

In the case of ducted-fan engines, the problems were similar to those of axial-flow compressors, but on a larger scale. The increased mass flow militated against heating the whole of the intake air, and surface-heating became necessary for the first rows of blading, the nose cowling and intake walls being heated by gas from the jet pipe.

Mr. Elliott next dealt with engine requirements (bleed proportions, and temperatures and pressures available) and then turned to the question of surface-heating requirements. These were substantially lower than those necessary for raising the temperatures of the whole of the intake air. Taking a multi-stage axial blower of 100 lb/sec mass flow, he estimated that a heat input of 240 watts per blade would be required. This resulted in the provision of heat as part of engine anti-icing either by the combustion heater, or by a jet-pipe muff, i.e., a heat exchanger, to take heat from the jet pipe. Of the two, the weight accountable to fuel consumption plus installation weight was greater in the bleed scheme.

An advantage of the bleed scheme was that full ram pressure could be made available to the wing, apart from cold-air intake losses. Both schemes introduced the problem of anti-icing the cold-air intake. This could best be done by either electrical heating or a small circulation of hot gas from the jet pipe.

When considering methods of obtaining exhaust-gas bleed for wing anti-icing, three possibilities existed: static tapping inside the jet pipe; scoop to obtain dynamic head inside jet pipe; and scoop to obtain dynamic head at the jet efflux.

Mr. Elliott considered that in the air-screw turbine engine the airscrew is much more intimately associated with the engine than it is in the piston-type of engine. He therefore devoted a part of...