employed spoilers located within the jet-pipe of the engine, and/or lips close to the discharge orifice. In both cases, control in roll was effected by inducing rotation of the jet.

With the wing serving as a jettisoned coelopter, a deflection of the trailing-edge flaps directly affects the thrust-producing jet. By moving these flaps in opposite directions the exit area is varied without deflecting the efflux. Such area restriction is helpful for avoiding the foredrams of any thrust produced by a switched wing immediately after the ramjet is switched off at high speed. It may also help as an air brake.

Coelopter Propulsion. As this aircraft class, like all jet-lifters and helicopters near the ground, cannot be landed normally when the propulsion has become inoperative, manned coelopters must have either dual propulsion or duplicated propulsion units, each of which is sufficient for safe landing.

For most coelopter projects, "combination propulsion" is preferable. For short periods of high speed flight, ramjet propulsion proved the lightest. This, however, demands that the aircraft is accelerated to its operational speed by other means, e.g., by a rocket motor or by a turbojet, and that sufficient static thrust is available to accelerate to operational speed by other means, e.g., by a rocket motor or by a turbojet, and that sufficient static thrust is available for ascent and descent. For manned or recoverable coelopters, ramjet propulsion alone is therefore considered inapplicable. It is employed solely for boosting to high supersonic velocities.

For ascent, the static thrust should be at least 1.25 times the take-off weight; for landing it may be less, and a value equaling the landing weight would appear adequate. Most currently used turbojets weigh around 0.3 lb/lb static thrust. This means that the weight of airframe, disposable load and fuel tanks should be equal to, or less than, half the static thrust. This is achievable, since a coelopter of the type with an outer wing half of that of a comparable standard aeroplane. Lighter turbojets render the scheme even more practical. The latest Atar 101E turbojet, of 7,700 lb static thrust, only weighs 0.235 lb/lb thrust, and Dr-Ing. H. Oestrich, the designer of this engine, holds further weight reductions to be possible for coelopter installations. The expendable Rolls-Royce Swift turbojet weighs only 0.15 lb/lb static thrust.

S.N.E.C. M.A. investigations show that turbojets with reheated and with additional ramjet propulsion guarantee coelopter performances which are unattainable by any standard aircraft, quite apart from the take-off and landing advantages. The ramjet would be put into operation at speeds in excess of about 500 m.p.h.

As far as ramjet operation is concerned, the cross-section of the duct is oversized; this leads to relatively low combustion temperatures and is therefore most desirable. Since, however, the velocity at which air enters the combustion space is high (of the order of Mach 0.3, in present projects), special burners have been developed. Spherical burners, designed to achieve sufficiently reduced local flow velocities for reliable combustion. The entry of these patented subsonic burners is shaped like a diffuser for a ram intake; high compression efficiency and low burning rates are obtained. Up to Mach 0.25, the pressure in the burner diffuser exceeds one atmosphere, decreasing to not less than half that pressure at 66,000 ft (where the internal flow velocity corresponds to about Mach 0.1). This safeguards the ramjet operation and makes it economical.

S.N.E.C. M.A. experimentation is at present concentrated upon the turbojet. A vertically ascending Atar engine with all flying control surfaces within the coelopter duct, forward of the wing trailing edge, the hot gas jet is surrounded by a cold air stream as long as the ramjet is inoperative (i.e., during launching and descent). By virtue of injector action, this cold air stream gives coelopter thrust.

Ducted airscrews can produce a substantially higher static thrust than the free-running type, provided that the duct exit area is suitably chosen. As its tailspin is located within the coelopter duct, forward of the wing trailing edge, the hot gas jet is surrounded by a cold air stream as long as the ramjet is inoperative (i.e., during launching and descent). By virtue of injector action, this cold air stream gives coelopter thrust.

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