HIGH FLIGHT

FLIGHT AT FORTY THOUSAND IN HIGH SPEED JET PLANES WILL BRING ITS PROBLEMS THIS METEOR PILOT REPORTS

by S/L W. A. WATERTON, AFC

PERHAPS it seems strange that, with a background of only jet fighter experience, I should discuss jet propelled aircraft from the civil operating viewpoint. It has often proved, however, that the problems of fighter aircraft today are those of the bomber tomorrow and of the civil transport the next day, although it would appear that the order of the last two might well be reversed these days in Britain.

Our work here at Glosters, with the "Meteor" and other jet aircraft, has given us a vast amount of experience in flying in all sorts of weathers at altitudes up to 50,000 ft. at very high speeds and Mach numbers. Additionally, overseas tours and ferrying trips involving long-distance flights have given our pilots a not inconsiderable insight into the problems of radio, navigation and flying control. With this information we have perhaps learned the fundamental factors influencing and affecting many design and operational features of jet-propelled commercial aircraft.

Many of the world's civil aviation authorities speak quite glibly of transporting passengers at 30,000 to 40,000 ft. at speeds of 600 mph. above the weather in smooth air "with the sun a ball of fire in an inky blue-black sky." I wonder if many of these gentlemen realize what lies ahead in making good these claims. A brief enumeration of some of the facts may prove of interest.

In the realms of meteorology much remains to be known, especially of conditions at higher altitudes. Winds of terrific velocities frequently are encountered at altitude; 200 mph. is not unknown and in many cases the winds are of sufficient strength to discredit severely the increases in range and endurance gained by operating jet engines at their best heights.

"Met. winds" at 30,000 ft. and over are far from accurate in many parts of the world, as landing up 60 miles south of track in an hour's flight from Greece to Italy over 8/8 cloud tops at 31,000 ft. has shown. Meteorologists rarely, if ever, predict cumulus or cumulo-nimbus cloud over 23,000 ft., but in England and over the Alps, Appennines, Corsica, Greece and the Massif Central of France, we have on numerous occasions seen heavy cu and cu-nimbus cloud with tops up to 38,000 ft. Dense layer cloud frequently extends to 30,000 ft. with heavy haze, and cirrus on occasion, well above 40,000 ft.

Not only is cloud and icing present at these great heights but with cumulus and cumulo-nimbus formations there is also extremely turbulent air. Additionally, turbulent air conditions are frequently encountered, certainly as high as 42,000 ft. without warning and in clear air.

Fortunately, indicated air speeds are low at high altitudes (50% of true at 40,000 ft.) and "G" is therefore not so liable to overload a comparatively lightly stressed commercial aircraft as if it were flying low down at high indicated air speeds. On the other hand, damping is comparatively poor if the aircraft's flight path is disturbed and shock loadings are extremely high.

Bearing in mind the stressing of the aircraft, and also passenger comfort, high climbing speeds must be considered to take the utmost advantage of engine characteristics and economy. Unfortunately these flight conditions occur at low altitudes where maximum turbulence can be expected.

With increasing speed, severity of bumps increases tremendously and it is doubtful if passengers can be subjected to the buffeting about they will certainly receive, even if the aircraft can "take it" safely.

Operation at high altitude will require extremely strong fuselages with a large pressure differential to keep cabin conditions not higher than 10,000 ft. Rate of pressure change must be kept low for passenger comfort during rapid climbs and descents and the system must be 100% foolproof against sudden decompressions. This means the provision of alternative sources of supply which themselves must set the designers a considerable problem in view of the amount of power required to pressurize a large section fuselage to 10,000 ft. at an altitude of 40,000 ft.

Heating and insulation will present terrific problems in the temperatures of minus 55 deg. C to minus 60 deg. C usually encountered over western Europe.

Aerodynamic noise must be considered carefully. Although pressurization will eliminate much noise, windows should be kept flush with the aircraft's outer skin. This is also especially necessary round the cockpit. Research must be carried out into providing more vision in rain as high speed aircraft are notoriously bad in this respect, though I personally favor a sharp V windscreen as an aid in this matter. The Canadian National Research Council (Dr. Sted-

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ABOVE—Gloster Meteor flown by the author.

High Altitude Flight

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man) has developed a rain repellent paste which in my experience has provided reasonable visibility in moderately heavy rain up to 500 mph.

Jet pipe effluxes will not doubt prove a source of extreme disquiet to passengers seated aft of the jet orifices and it is doubtful whether this problem can be solved with orthodox-type aircraft employing passenger accommodation aft of the wings. However, the flying wing, the delta wing, or the type of configuration employing tail booms should provide a solution to this problem.

Materials and equipment as used at present can be expected to prove sources of trouble in large aircraft flying under the conditions outlined. Perspex and glass in use at present is liable to give a great deal of trouble in respect of breakage due to thermal stresses. Electrical equipment deteriorates in efficiency at high altitudes especially in regard to generator brush wear and overheating. Condensation on coming down from extreme cold will have to be carefully budgeted for, otherwise corrosion will be a source of embarrassment. Radio and radar equipment will almost certainly have to be heated and pressurized to work at top efficiency over long periods at high altitude.

For economy of operation jet aircraft should reach high altitudes as quickly as possible owing to their high fuel consumption on the ground at idling and in flight at low altitudes. As aircraft drag for a given true air speed will normally decrease with altitude up to an optimum dictated by the wing loading, configuration and drag rise characteristics, it behooves the operator to get to the particular machine's best operating height as quickly as possible and remain there as long as possible. The importance of this can best be appreciated by the fact that existing jet fighters more than double their range for a given amount of fuel by flying at 40,000 ft. as against sea-level flight. The optimum range is generally gained by throttling well back and commencing a semi-glide from as much as 60 miles from the aircraft's destination. For the ascent, high forward speeds in the order of 300 to 400 mph. will have to be maintained in order to obtain the maximum efficiency and economy from the turbines and at the same time achieve the maximum rate of climb of the aircraft.

Landings are liable to present no special difficulties either in pilotage or from the passengers' point of view. Take-offs and overshoots or baulked landings, however, comprise another story altogether. It is one which is almost certain to cause the scorching of a great deal of brainfat among designers if ICAO requirements are to be met with a commercial payload plus a reasonable range, and if existing airfield installations and runway lengths are to be used.

Low wing loadings, which are desirable for high-altitude efficiency, will help in this matter, with low take-off speeds and low safety speeds in asymmetric flight, provided the engines are mounted close to the fuselage.

Nonetheless, at the conditions under discussion, the pure jet turbine is at its worst with relatively small quantities of air going through it. To this must be added the inertia of a very heavily-loaded commercial aircraft, all of which adds up to long take-off runs and poor overshoot characteristics.

It would appear that a power-weight ratio of not less than 0.33 to 1 will have to be employed with the possible addition of JATO (jet assisted take-off) in order to obtain a satisfactory take-off. The fitting of reheat equipment probably will provide the most satisfactory solution to this problem but notice must be taken of the detrimental effects of high altitude airdromes, and the high temperatures experienced in tropical latitudes, which affect pure jets to a greater extent than piston engined-propeller combinations.

From the foregoing it is evident that the whole technique and conception of flying control will have to be drastically altered to meet the new problems associated with commercial jet-propelled aircraft. If stacking or waiting is employed it must be done at the aircraft's economical cruising altitude — with a steep, rapid descent, employing air brakes, being carried out when landing clearance is given. This is not likely to prove popular with passengers, nor is it 100% practical under instrument conditions through thick layers of cloud.

Plan Long Descent

Additionally, problems of buffeting and control may be posed to the designers if it becomes necessary.

The better procedure for economy would be the long descent, with idling engines, starting as far as 100 miles from base. This would require an absolutely clear final approach, possibly even necessitating clearance for take-off at the point of departure, and accurate timing, in order to keep rigidly to the flight plan.

Instantaneous take-offs without delay will also have to be budgeted for, with taxiing cut to an absolute minimum.

All these problems are far from insoluble; but they do exist together with numerous others not touched upon, but nonetheless pertinent, in such widely diversified realms as blind flying instruments, navigation, radio and radar aids, crew training and flying technique.

To me the important thing is that they should be recognized and admitted and faced up to forthwith with foresight, which alone can ensure British civil aviation a bright future. That no airline company has yet had the initiative to operate a proven pure jet aircraft (such as the Gloster "Meteor T7") over any regular short-distance services, external or internal, would seem to me to be a serious disregard for the factual basis on which future policy must be decided.