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PISTONS TO ROCKETS

THE various types of power plants, from reciprocating engines to rockets, were discussed by Peter G. Masefield, Director-General of Long Term Planning, England, in an analysis of civil aviation trends. Each type has its sphere of usefulness, he said.

"(a) **The standard piston engine** is suitable for operations over all but the very long ranges. In the present state of the art, its most economic performance is gained at heights of up to 25,000 ft., at speeds up to about 350 mph, and in present aircraft sizes, for stage lengths not exceeding 2,000 miles. One of its great advantages is its flexibility of performance within its economic speeds and heights.

"(b) **The compound piston engine** is most suitable for very long range operation at moderate speeds and at greater heights than the piston engine. In contemporary sizes, of aircraft it has advantages over the piston engine for stage lengths of more than 2,000 miles. For long ranges the compound piston engine gives promise of being even more flexible than the standard piston engine, for heights up to about 35,000 ft. and speeds up to about 400 mph.

"(c) **The propeller-turbine engine** is at present most suitable for medium range operations at moderate speeds and heights—up to about 425 mph and 35,000 ft. When more fully developed for civil purposes, eventually, in conjunction with improved air traffic control, **the propeller-turbine is likely to show advantages over the piston engine for all but very short or very long range operations and — in the largest sizes—for all operations.**

The chief difficulty with the propeller-turbine engine today is that because of the small amount of interest in it for military purposes, almost all the development costs have to be spread over relatively few civil orders. The propeller-turbine is, in consequence, not receiving the amount of effort which it deserves and only a fraction of the development which is being concentrated on the turbo-jet.

"(d) **The plain jet engine** is most suitable at present for moderate ranges at high subsonic speeds and at great heights—not less than 450 mph at not less than 30,000 ft. In the course of aeronautical development **the plain jet turbine will probably show improved commercial efficiency at supersonic speeds, up to about 1,500 mph at heights up to 75,000 ft.** Although at high speeds the jet is more efficient than any propeller-driving engine, such speeds must always be costly to provide, although not necessarily less economic in operation because additional revenue may be attracted.

"In the immediate future **the jet engine appears unlikely to be worth while for distances of less than 300 stage miles or greater than 2,000 stage miles.** Its development beyond these confines will depend on the development of air traffic control to permit rapid landings.

(e) **The plain jet with after burning** is inefficient at subsonic speeds except as a take-off device. It is likely to prove suitable for cruising speeds of not less than 650 mph at 50,000 ft. and for supersonic cruising speeds of up to 2,000 mph at 80,000 ft. or more. The remarks on the plain jet apply with still greater force to the engine with "after burning" added.

(f) **The ram-jet** takes us, necessarily, into the almost unexplored realms of supersonic speeds, about which, one day, enough will be known to permit economic commercial operation.

"When the time arrives **the most satisfactory operating speed of a ram-jet airplane would appear to be around 2,200 mph at 50,000 ft.** or more for stage lengths of around 1,000 miles.

"(g) **The rocket power plant** applied to commercial aircraft is a further stage away. With it, speeds of up to 5,000 mph at not less than 100,000 ft. for stage lengths of some 500 miles appear possible. The economics at present look poor, but may improve materially as nuclear science advances.

"(h) **The rocket projectile** is at the moment the ultimate peak of high speed transport to which we can look forward. With theoretical intra-terrestrial speeds of up to 18,000 mph and inter-planetary speeds of 25,000 mph, the rocket projectile may eventually bring any point of the earth's surface within an hour's block time of any other point—at an economic fare.

"Although such prospects may sound fantastic, the progression to a service "On the Hour to Anywhere in the Hour" is no greater than that from the stage coach of yesteryear to the 300 mph transport airplane of today.

(I should add that my more detailed economic and performance explorations in this paper go no further than the plain jet.)

"Types and sizes of aircraft have their own most suitable spheres of use.

"(a) **The commercial helicopter,** in sizes of not less than 10 seats, will find its most useful application in stages of from 50 to 200 miles, particularly for journeys involving short sea crossings. At present, helicopter costs are likely to be a good deal more than costs of fixed-wing aircraft. But the helicopter is still at an early stage. Its development is likely to be rapid during the next 10 years.

"(b) **Short stage fixed-wing aircraft** are, in general, incapable of competing with efficient surface transport for distances of less than 200 miles except where sea crossings, mountains, or other geographical barriers intervene. From 200 miles onwards the airplane shows increasing advantages over surface transport — with the turbine offering possibilities of marked reductions in costs when the "stacking" problems have been solved.

"(c) **Medium and long stage fixed-wing aircraft** represent the most advantageous developments in air transport vehicles. **Large aircraft are necessary for long stage routes.** But once the largest economic payload has been decided and allied to the longest route which requires to be operated, then every technical development will tend to reduce the size of airplane required for the job. At the present time aircraft of between 100,000 and 300,000 lb. represent the peak of development for long stages. We

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shall probably see bigger types still before evolution begins to reduce the size.

"One of the most important factors contributing towards economic operations is the **matching of aircraft size and types of aircraft to the routes and stage lengths over which they will be required to operate.** In the present state of the art a 100,000 lb. airplane is most suitable for stages of about 1,750 miles, whereas a 300,000 lb. airplane is most suitable for stages of about 3,000 miles. For the same most economic stage distances and the same payload, turbine aircraft will have to be larger than aircraft powered with conventional engines until turbines consumptions have been improved very much compared with present prospects."

GAS TURBINE SCHOOL

THE School of Gas Turbine Technology, near Rugby in England, run by the Power Jets (Research and Development) Ltd., 25 Green Street, London, W.1., is the only one of its kind in the world. Students from other countries who wish to learn Britain's approach to this new range of engineering development may spend a few weeks attending a course at this school.

The reason for this is that during World War II, Britain made tremendous strides in the development of the gas turbine.

The first patent for a gas turbine was taken out by an Englishman, John Barber, in 1791. Sir Frank Whittle was the first man to link gas turbine and jet propulsion. Today Power Jets (Research and Development) Ltd., the successor to Whittle's first company, Power Jets Ltd., is a publicly owned company and controls and operates some 2,000 gas turbine patents and applications in 15 countries.

The school was opened by Power Jets Ltd., to teach Britain's Royal Air Force and the Commonwealth countries air forces how to service the new engines they were beginning to use, and gradually this teaching was spread throughout Britain's aero-engine industry. This proved so useful to the aero industry that it was decided to enlarge the scope of the courses to serve the needs of the industrial user and maker of gas turbines.

There are three main types of