A STUDY of the development of aero engines during the past fifty years brings to light the rather remarkable fact that, whereas immense strides have been made in improving power/weight ratio, overhaul life and reliability, comparatively little has been done to improve thermal efficiency or specific fuel-consumption. Today, in fact, piston engines are scarcely 20 per cent better in these respects than they were in the 1914-18 war. The advent of gas-turbine power has not materially affected the overall position; while accelerating the improvement of power/weight ratios and holding forth promise of very good trouble-free life in the years to come, the gas turbine has made little contribution towards overall efficiency—in fact, the earliest turbojets were, in this respect, decidedly retrograde.

This seeming lack of progress is by no means due to want of effort. The need for increased efficiency has always been clear enough, and is today of transcendent importance both to the military logistics planner and to the airline operator. To some extent, also, better power-unit efficiency is desirable to permit increased aircraft range or duration. But every engineer or company that has set out to achieve a significant improvement in fuel consumption has, sooner or later, given up the unequal struggle against weight, complexity and unreliability.

Without going too deeply into thermodynamics, it may be said that the basic aim of the engine designer is roughly as follows: the working fluid (air, or hot gas, in aero engines) should initially be as cold as possible; it is then compressed as much as is practicable, in an adiabatic manner, so that heat losses are minimized; finally it is expanded and cooled as nearly as possible back to its original condition, and is made to do useful work during the latter part of the cycle. The relatively poor efficiency of most aero engines results from insufficient compression and expansion ratio, and insufficient cooling of the working fluid before expulsion back to atmosphere; even in highly boosted engines with adequate peak temperatures and pressures, the exhaust is discarded while still very hot and at high pressure. At full throttle, about three-quarters of the heat energy originally released by burning the fuel is wasted by reason of the fact that the exhaust is released too soon.

Innumerable methods have been adopted to reduce such waste. Accepting an inefficient power unit as a fait accompli, some improvement can be made by employing ejector exhaust-stacks or, better, by extracting some of the exhaust energy by inserting a turbine in the gas stream and turning the shaft power to good account, either by making it drive a supercharger or by gearing the rotor to the crankshaft. Alternatively, a fresh start can be made on an engine with a revised thermodynamic cycle, such as a compound engine, or a diesel unit, or a more complex affair with various compressors, heat-exchangers and intercoolers. All these have been tried, but the insistent demands of installed weight, simplicity, low first cost and high reliability have been strong enough to confine the propulsion of aircraft to essentially simple engines, whether of the reciprocating or turbine type.

Now, however, an engine has been developed which is likely to see wide service in both military and civil roles as a result of its unmatched efficiency; in fact, its overall efficiency is of an altogether higher order than that achieved by any other aero engine. Particularly remarkable is the fact that, in spite of this unrivalled economy, the engine is extremely competitive in all other parameters, including power/weight ratio, complexity, bulk, altitude performance, flexibility and control, and ease of installation. Further, it can burn a wide range of fuels (not only accepted aircraft fuels) and it is likely that its overhaul time, overall life and reliability will be of an exceptionally high order. This engine, the Napier Nomad, is the result of many years' development by a British company, D. Napier and Son, Ltd. From a technical standpoint it is one of the most interesting aero engines ever designed, and the narrative which follows is accordingly the most extensive engine description that we have ever published.

The germ of the idea grew from an official specification of 1944-45 calling for a 6,000 h.p. engine; this was, of course, the size which might have been required had the war continued, and gas-turbine development—especially of shaft-drive engines—was still in its infancy. The specification was written around a four-stroke piston engine, but Napiers (with whom we may couple the name of Mr. E. E. Chatterton, B.Sc.(Eng.), M.I.Mech.E., F.R.Ae.S., now chief engineer of the piston-engine division) were studying the promise of a compound unit incorporating a two-stroke diesel engine.