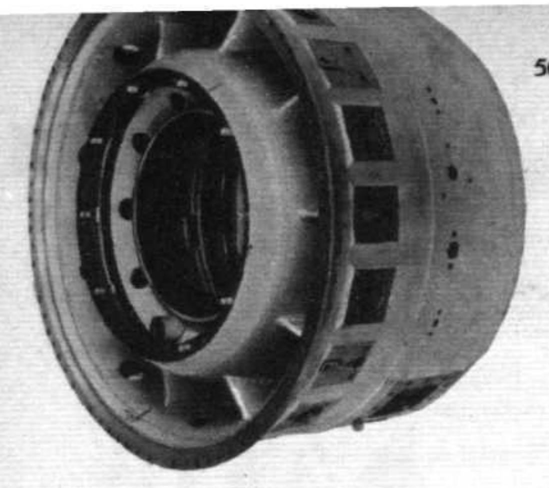
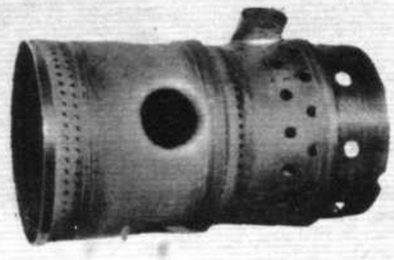
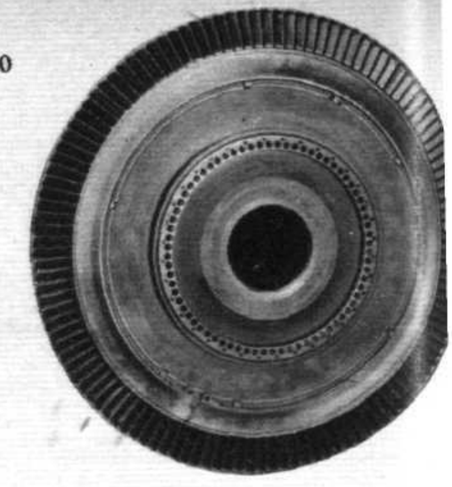






TYNE . . .

the rotor shaft has splined lands on which the steel discs are mounted. Seven of the stages have titanium blades, but the last two are of steel to suit the higher temperature.

A fabricated steel delivery duct guides the air into the cannular combustion chamber. An argument for the cannular system in civil use is the long life and repairability of flame tubes. The Lucas/R-R duple burners are individually removable from outside. A separate heat shield round the shafts contains the cooling air.

Details of the single-stage h-p. turbine are restricted because of the cooled blading, although the air which cools the nozzle guide vanes leaves via five holes on the concave side near the trailing edge. The three-stage l-p. turbine has shrouded blades with fir-tree platform roots. Its large variation in hub/tip ratio is indicative of the work extracted. All rotor blades are forged and machined from various grades of Nimonic, while the nozzle vanes are Nimonic investment-castings. Discs are ferritic, and the casing is of cast steel for the inner shell and fabricated steel for the heat shield. The tailcone is built up on ten radial struts attached to a decagonal casing forming a triangulated structure. Inside some of the struts are cooling-air and oil tubes.

Reduction gear design shows a clear relationship to that of the Dart. Complications in the Tyne stemmed from the need to keep the cruising helical tip-speed of the 14ft 6in D.H. propeller down to M0.85, while maintaining high r.p.m. at take-off. The propeller aspects of the problem have been fully discussed (*Flight*, April 25 and August 8, 1958). Compressor matching was chosen so that the l-p. system overspeeds at take-off, while cruising is done at the lowest r.p.m. consistent with component efficiency.

Gear ratio is 0.064. An epicyclic gear was chosen, with helical teeth, for uniform seating without tilt under load. The high-speed pinion is splined to the l-p. shaft and drives three planet wheels. Deflection is only 0.0015in on the length of the planet pinion at full torque—and this is complementary to that of the high-speed pinion. White-metal plain bearings, with white-metal thrust washers, are used for the layshafts, and the high-speed pinion is supported in a double ball race bolted to the propeller shaft. This last is carried in a ball thrust race and roller journal bearing. The three propeller oil lines are transferred by concentric sleeves on the high-speed pinion via the three spider arms of the carrier to their respective bores and ducts in the propeller shaft.

Torquemeter and negative-torque signalling are essential features of high-power engines, where sudden change from thrust to drag can be catastrophic. In the Tyne the annulus gear is attached to the reduction gear nose casing by 24 dashpot cylinders which provide a hydraulic balance to the positive torque applied to the annulus under normal running conditions. The torquemeter oil pump supplies them with oil through a master cylinder, and the pressure-drop gives the torque reading. In combination are the engine portions of the automatic drag-limiting system (ADLS) consisting of four cylinders, disposed axially round the nose casing, containing pistons connected by push-rods to the annulus gear. Movement of the latter thus moves the pistons, and negative torque reduces oil pressure in the ADLS. If the latter were to occur in flight the annulus gear would rotate until it tripped the ADLS lever connected to the feathering control. However, the Tyne system also has to deal with reverse pitch and flight-idle, where negative torque is present. This is catered for by a mechanical override linkage from the engine control lever, which resets a relief valve controlling the negative-torque pressure in the flight-idle and beta pitch ranges (defined by control lever position) to render the ADLS inoperative until a preset negative torque is exceeded.

Engine power control has been so lucidly described by Rolls-Royce that it is impossible to better their own text:—

"Engine power control is exercised by a single lever in the cockpit which operates the linkage on the engine by means of which fuel flow and l-p. r.p.m. are interconnected. The r.p.m. in the flight range is controlled by the propeller control unit in the usual way, and the fuel flow by the flow control unit which automatically corrects for forward speed and altitude. Basically, this is the system of control which has given such satisfactory service on the Dart.

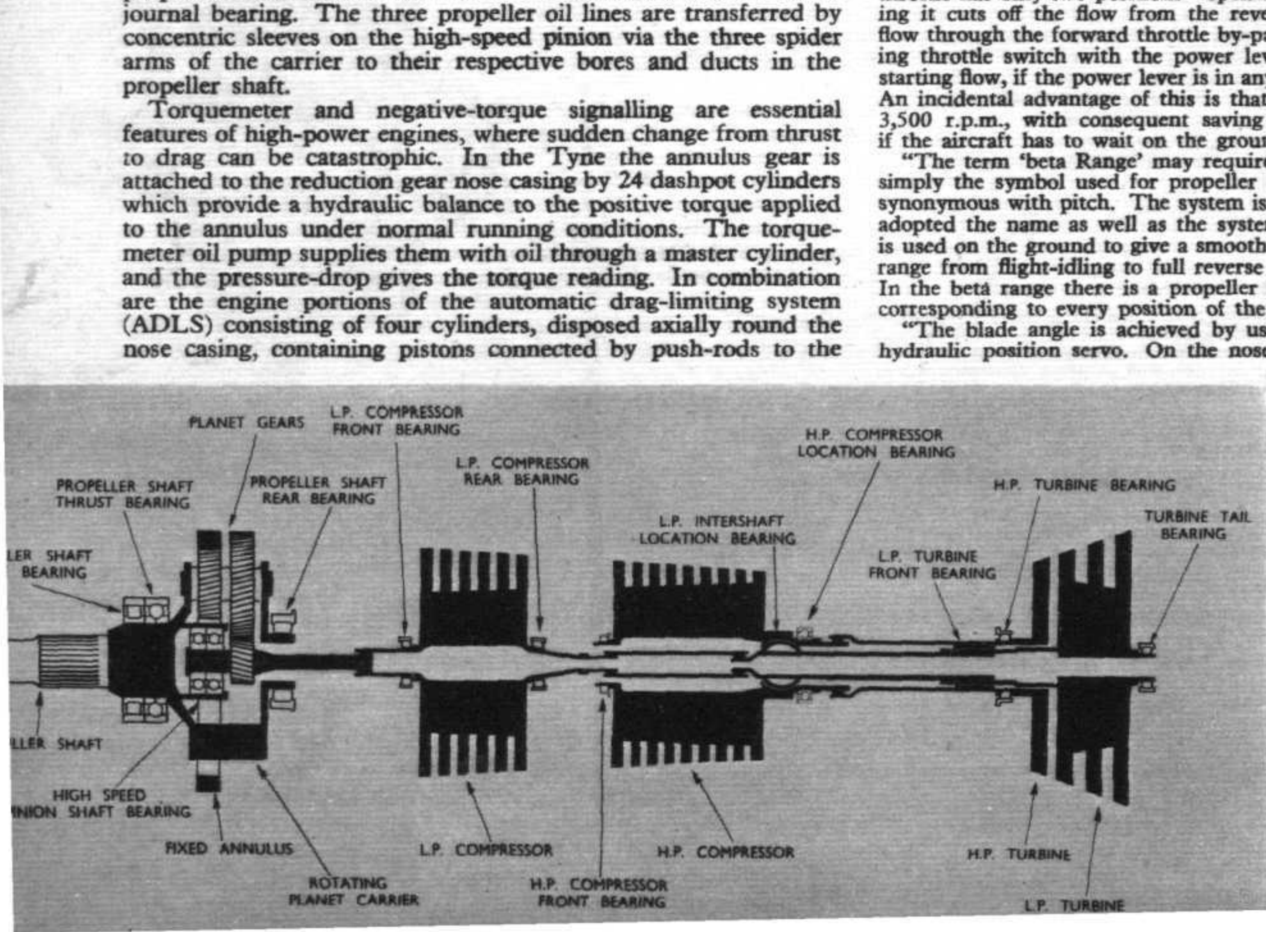
"Extensions of this linkage operate the negative-torque setting valve, the l-p. variable-datum governor [and, originally, the anti-icing valve] which are scheduled in accordance with the engine power setting. A further lever in the cockpit, known as the condition lever, operates another linkage on the engine by means of which the h-p. fuel cock can be operated, propeller feathering and unfeathering selected mechanically, and the proportional fuel trimmer linkage operated. The trimmer linkage provides a means whereby the fuel flow can be varied independently of r.p.m. over a limited range, in order to allow for variations in ambient temperature.

"Additions to the Dart system have been necessary in order to permit reverse-pitch braking to be used, and this has resulted in another throttle. This throttle controls the fuel flow in the beta range and provides at all times slightly more fuel than is required to keep the engine speed up to the l-p. variable datum governor. Both throttle valves are controlled by the power linkage on the engine.

"Since fuel flow scheduled by the reverse throttle at ground-idle in the beta range is too high for starting, some means is necessary to reduce it to the required value. This is provided by a starting-flow throttle, operated by an electric actuator mounted on the flow control unit. This throttle has only two positions—open or closed. When closed for starting it cuts off the flow from the reverse throttle and leaves only the flow through the forward throttle by-pass. Interconnection of the starting throttle switch with the power lever makes it impossible to select starting flow, if the power lever is in any position other than ground-idle. An incidental advantage of this is that the engine can be idled at only 3,500 r.p.m., with consequent saving in fuel and reduction of noise if the aircraft has to wait on the ground with engines running.

"The term 'beta Range' may require a word of explanation. Beta is simply the symbol used for propeller blade angle; in this context it is synonymous with pitch. The system is of American origin and we have adopted the name as well as the system. Beta control of the propeller is used on the ground to give a smooth transition of thrust over the full range from flight-idling to full reverse both on landing and in taxying. In the beta range there is a propeller blade angle and an engine speed corresponding to every position of the pilot's throttle lever.

"The blade angle is achieved by using the propeller controller as a hydraulic position servo. On the nose casing of the reduction gear is



This diagram, which is not strictly to scale, clarifies the basic geometry of the main rotating assemblies. The low-pressure intershaft bearing is shown as a spherical pattern; in fact this is now a ball race, as explained on page 564