THE JET-ENGINE FUEL SYSTEM

Supply, Atomising and Control Equipment

Developed by Joseph Lucas

WHILST the work of evolving the jet-engine combustion system and equipment was proceeding, a parallel activity of Joseph Lucas, Ltd., was the development of fuel pumps, burners and regulating components for the control of the engine. Initiated in Birmingham, this work was for a short time transferred to Acton, but subsequently returned to a specially equipped factory at Birmingham.

Early Whittle engines employed a constant-displacement pump and a barometrically-controlled variable by-pass, but it was decided at the outset that such a system suffered from certain limitations and did not offer adequate scope for future development. To meet the wide ranges of fuel flow required by the gas turbine at varying air speeds and altitudes a pump having a variable stroke, regulated by a servo system under barometric control, was deemed more desirable. As no pump of light weight and occupying small space was available to meet these requirements, the development of a special pump was undertaken. After surmounting early difficulties of considerable magnitude, a successful design was evolved for the pump which has been employed on all Rolls-Royce jet engines.

Clean fuel is essential for satisfactory operation owing to the fine working clearances of the components and the relatively restricted passages in the burners. Accordingly, all Bowser tankers employed for refuelling jet aircraft are equipped with Streamline filters to prevent the transfer of foreign matter to the aircraft tank. Fuel is drawn from the tank by a sub-merged electrically-driven, centrifugal-type Pulsometer pump and is passed through a Tecalemit fabric-type filter before reaching the pressure pump.

On the power unit the fuel system includes the following components—variable-stroke pump with a built-in maximum speed governor and an automatic pressure-relief mechanism, barometric control unit, throttle valve, a unit embodying accumulator, trip valve and high-pressure cock, fuel manifold and burners. Disposition of this equipment on the wheel case at the forward end of the Rolls-Royce Derwent engine is shown in an illustration, and connections can be readily followed in the diagrammatic layout.

Fuel is fed to the engine-driven pump, which operates in conjunction with the altitude-conscious barometric control unit and is subject to the overriding control of the hydraulic-type governor, which prevents the engine speed exceeding a predetermined maximum. From the pump the fuel is delivered to the throttle valve, which is regulated by the pilot from the cockpit, and thence to the accumulator unit, the ring manifold and, by means of flexible pipes, to the burners in the combustion chambers. The accumulator is required to build up a volume of fuel under adequate pressure for starting purposes. When shutting down the engine the high-pressure cock shuts off the flow of fuel to the burners. Drain connections from pump, throttle and accumulator unit discharge to atmosphere. Gauges are provided to indicate pressure at the pump delivery and in the manifold and depression at the pump intake. In conjunction with the last, a pressure-sensitive switch operates a warning light in the event of the fuel supply being interrupted by a clogged low-pressure filter.

The seven plungers of this positive-displacement pump reciprocate in a rotor running in a carbou bush and a roller race mounted in the engine by a splined quill shaft. The bores for the plungers are spaced evenly around a pitch cone concentric with the rotor axis and converge towards the inner or pumping end. Reciprocation of the plungers is effected by means of a cam plate engaging the outer ends of the plungers. The cam plate is carried on a large-diameter ball bearing mounted in a control ring swivelling on a pair of trunnion pins set at right angles to the rotor axis. By varying the angle of the plane of the cam plate relative to the rotor axis from 90 deg. to 81 deg., the stroke of the plungers is varied from zero to approximately 10.5 mm. Retraction of the plungers on the inlet side is ensured by helical springs located against the reduced inner ends of the bores.

At its inner end the face of the rotor is ground flat and smooth to make a pressure-tight seal with a valve insert furnished with two kidney-shaped ports communicating respectively with the pump intake and the pump delivery. Thus each plunger bore is in communication with the suction and delivery passages of the pump once in each