

Part I

Chapter 6—Engines

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1 General

(a) The Sapphire Mk. 202 or Mk. 207 engines are each rated at 11,000 lb. static thrust at sea level. The main engine systems include:—

Electric starting (see para. 3)

Relighting facilities (see para. 4)

High-pressure fuel system (see sub-para. (b))

Self-contained oil system (see sub-para. (c))

Anti-icing (see sub-para. (d) and Part I, Chap. 9, Para. 5 which deals with air intake anti-icing)

Automatic JPT controls (see sub-para. (e))

(b) High pressure fuel pumps

A single variable-output HP pump is fitted to each engine. Delivery from each pump is regulated by a maximum speed governor, a barometric flow control unit and an air/fuel ratio control. The maximum speed governor is sensitive to jet pipe pressure and with reducing pressure reduces max. engine speed to prevent the

JPT exceeding the limits. The BFCU maintains selected engine speed under conditions of varying altitude and airspeed. The A/FRC comes into action only during periods of rapid throttle opening to prevent the possibility of compressor stall.

(c) Oil system

Each engine has one pressure and three scavenge pumps which maintain a continuous circulation through an oil cooler to the engine bearings and gears. The engine oil tank capacity is 18 pints of oil with 6 pints air space.

(d) Engine anti-icing

(i) The inlet guide vanes, air intake struts and starter motor fairing of each engine are heated by hot air from the engine centre section. Control of the hot air supply to each engine is by means of 4 four-position OPEN/CLOSE/HALF-OPEN/AUTO switches, on panel AD, which actuate the hot air valve shutters. When Mod. 2007 is embodied the AUTO switch position is inoperative.

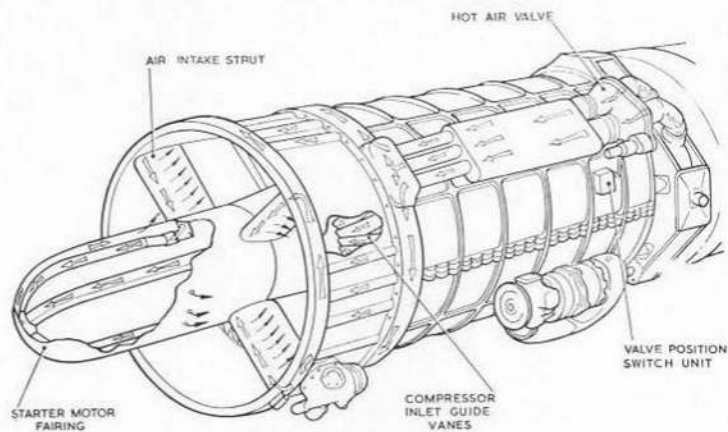


Fig. 1 Engine Anti-icing

(ii) With the switch in the AUTO position control of the system is by the ice detector relays which, when energised, cause the hot air valve shutter to move from the closed to the half-open position. When icing conditions no longer exist it will be necessary to select CLOSE to switch off the system.

(iii) The 28-volt DC supplies to the systems are from feeders 7P7 (Port engines) and 10P7 (starboard engines) on panel AH.

(iv) The leading edges of the engine air intakes are kept free of ice by the airframe anti-icing system.

(e) *Automatic JPT control system (Mk. 1A only)*

(i) A three datum JPT control system is embodied to maintain constant JPT at the Intermediate (98%) and Maximum Continuous (96%) engine speed ratings and to limit the maximum JPT to 660°C. A three-position TAKE-OFF/CLIMB/CRUISE, ratings selector switch is fitted on panel AZ and four NORMAL/OFF isolating switches, one for each engine, are fitted below the 1st pilot's side window.

(ii) With the selector switch set to TAKE-OFF the system will limit the maximum JPT to $660^{\circ}\text{C} \pm_{10}^0$ and engine speed at full throttle is controlled by a fuel governor trimmed as necessary by the JPT control. Any other desired operating condition can be obtained by normal movement.

NOTE: With the isolating switches set to OFF or if the jpt control system fails, engine speed is controlled entirely by the fuel pump governor and take-off power is ensured by a 'fail safe' device.

(iii) After take-off, with the isolating switches all ON, selection of the switch to CLIMB trims the fuel governor to ensure that the JPT is maintained at $625^{\circ}\text{C} \pm_{10}^0$. Engine speed is thereby adjusted without any throttle movement from fully open. Similarly, subsequent selection of CRUISE further trims the fuel governor to maintain $600^{\circ}\text{C} \pm_{10}^0$, again without throttle adjustment.

NOTE: In both CLIMB and CRUISE conditions, throttle control is normal if power settings below those selected are required.

(iv) Setting any of the isolating switches to OFF isolates the JPT control of the associated engine which must then be controlled by throttle manipulation.

2 Throttle/HP cock controls

(a) A throttle quadrant, containing 4 interconnected combined throttle lever/HP cock controls is fitted on each pilot's console. A throttle damper mechanism is fitted only to the 1st pilot's control box, but it can be operated by the 2nd pilot through a system of cables. A damper-operating lever is outboard of each throttle quadrant.

(b) Each throttle lever has two stages of travel; the initial 5° movement forward actuates a micro-switch to open the electrically-actuated HP cock. Before any forward movement can be obtained a gate must be released. Once forward of the gate if it is desired to close the HP cock the gate must again be released before the lever can be returned.

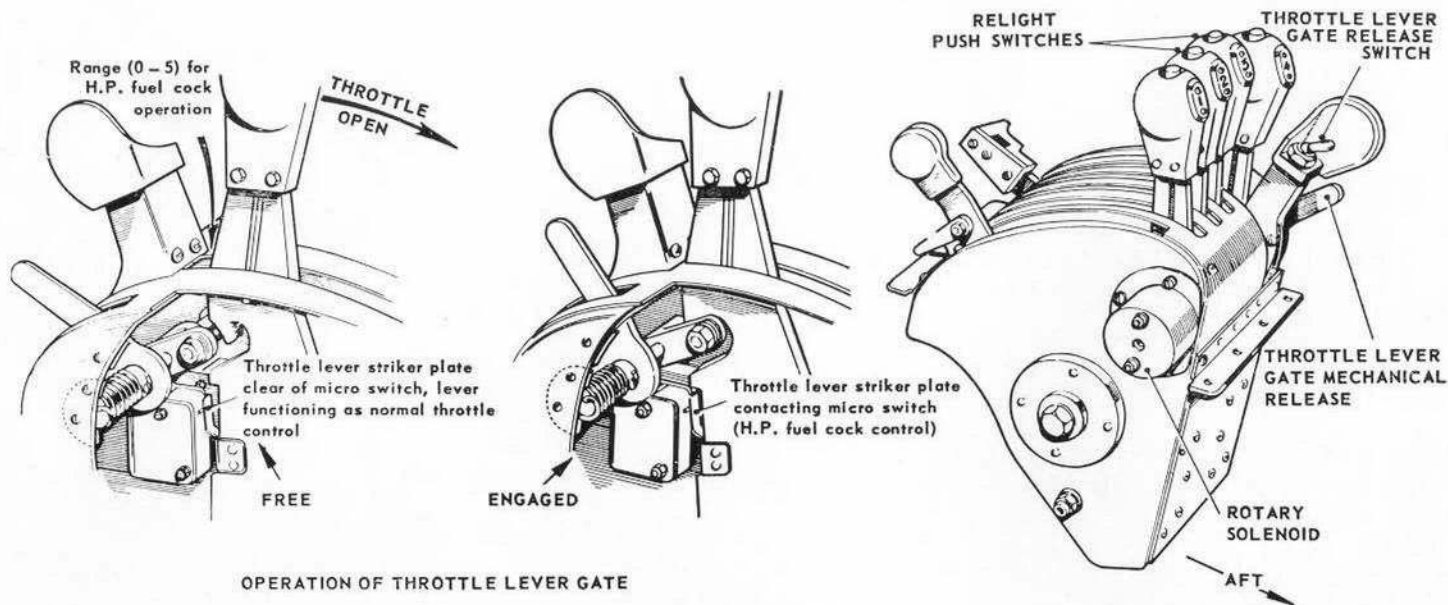


Fig. 2 Throttle controls

(c) The gate release mechanism is fitted only to the 1st pilot's quadrant but is controllable from either quadrant by means of a spring-return switch at the rear of each throttle box. A manual override lever, on the 1st pilot's quadrant, is fitted to meet the case of electrical failure. Mod 3645 introduces a guard to the mechanical trip lever to prevent inadvertent operation.

(d) Circuit breakers, one for each engine HP cock, are on panel AJ.

(e) Mod. 4020 introduces a visual indicator for the throttle gate lever. A white knob replaces the black knob on the lever and a second knob is provided at the inner face of the sleeve guard. When aligned the knobs provide visual and feel indication to the 1st pilot that the gate is engaged.

3 Starting system

(a) The starting controls are all grouped on the roof panel AL. The starter master circuit breaker is on panel AJ. Starting is effected by an electric starter motor which rotates its associated engine until light-up occurs and the engine becomes self-sustaining. For ground starting an external electrical supply is normally to be used.

(b) The starting controls comprise:

- (i) An ignition isolation switch
- (ii) A starter motor isolation switch
- (iii) An engine start selector
- (iv) A 3-position starter master switch; INT/GROUND/FLIGHT

- (v) A starter pushbutton
- (vi) A starter warning light
- (vii) A starter circuit breaker

(c) With the battery master, ignition and starter motor isolation switches ON, the appropriate engine selected, the starter master switch set to GROUND (INT for starting without an external electrical supply) the HP and LP cocks OPEN and booster pumps ON, the starter warning light will come on 3 seconds after the starter pushbutton is pressed.

(d) Initially the starter motor runs at low speed to ensure smooth engagement. The electrical current also causes the time switch to wind up and run. The speed of the starter motor is then progressively increased until it reaches full speed. After about 20 seconds the starter pushbutton hold-in solenoid is de-energised, at which time the engine should have reached a speed of about 17.5%. When the engine speed reaches approximately 30% RPM the next engine can be selected and started provided that a time of 36 seconds has elapsed from first pressing the starter pushbutton. The STARTER WARNING light then goes out.

(e) Irrespective of whether the engine has lit or not the time switch de-energises the circuit after 30 seconds running time and then runs for a further 6 seconds to reset the starting circuit.

◀(f) A mechanical interlock between the engine start selector switch and the pushbutton ensures that a further engine selection cannot be made until the existing starting cycle is completed. ▶

4 Relighting system

A relight button is incorporated in the top of each throttle lever on both quadrants. When pressed, with the starter master switch at FLIGHT, each one completes the circuit to the igniter plugs of the associated engine.

5 Engine instruments

Oil pressure gauges, one for each engine, are fitted on panel A. A percentage calibrated engine speed indicator for each engine, together with its associated jpt gauge below it, are also on panel A.

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