Chapter 8E AIR SYSTEMS - MISCELLANEOUS VALVES

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DESCRIPTION

GUN-PURGING VALVE

General information *(fig.1)*

1. The gun-purging valve is mounted in the hot-air supply pipe *(Chap.8C)* and, in normal operation, allows the passage of air to the anti-icing and de-misting services. When the guns are fired, the valve diverts the hot-air supply to the guns where it is employed to expel burnt gases. The complete unit consists of a valve body assembly, a piston and throttle assembly, and an electrically-operated control valve which is energized by the gun-firing circuit *(Sect. 6, Chap.1)*. A delay device prevents the valve closing immediately the gun trigger is released, and the time lag ensures complete purging of the guns.

Description

Valve body

2. The valve body is constructed in three parts assembled into a complete unit. The middle section is a sleeve with two rows of ports communicating with two annular ducts, which direct air from the ports to the anti-icing and gun-purging systems respectively; a conical poppet-valve seating is formed mid-way along the inner face. A flanged inlet coupling is screwed to one end of the sleeve. At the opposite end, a cylinder is screwed to the sleeve and secured by a locking screw; slots around the screwed end admit static pressure to one side of the piston of the assembled valve.

Piston and throttle

3. This assembly is enclosed in the valve body and is capable of limited axial movement; it comprises a poppet valve, a throttle sleeve, and a hollow piston, the last two items being a sliding fit in the body sleeve and body cylinder respectively. A bleed passage is drilled throughout the length of the assembly.

Control valve

4. The control valve is bolted to a flange on the open end of the valve body.

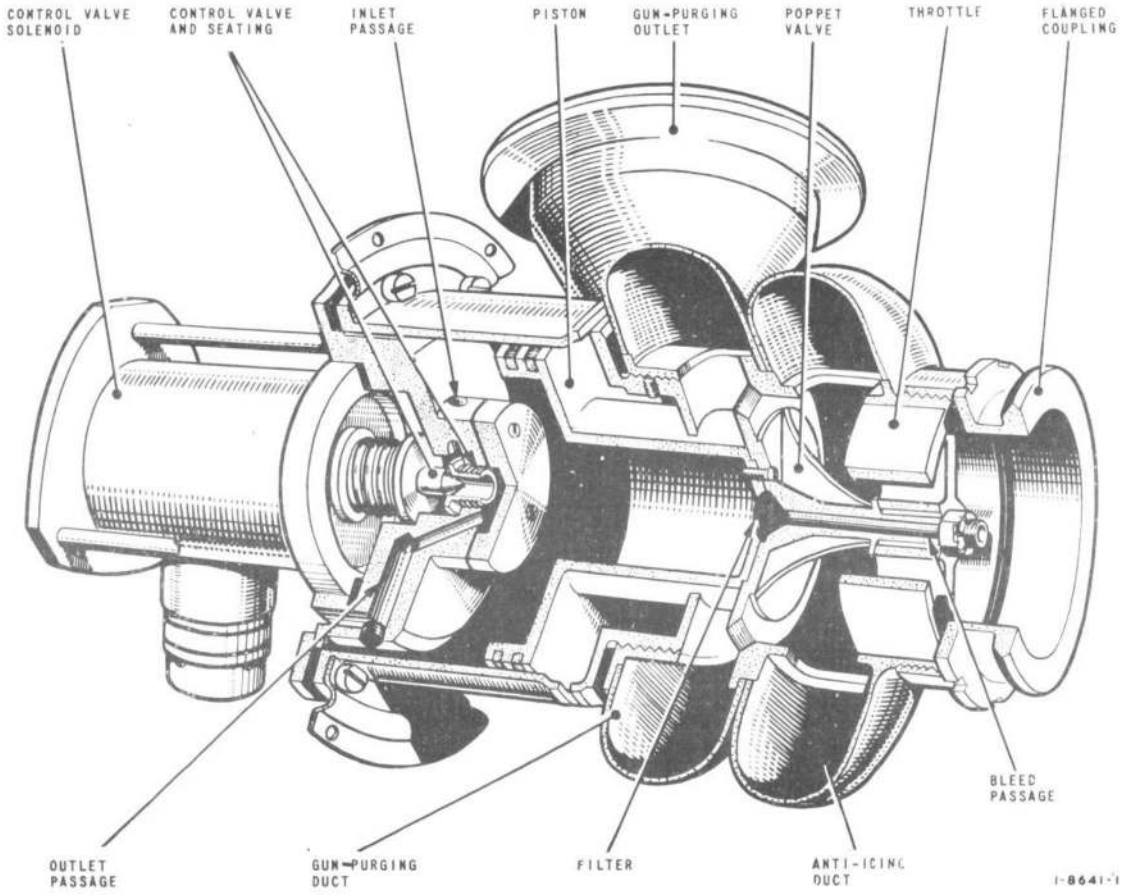

Fig. 1. Gun-purging valve

It consists of an enclosed solenoid the top cover of which contains a valve seat and a number of inlet and outlet passages; the passages are connected to the space behind the piston, and to the outside of the solenoid casing respectively. The solenoid armature incorporates a needle valve, and is spring-loaded to hold the valve in contact with the valve seat when the solenoid is de-energized thus isolating the inlet passages from the outlet passages. Electrical connections to the solenoid are made through a 2-pin plug on the solenoid casing.

Operation

5. When the aircraft engines are running, and the solenoid is de-energized, air under pressure enters the valve through the flanged coupling, a proportion of the air flows through the drilling in the piston and throttle assembly until a pressure balance is achieved. In this condition, total pressure on the piston exceeds the total pressure on the poppet valve; if the poppet valve is not already closed, the piston and throttle assembly will, therefore, move bodily towards the air inlet, closing the poppet valve and exposing the anti-icing ports in the valve body to permit air flow to the anti-icing system. When the guns are fired, the solenoid is energized and the control valve is withdrawn from its seat, permitting the pressure behind the piston to exhaust to atmosphere. Inlet pressure, acting on the poppet valve, then moves the piston and throttle assembly towards the control valve until the poppet valve contacts a stop in the valve body. The throttle covers the anti-icing ports and the air flows through the poppet valve port to the gun-purging ducts. When the gun trigger is released, a time delay mechanism, in the electrical circuit, prevents immediate de-energizing of the solenoid. The valve, therefore, continues to direct air to the gun breeches for a short period after firing has ceased, thus ensuring complete scavenging of the breeches. When the solenoid is de-energized the control valve closes and pressure builds up behind the piston to close the gun-purging supply and open the anti-icing supply.

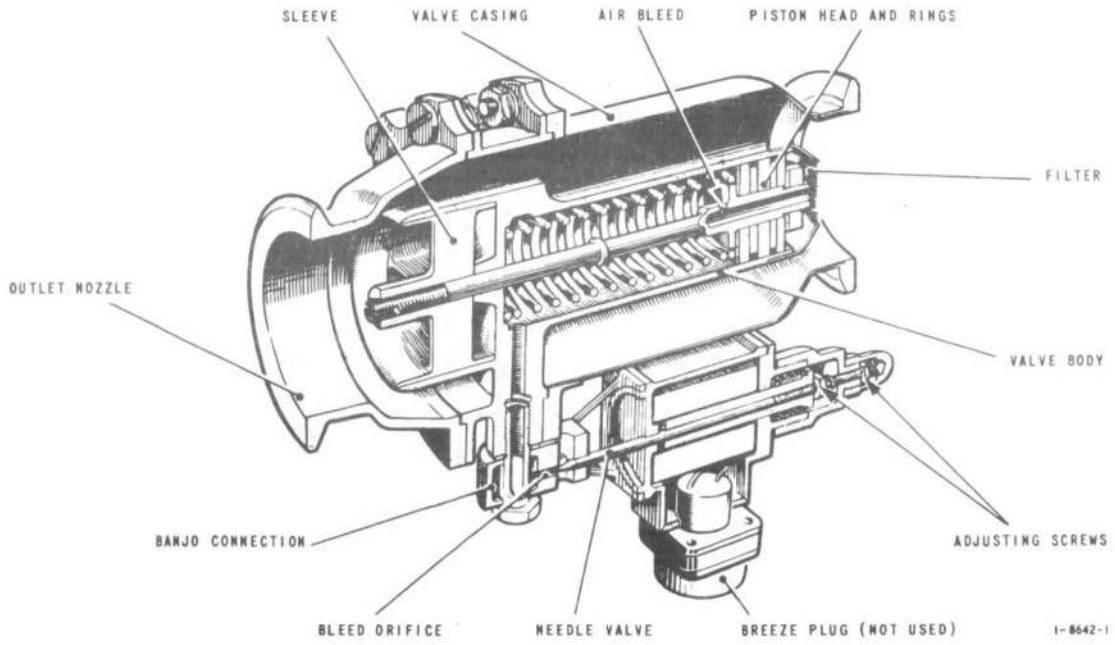

Fig. 2. Constant-flow valve

CONSTANT-FLOW VALVE

General information

6. The constant-flow valve is fitted in the air supply pipe to the gun-purging valve to regulate the mass flow of air to a constant value irrespective of upstream pressure, downstream restriction, or aircraft altitude. The valve operates automatically, except for a bleed system which is controlled by an electrically-operated needle valve to select either of two preset mass flow values. The lesser of these two

values is sufficient to supply either anti-icing and de-misting or the two upper guns. If, however, the gun pack is fitted and the number of guns increased to four, the larger mass flow is required for gun purging. In these conditions fitting the gun pack automatically connects the needle valve operating circuit to the gun firing trigger on the control column handle. The principal components of the valve are a valve body, a valve casing and a needle valve assembly.

Description *(fig.2)*

Valve body

7. The valve body is essentially a cylinder divided, by a transverse wall, into two chambers of differing lengths and diameters. The chambers enclose a spring-loaded piston and sleeve assembly, the spring and piston in the upstream chamber and the sleeve in the downstream chamber both connected by a rod passing through the transverse wall. Three webs, radiating from the valve body, support a flanged annular ring to which the two parts of the valve casing are bolted; when the valve is assembled the annular ring forms part of the casing.

Valve casing

8. The casing is in two parts flanged to match the body and incorporating coupling flanges for assembly into the air system. The downstream component is a profiled nozzle which, in conjunction with the sleeve, forms a variable-area restriction to air flow through the valve.

Bleed system

9. Two passages communicate with the piston chamber, one from the valve body inlet, through the piston rod, and the second through one of the radial support webs. The latter passage terminates at the bleed orifice of the solenoid-operated needle valve. The needle is so arranged that, when the solenoid is energized, it moves into the bleed orifice and decreases the bleed area.

Operation

Flow regulation

10. Air entering the valve flows through the annular chamber surrounding the valve body and out through the outlet nozzle. Air pressure acts on the piston head through the filter and some of this air enters the bleed system and vents to atmosphere through the bleed orifice. The bleed system maintains a constant pressure ratio across the piston for a given orifice size, thus making the spring the controlling factor. If inlet pressure increases, pressure on the piston compresses the spring and dis-

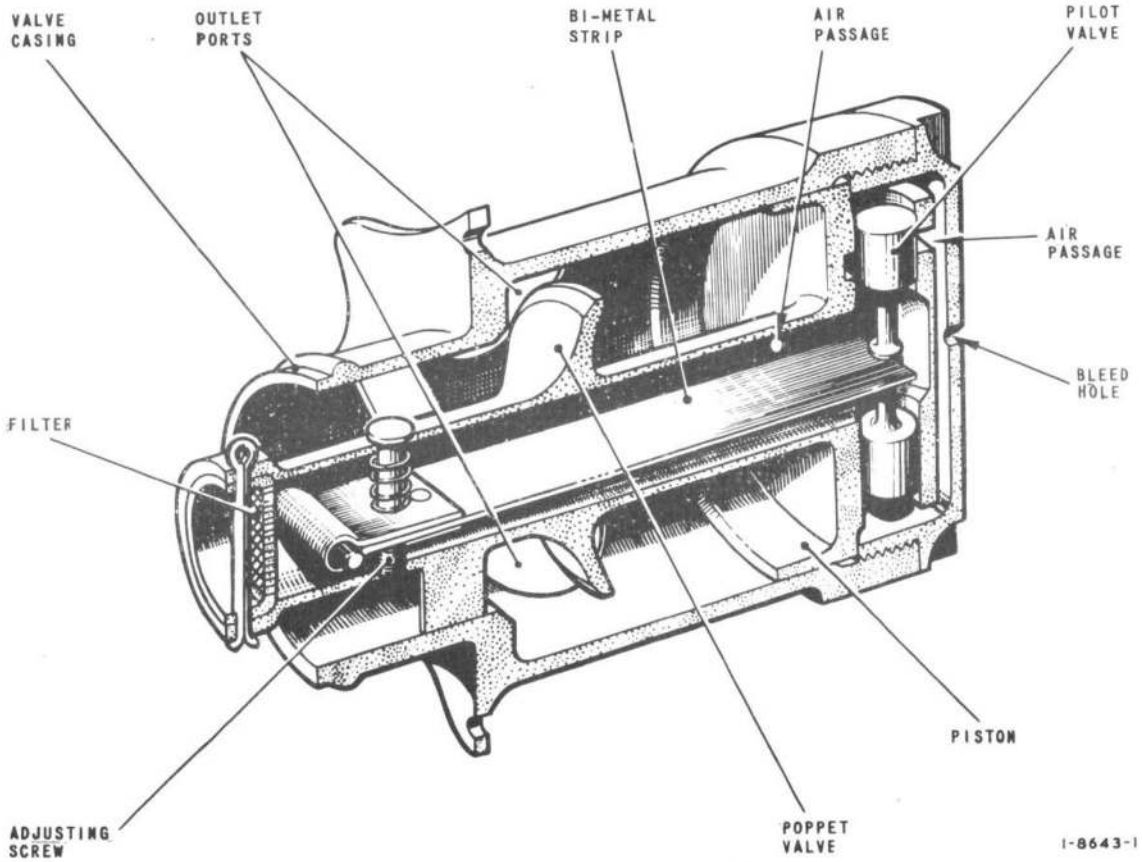

Fig.3. Cooling-air-temperature control valve

places the sleeve into the nozzle, so reducing the outlet area and preventing the increase in mass flow which would normally result from the pressure rise; a reduction in inlet pressure allows the spring to extend with the opposite effect.

Flow change-over

11. During normal operation of the air system, the needle valve is held back by its spring and the area of the bleed orifice is at its highest value; conversely, back pressure is at its lowest value. When the gun firing circuit is energized the solenoid pulls the needle into the orifice and reduces the bleed area, so increasing the back pressure on the piston. This withdraws the sleeve from the nozzle profile, and alters the datum about which the automatic operation takes place, to give increased mass flow from the valve during the period in which the guns are firing.

COOLING-AIR-TEMPERATURE CONTROL VALVE

General information

12. This valve is fitted to the end of the pipe conveying air to the equipment compartments; its function is to shut off the supply of ram air when the air temperature in the pipe exceeds 60 deg C, thus preventing overheating of the equipment. The valve is entirely automatic, air temperature being the controlling factor.

Description

13. The valve consists of a cylindrical casing, enclosing an automatic flow controller. The casing has an inlet duct at one end, and the other end is closed by a screwed cap with a centrally-disposed bleed hole; the wall of the casing is pierced by five circular outlet ports. The controller comprises a hollow stem embodying a poppet valve and a piston, the whole assembly being capable of axial movement within the casing. A rectangular block, formed on the piston head, is drilled throughout its length to accommodate a pilot valve. A central collar on the pilot valve stem is engaged by an adjustable bi-metal strip, extending through the hollow controller stem and fixed at the intake end. A slot in the piston head communicates with the controller stem but is blanked off by the pilot valve when the valve is in its open condition.

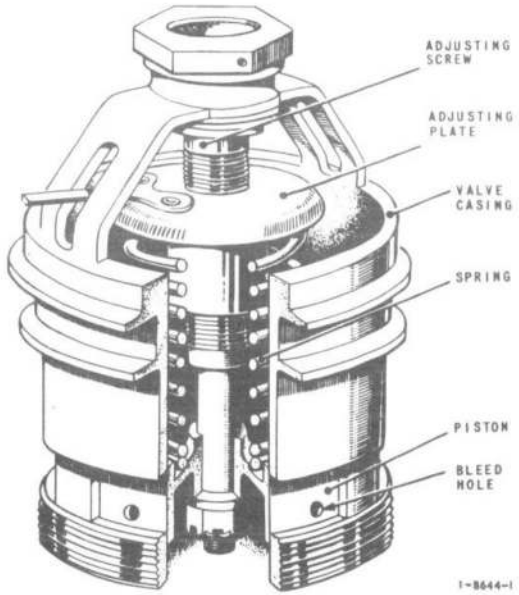

Fig. 4. Spill valve

Operation

14. When the air temperature is below 60 deg C, air enters the valve and passes between the poppet valve and its seat to exit through the outlet ports into the equipment bay. Some of the intake air enters the controller stem and vents into the main flow, downstream of the poppet valve, through an air passage in the stem, providing a constant flow of intake air over the bi-metal strip. When the temperature of the ram air is approximately 60 deg C, deflection of the bi-metal strip moves the pilot valve to expose the slot in the piston, allowing ram air to flow into the chamber behind the piston. The pressure differential across the piston will then cause the controller to move bodily until the poppet valve seats and shut off the air flow to the equipment compartments. The small flow of air over the bi-metal strip is maintained, however, so that a drop in air temperature will cause the strip to close the pilot valve. The air pressure behind the piston then disperses through the bleed hole, and inlet air pressure pushes the poppet valve off its seat, permitting a resumption in the flow of ram air to the equipment compartment.

SPILL VALVE

Description *(fig.4)*

15. The valve consists of a casing containing an adjusting screw, an adjusting plate, and a spring-loaded piston. The screw is free to rotate in the casing and, when rotated, causes the plate to move along the thread to increase or decrease pressure on the spring. The

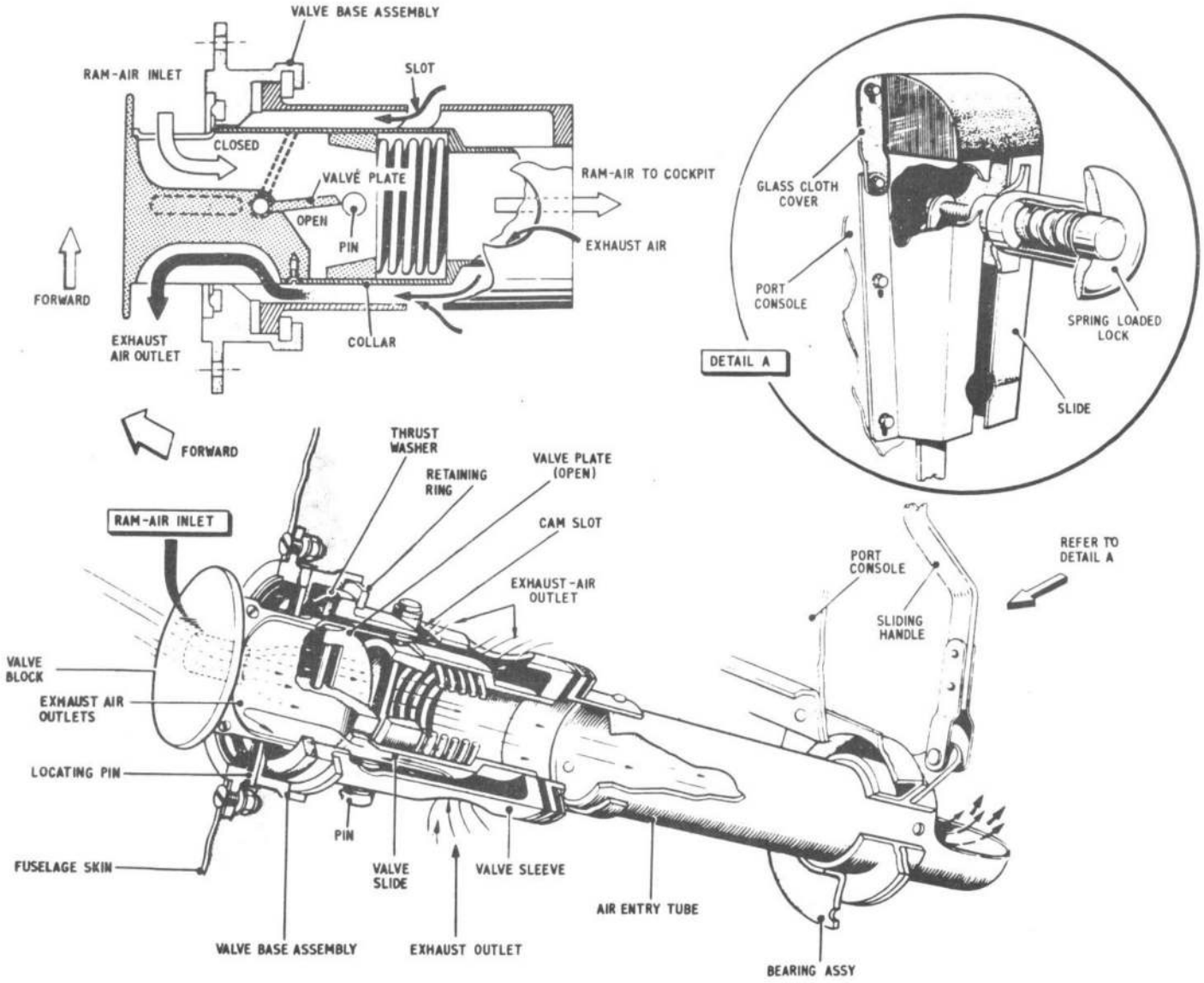

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FIG.5. EMERGENCY RAM-AIR VALVE

◀ REVISED TITLE ▶

piston is free to slide along the plainn portion of the screw against spring pressure.

Operation

16. When air pressure acting on the underside of the piston is less than spring pressure the piston closes off the ports in the casing wall; this shuts off the air supply to the equipment compartments with the exception of a small permanent bleed through the holes in the piston. When air pressure from the cold-air unit exceeds 5.5 lb/in^2, however, the piston is raised to permit overload air to enter the equipment cooling system.

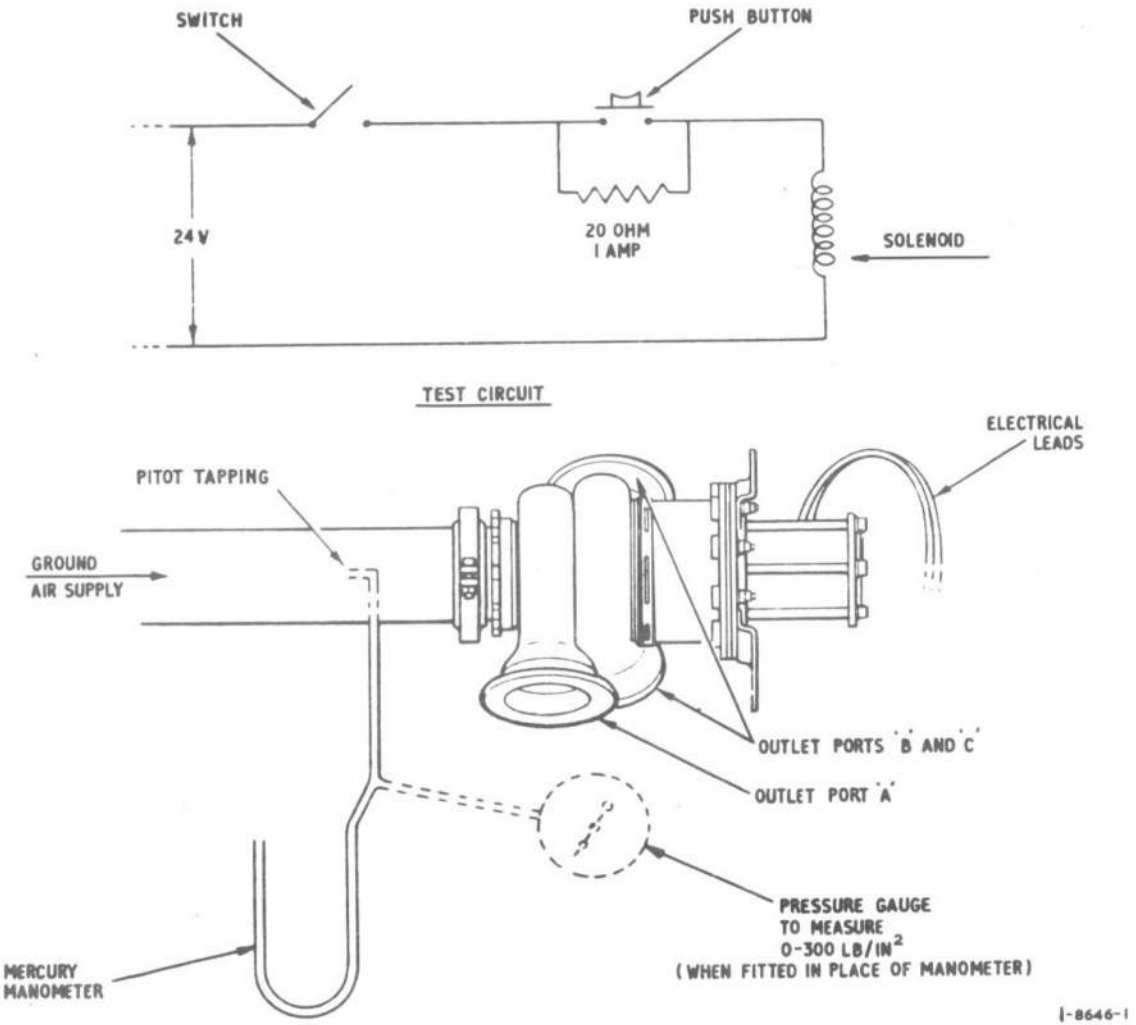

Fig.6. Gun-purging valve test procedure

◀ EMERGENCY RAM-AIR VALVE ▶

Description

17. The valve is installed in the port console so that, in the closed position, the outer end is flush with the aircraft skin, the inner end protruding into the cockpit. The valve consists basically of a sleeve containing a tubular slide capable of axial movement within the sleeve. Inlet air to the cockpit passes through the slide; air from the cockpit is exhausted through outlets in the valve sleeve which communicates with an annular chamber between slide and sleeve. Bolted inside the outer end of the slide is the valve block which forms the inlet and outlet ports, and also seals the cockpit when the valve is closed. A spring-loaded pin with a roller at each end passes transversely through the slide and engages a helical cam slot in the valve sleeve. The slide is restrained from rotary motion by two locating pins in the valve base which engage axial slots in the valve block. A freely-pivoted valve plate serves to close the inlet port when internal pressure exceeds atmospheric pressure. Bolted to the inner end of the valve casing is the air entry tube which carries a lever, pin-jointed to a sliding handle on the console diaphragm; the end of the tube is open to allow the passage of air to or from the cockpit.

Operation

18. Movement of the handle to the OPEN position rotates the air entry tube and valve sleeve in the valve base. The valve slide, prevented from rotating by the pins in the valve base, moves outward under the influence of the cam slot into the air stream. Air at ram pressure enters through the inlet port, and air from the cockpit leaves via the exhaust port. Should there be a large pressure differential between the cockpit and the outside atmosphere, the valve plate will close the inlet port so that cockpit pressure is relieved only through the exhaust port, thus regulating the rate of decompression.

SERVICING

◄ **WARNING**

The relevant safety precautions detailed on the LETHAL WARNING marker card must always be observed before entering the cockpit or performing any operations upon the aircraft.

Functioning checks

Gun-purging valve

WARNING

It being necessary to use air for pressurizing the valve during this test, the valve must be enclosed in a heavy cover so that, should the valve fail, air can escape without any fragment of burst metal injuring the operator.

19. Refer to fig.6 and proceed as follows:-

(1) Connect one side of a mercury manometer to a pitot tapping in the valve inlet pipe and the other side of the manometer to atmosphere.

(2) Blank off the outlet port 'A' and attach a cover plate, with a 0.5 in. dia. hole drilled through its centre, to each of the outlet ports 'B' and 'C'

(3) Connect an air supply to the valve inlet.

(4) Energize the solenoid, using the test circuit shown in fig.6, to avoid overheating the solenoid during the time it is in use.

(5) Turn on the ground air supply and gradually increase the pressure until the valve opens.

(6) Note the pressure at which the valve opens; this should not exceed 5 in. (pre Mod.4047) or 8 in. (post Mod 4047) of mercury.

(7) Turn off the air supply and check that the valve is fully open.

(8) De-energize the solenoid.

(9) Turn on the air supply and gradually increase the pressure until the valve closes.

(10) Note the pressure at which the valve closes; this should not exceed 4 in. of mercury.

(11) Turn off the air supply and check that the valve is fully closed.

(12) Disconnect the manometer and substitute a 0-200 lb/in^2 pressure gauge.

(13) At each of the following pressures, measured with the valve in the closed position, operate the valve three times and check that it is opening and closing satisfactorily.

45 lb/in^2

90 lb/in^2

135 lb/in^2

180 lb/in^2

20. The mass flow passing through the valve during this test should be such that the pitot pressure measured when the valve is open does not exceed 30 lb/in^2.

21. Remove the test equipment. ►