Chapter 8D AIR SYSTEMS - AUXILIARY AIR SYSTEMS AND EQUIPMENT COOLING SYSTEMS

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DESCRIPTION

AUXILIARY AIR SYSTEMS

General information

1. Air from the engine compressors is employed for pressurizing the fuel tanks and the hydraulic fluid reservoirs; it is also used to modify operation of the fuel tank vent valves and the stand-by generator isolating valve *(Chap.8A)*, and for driving the reheat fuel pumps. For details of its application to hydraulic, stand-by generator and fuel systems, refer to Chap.6, Chap.8A and Sect.4, Chap.2 respectively.

Air supply *(fig.2)*

2. Two auxiliary air system tappings are provided on each engine compressor at the 15th stage. One tapping delivers air to the associated reheat fuel pump turbine; the other supplies the fuel and hydraulic systems services. The latter supply flows from each engine through pipes incorporating non-return valves before combining in a T-connection at frame 47 on the port side. From this point, a common pipeline directs the air through a heat exchanger, a filter and two combined pressure-reducing/relief valves; all these components are located between frames 46 and 49. From the valves the air flow is divided to supply the fuel and hydraulic systems services. A tapping from the supply to the heat exchanger directs air to the stand-by generator isolating valve.

Heat exchanger

3. This unit is mounted in the fuselage between frames 47 and 48. Compressor bleed air is passed through the matrix of the heat exchanger to be cooled by exhaust air from the air turbine oil-cooler outlet *(para. 16)*.

Combined pressure-reducing/relief valves

4. Two combined valves are on the front face of frame 47. Each combination comprises a 17 ± 1 lb/in² pressure-reducing valve and a 19.5 lb/in² pressure-relief valve, the main body being the reducing valve with the relief valve screwed into the head.

Test connections

5. Three test connections, two for the pressure gauges and the other for the air supply are provided for ground servicing; they are accessible behind panel 63P.

Reheat fuel pumps

6. Two reheat pumps, one for each engine, are in the fuselage on the port side at frames 27 and 47 respectively. Each pump is driven by a two-stage air turbine controlled by an electrically-operated shut-off valve bolted to the engine compressor casing. Exhaust air is vented to atmosphere through the fuselage skin.

EQUIPMENT COOLING SYSTEMS

General information

7. Wireless, radar and electrical equipment in certain compartments in the fuselage is cooled by air obtained from one of two sources. Equipment in the front fuselage compartments is cooled by overload air from the cockpit

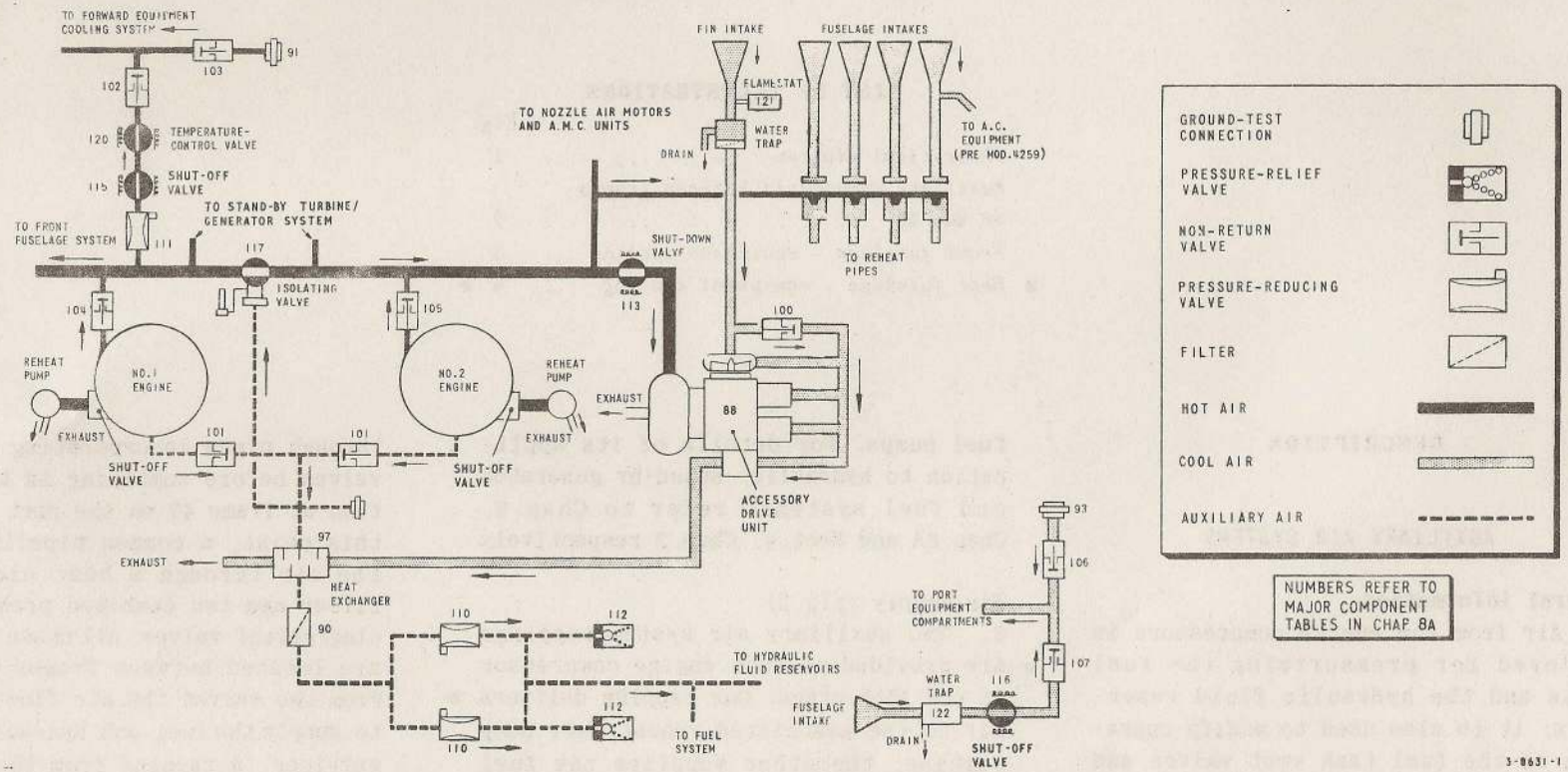

Fig. 1. Theoretical diagram

air system *(Chap.8B)* and that in the rear fuselage compartments by ram air. The electrical accessories driven by the air turbine, the turbine-oil cooler, auxiliary air and engine reheat jet pipes *(Chap.8A)* are all cooled by ram air. For descriptive purposes, the cooling systems are divided under the headings of front fuselage and rear fuselage.

Front fuselage equipment cooling

General information (fig.3)

8. Cooling air for the wireless and radar equipment in the main equipment compartment and spine compartments immediately behind the cockpit, is obtained from the cockpit air supply through a spill valve *(Chap.8B)*. The valve opens to admit air to the cooling system only after cockpit requirements have been satisfied. Cooling air temperature is regulated by mixing metered hot air from the main air supply *(Chap. 8A)* with cool air from the spill valve. Both supplies feed into a common duct from which three branch pipes direct air as described in para.9, 10, and 11.

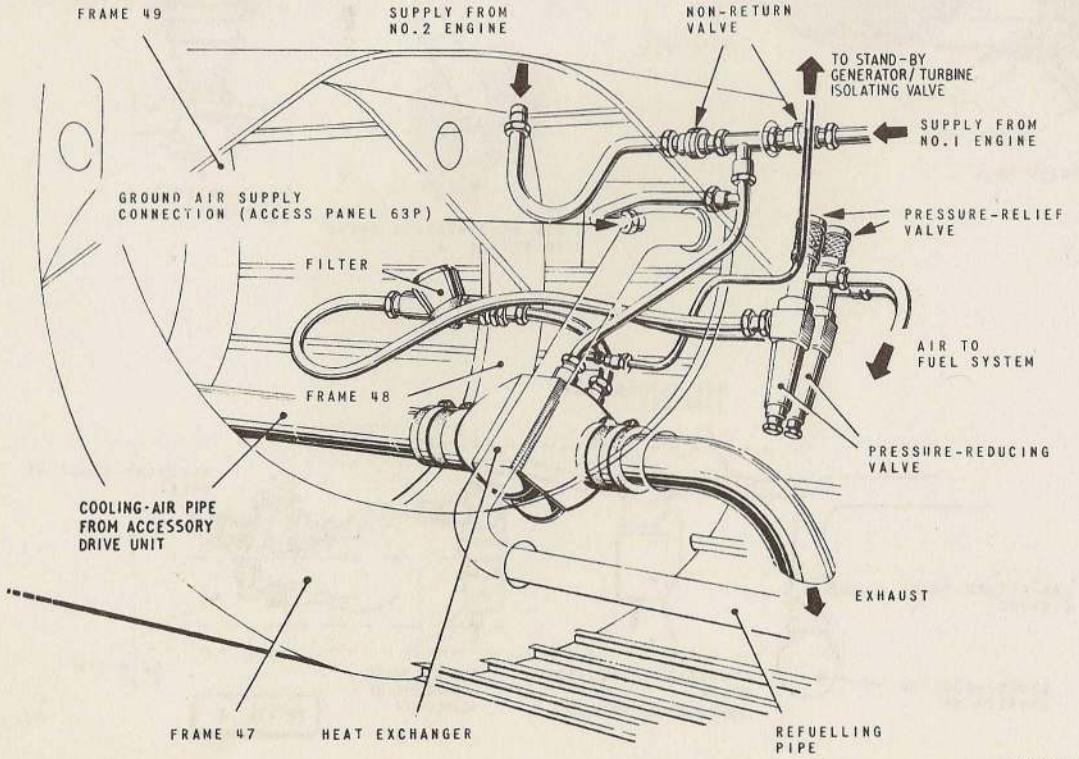

Fig. 2. Auxiliary components between frames 46 and 49

Note...

On post Mod.4259 aircraft, there is no cooling air supply to the a.c. equipment in the spine.

Branch pipes

9. The first branch pipe positioned mid-way along the duct between frames 20 and 21 is further divided into two, one supplying the U.H.F. and the stand-by U.H.F. units in the spine, and the other supplying the Data Link converter unit in the main equipment compartment.

10. The second branch pipe at the forward end of the duct between frames 18 and 19 directs the supply through a distribution box and a manifold to the M.R.G. unit in the main equipment compartment. The manifold has two outlet stubs, one of which (depending upon the type of unit installed) is blanked off by a removable blanking plug; with M.R.G. Mk.1 installed the outer stub of the two is blanked off, and with Mk.2, the inner stub. A tapping, upstream of the manifold, is joined to a temperature-sensing flamestat, and the distribution box houses a temperature-sensing ductstat.

11. The third branch pipe takes air from the distribution box and directs ◀ the supply to the three AI 23D units and the Tacan unit in the main equipment compartment. The supply passes to a manifold on the AI 23D marker and receiver unit mounting and a tapping directs air to the AI 23D gyro unit. A ▶ section of the branch pipe has a series of holes drilled in the top surface

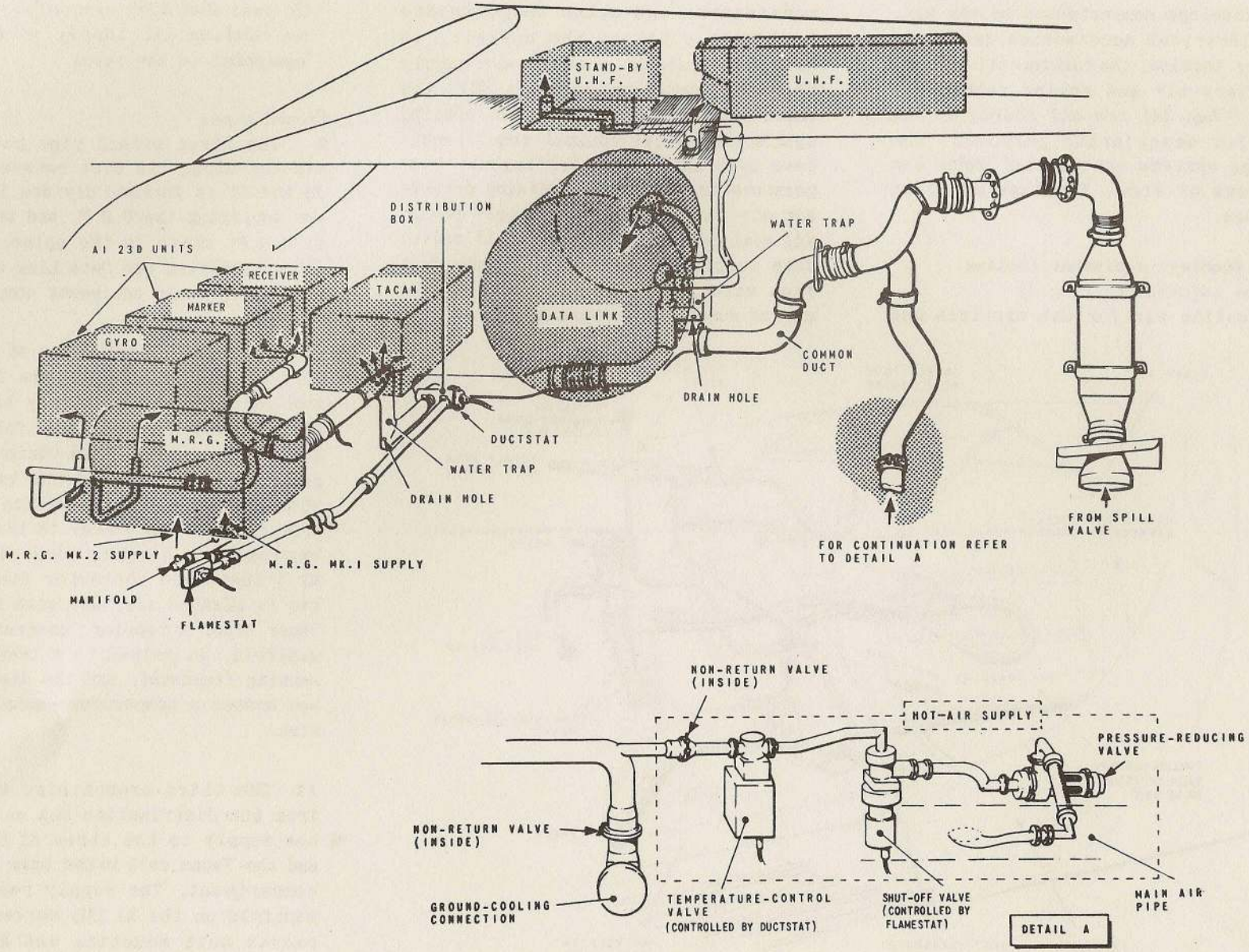

FIG. 3. FRONT FUSELAGE-EQUIPMENT COOLING

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through which air is sprayed on the Tacan unit.

12. The moisture content of the cooling air is reduced by two water traps formed by elbow joints in the Data Link supply and the AI 23D supply respectively. A ground cooling connection between frames 35 and 36 starboard side connects into the common duct between frames 22 and 23.

Cooling air temperature control

General information

13. Cooling air temperature is regulated by mixing hot air, tapped from the main air system downstream of the stand-by turbine isolating valve, with cool air leaving the spill valve. The hot air passes through a pressure-reducing valve, a shut-off valve, a temperature control valve and a non-return valve before entering the duct via the ground cooling tapping *(para. 12)*. The former three valves are similar to those described in Chap. 8B.

Temperature regulation

14. Temperature regulation is effected by varying the degree of opening or closing of the temperature control valve. The temperature is maintained automatically at 12 ± 6 deg C by an electrical system having primary and secondary control. The temperature control valve and the ductstat form the primary control system and the flamestat and shut-off valve the secondary. Should the cooling air temperature rise above, or fall below 12 ± 6 deg C the ductstat senses the temperature variation and the temperature control valve opens or closes accordingly. If a fault occurs in the primary system and the temperature rises to 35 deg C, the flamestat will operate to close the shut-off valve. When the temperature falls to 20 deg C the flamestat will operate to open the shut-off valve. For details of the electrical control system refer to Sect. 6, Chap. 6.

15. *Deleted.*

Rear fuselage equipment cooling

General information (fig. 4)

16. Air for cooling the a.c. and d.c. generators, the main air-turbine oil-cooler and the auxiliary air heat exchanger is introduced through an intake in the leading edge of the fin connected to a pipe around the starboard side of frame 54. A water trap with a drain to atmosphere is fitted between frames 53 and 54. The air flow is maintained during flight by ram pressure, and on the ground by a fan driven from the air-turbine gearbox. Should the fan become blocked, or the ram air intake pressure exceed impeller capacity, a by-pass pipe incorporating a non-return valve diverts air to by-pass the fan. From the fan or by-pass pipe air flows through the a.c. and d.c. generators and the air-turbine oil-cooler; it is then ducted forward to pass through the auxiliary air-to-air heat exchanger whence it is exhausted into the fuselage.

17. Air for cooling the I.L.S., I.F.F. and electrical equipment, located in four compartments between frames 49 and 53 on the port side, is taken from an intake on the side of the fuselage and directed through a water trap, a shut-off valve and a non-return valve, to a common duct. From the duct three branch pipes supply cooling air to the compartments; a fourth branch pipe, incorporating a non-return valve, is joined to a ground cooling connection between frames 51 and 52 on the port side. For descriptive purposes the four compartments divided by frames 50, 51 and 52 are numbered 1 to 4 respectively.

18. From the common duct *(para. 17)* compartments 1, 2 and 4 are supplied with cooling air by the branch pipes. Compartment 2 serves as a collector box and has a flap valve through which all cooling air is exhausted into the fuselage. The air from compartment 4 passes into compartment 3 and via a transfer pipe to compartment 1. From compartment 1 all air passes into compartment 2.

Air shut-off valve

19. This butterfly-type valve is operated to either of two positions – open or closed – by a rotary electric actuator controlled by the flamestat *(para. 20)*. The shut-off valve is fitted at the outlet side of the water trap whilst the actuator is mounted on the aft face of frame 52, the two components being linked by a connecting pin. The valve is closed when an indicator, on the outboard side of the actuator, reads 0 deg and is open when 90 deg is registered. The indicator can be seen after removing a small access panel just aft of the air intake *(para. 17)* and the assembly is accessible through No. 2 engine hatch.

Compartment air-flow control (fig. 4)

20. The supply of cooling air to the four equipment compartments is governed by the air shut-off valve and controlled automatically by a temperature sensing

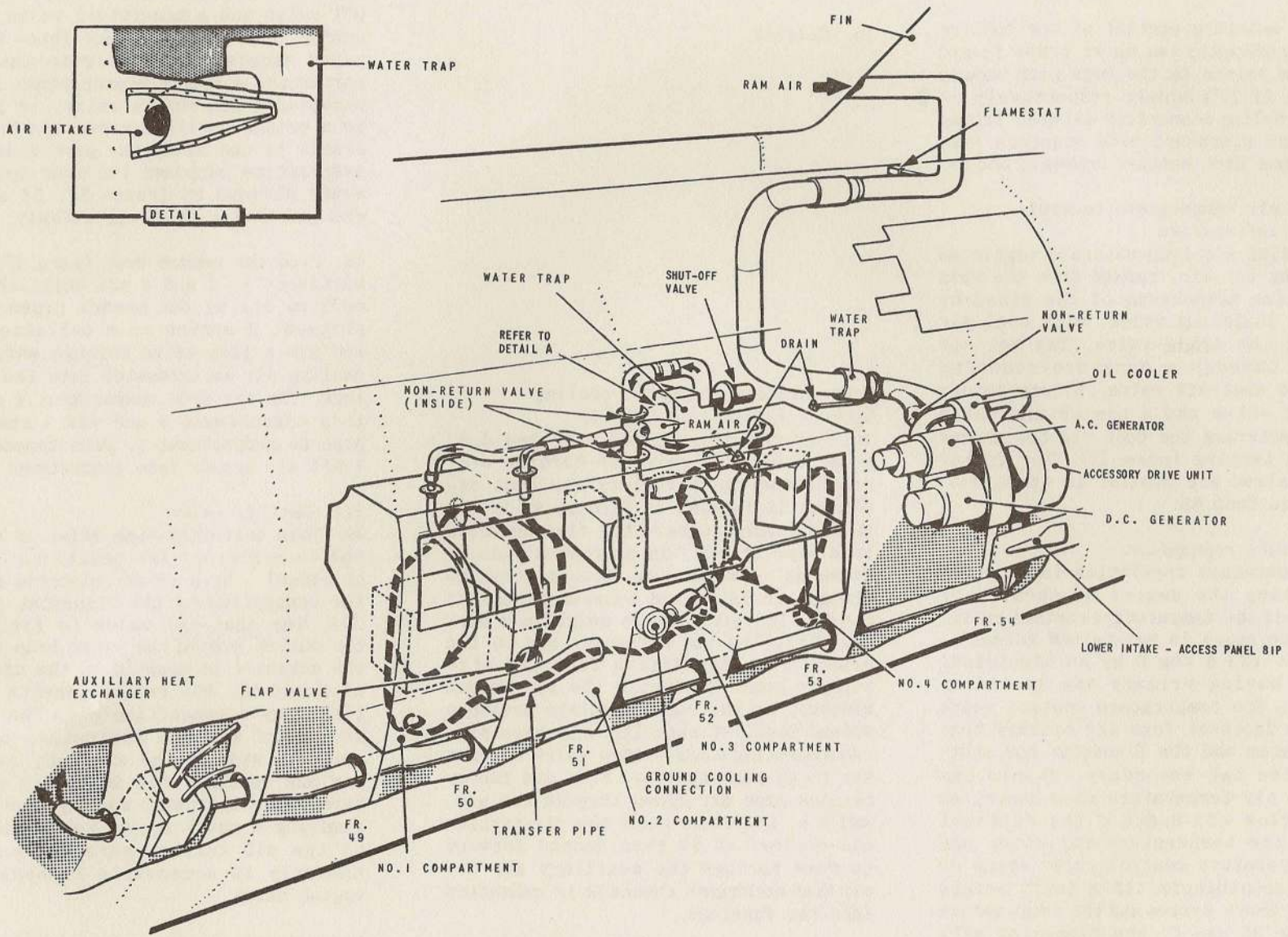

FIG. 4. REAR FUSELAGE-EQUIPMENT COOLING

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flamestat inserted in the ram-air pipe from the fin. Should the ram-air temperature in the fin pipe exceed 75 deg C the flamestat trips and the shut-off valve closes. The valve opens when the temperature falls below 65 deg C. For details of the electrical system refer to Sect.6, Chap.6.

Reheat jet pipe cooling

21. The engine reheat jet pipes are double-skinned and the inner skins are covered with insulation blankets. Ram air is introduced to the interspaces through four intakes in the fuselage skin, *(Chap.8A)*, one port and one starboard for each jet pipe. During ground running, cooling air flow is induced by hot air injected into the intake ducts through a tapping from the main air pipe *(Chap.8A)*.

▶◀

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.

FRONT FUSELAGE EQUIPMENT COOLING

General information

22. Mod.4060 introduces a counter and push button control into the front fuselage equipment cooling systems *(para. 14)*. This provides facilities for after flight system monitoring and also permits a serviceability check of the system to be carried out during an engine ground run. The counter and push button are fitted on the cockpit aft pressure bulkhead.

Test procedure

23. To check the serviceability of the primary system proceed as follows:-

(1) With engines running and a.c. and d.c. power ON, check that the counter does not register.

Note...

If no counts are registered the system is either normal or failed shut. If the counter registers continuously at approximately three counts per minute, the primary system has failed and the secondary system is operating normally.

(2) Operate the push button and check that the counter registers.

Note...

If counts are registered the system is serviceable. If no counts are registered the system is either electrically or mechanically defective.

General use of digital counter

24. Apart from its use in testing *(para. 23)*, the digital counter can be used to monitor the operation of the system. By monitoring the digital counter after each flight, or after a specified series of flights, a ready guide to system performance can be obtained as follows:-

(1) *Tropical climates (above 95 deg F)*

(a) No counts registered for up to three successive flights:- The system is probably failed shut. Carry out the test procedure *(para. 23)*.

(b) Up to ten counts per flight:- It may be assumed that the system is operating normally.

(c) More than thirty counts per flight:- It is almost certain that the primary system has failed open. Carry out the test procedure *(para. 23)*.

(2) *Temperate climates (below 95 deg F)*

(a) No counts registered for up to three successive flights:- The system is probably failed shut. Carry out the test procedure *(para. 23)*.

(b) Up to three counts per flight:- It may be assumed that the system is operating normally.

(c) More than four counts per flight:- It is almost certain that the primary system has failed open. Carry out the test procedure *(para. 23)*.