BRISTOL SIDDELEY

AERO ENGINE SCHOOL

SECTION 6
AIR SYSTEMS

6.1 ENGINE AIR SYSTEM

6.2 ENGINE BAY VENTILATION

6.3 ENGINE ANTI-ICING

6.1 ENGINE AIR SYSTEM

INTRODUCTION

The engine air system fulfils the following purposes :-

Pressurization of constant speed unit oil tank and bulkhead seals.

Pressurization of fuel tanks and fuel recuperators.

Hot air supply to aircraft services.

Hot air supply to fuel heater.

Engine cooling system.

Inducer cooling air to the alternator, constant speed unit oil cooler and zone 2B.

Engine breathing system.

Engine bay ventilation.

Engine anti-icing.

Pressurization of Bearing Seals

To minimise the loss of oil from main bearings the seals are pressurized; l.p. compressor delivery air tapped from the intermediate casing is utilised to pressurize these seals, with the exception of the 2nd stage turbine bearing rear seal which is supplied from the h.p. compressor.

Delivery air flows through the space between the 5th stage l.p. compressor rotor disc and the intermediate casing front diaphragm into an annular chamber to pressurize the l.p. compressor rear bearing seal. To pressurize the l.p. compressor front bearing seal, air passes from the chamber through ports in the l.p. compressor driving rotor discs to the bearing and oil separator seals in the air intake casing.

The h.p. compressor front bearing seal is pressurized by 5th stage l.p. compressor delivery air passing into an annular chamber formed by the

intermediate casing ....

intermediate casing rear diaphragm and the h.p. compressor 1st stage rotor disc. Air from this chamber flows through the ports of the h.p. compressor front rotor disc into an annular chamber and through the bore of the rotor discs to the h.p. compressor rear bearing seal. Air flowing through ports in the h.p. compressor rear bearing seal passes into the delivery casing diaphragm annulus and is then carried by a pipe through the turbine bearing support to pressurize the 1st stage turbine bearing seal.

The 2nd stage turbine rear bearing seal is pressurized from a tapping on the h.p. compressor casing; air from the 3rd stage stator blades passes through to an elbow on the casing and is piped to the exhaust annulus, thpough No.1 vane to the rear diaphragm cone; it then passes through the diaphragm cone and ports in the bearing housing to the bearing seal.

Pressurization of Constant Speed Unit Oil Tank and Bulkhead Seals.

5th stage l.p. compressor delivery air enters an aperture in the front face of the intermediate casing diaphragm and flows through No.1 vane to the banjo of the air supply connection; air is then piped externally to the oil tank which is secured to the intermediate casing on the starboard side of the engine; the air enters the oil tank through a banjo union on the valve housing. Air is also utilised from this banjo union to pressurize the front and rear bulkhead seals; it is piped to the seal inlet valve at the base of each seal.

Pressurization of Fuel Tanks and Fuel Recuperators.

H.P. compressor delivery air enters the apertures in the delivery casing diaphragm and flows through No.3 vane into the inducer elbow of the alternator and constant speed drive unit cooling ducts. The fuel tanks and recuperators are pressurized from a tapping

on the inducer ....

on the inducer elbow.

Hot Air Supply to Aircraft Services

H.P. compressor delivery air passes through apertures in the delivery casing diaphragm, into No.2 vane and then into the duct elbow from which it is ducted forward through a non-return valve to the hot air valve fitted on the starboard side of the intake casing. When the valve is open it allows hot air to flow to the aircraft for the following services :-

Cabin pressurizing

Cabin heating

Cabin air conditioning

Wing and fin anti-icing

Portions of this ducting are also used for conveying air to the engine starter unit.

Hot Air Supply to the Fuel Heater

H.P. compressor delivery air passes through apertures in the delivery casing diaphragm and through No.7 vane to the elbow on the casing. Air then flows through the fuel heater supply pipe to the front of the engine where it is directed to the aircraft fuel heater.

Engine Cooling System

Turbine discs

The front and rear cases of the 1st stage turbine disc and the front face of the 2nd stage turbine disc are cooled by h.p. delivery air. The air enters apertures in the seal housing support of the delivery casing and flows through three turbine air feed pipes to the bearing diaphragm; it is then piped through the turbine bearing support drum to discharge, through three apertures, on the front face of the 1st stage turbine disc.

The outer portion of the 1st stage turbine disc rear face is cooled by air from the annulus in front of the disc, flowing through ports in the disc into the chamber enclosed by the disc rear face and the

inter-stage diaphragm ....

inter-stage diaphragm. This air flows outwards across the disc face and exhausts into the turbines.

To cool the inner portion of the 1st stage turbine disc rear face and the 2nd stage turbine disc front face, air passes through ports in the 1st stage turbine shaft hub and into the space between the turbine shafts to pass into the annular chamber between the faces of the turbine discs. The air flows outwards across the 2nd stage disc front face and exhausts into the turbines.

The supply of air used to pressurise the 2nd stage turbine rear bearing seal is also used to cool the rear face of the 2nd stage turbine disc and the front face of the bearing housing. The air flows through the bearing housing and the wheel hub air cover on to the rear face of the 2nd stage turbine rotor disc and exhausts into the jet stream immediately after the 2nd stage turbine. A smaller supply of air from the same source is directed between the rear face of the bearing housing and the diaphragm cone, passes through ports in the rear face of the diaphragm cone into the vanes of the exhaust annulus and is then exhausted through holes in the trailing edge of the vanes into the jet stream.

Combustion chambers, casings and turbine casings

Compressor delivery air flowing through the annulus of the combustion system cools the skins of the combustion chambers and casings, flows rearwards through ports in the turbine casing and exhausts into the jet stream at the rear of the 2nd stage turbine wheel.

Inducer Cooling Air to the Alternator, Constant Speed Unit Oil Cooler and Zone 2B

H.P. compressor delivery air enters apertures in the delivery casing diaphragm and passes through No. 3 vane and the inducer elbow to the inducer control valve. The valve, when opened, causes an inducer to operate, in the constant speed drive unit oil cooler ducting, in the alternator outlet.....

alternator outlet cooling duct and also in zone 2B. A pipe from the control valve carries air to the inducer in the oil cooler outlet duct and a tapping from this inducer conveys air to the inducer in the alternator cooling outlet duct. Zone 2B is cooled by air piped from a tapping below the control valve, passing through the rear bulkhead to discharge from the inducer into zone 2B.

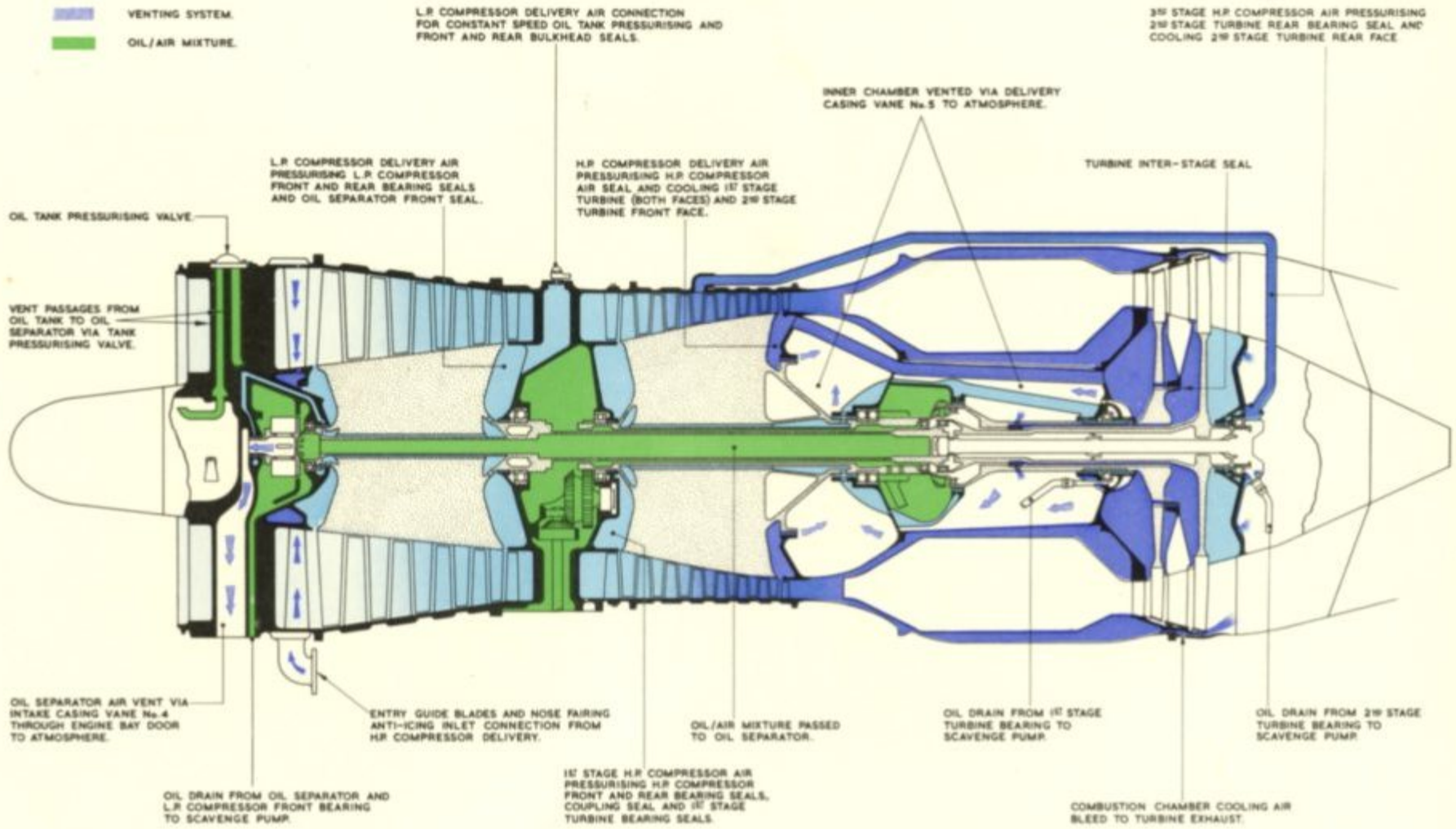
Engine Breathing System

Pressurised oil and air mixture from the engine oil tank in the nose bullet is vented to No.6 vane of the intake casing. At the outer end of the vane is the tanks pressurizing valve; when the pressure in the tank exceeds 2 lb/in^2 the valve opens and allows the mixture to flow through a second passage in the vane to the oil separator. The air is then vented to atmosphere via No.4 vane and the main engine breather outlet. When the pressure is less than 2 lb/in^2 the mixture by-passes the pressurizing valve via a vent hole in the valve housing and enters the second passage in the vane to the oil separator and then to atmosphere.

The mixture of oil and air from the intermediate casing gear chamber, delivery casing coupling chamber, compressors and inter-shaft bearings, flows through ports into the hollow l.p. compressor shaft and passes to the front of the engine into the oil separator; it then flows through No.4 vane of the intake casing and is ducted rearward to be discharged to atmosphere through the main engine breather outlet. The oil and air mixture from the 2nd stage turbine bearing passes into the hollow 2nd stage turbine shaft and flows forward to the end of the shaft in the delivery casing where it is ducted via the coupling to the inter-stage bearing and through the l.p. compressor shaft to be vented to atmosphere with the other mixtures.

Air from the .....

Air from the seals of the 1st stage turbine bearing, the 2nd stage turbine air seal and the 1st stage turbine shaft coupling seal discharges into the turbine bearing support drum; the air then passes through the apertures of the delivery casing diaphragm to augment the air from the h.p. compressor rear seals and the h.p. compressor rear bearing seal; the whole volume of air from these seals then passes through No.5 vane of the delivery casing to a vent pipe on the casing which directs the air to atmosphere via the main engine breather.



AIR SYSTEM DIAGRAM
BRISTOL SIDDELEY OLYMPUS 201 TURBOJET

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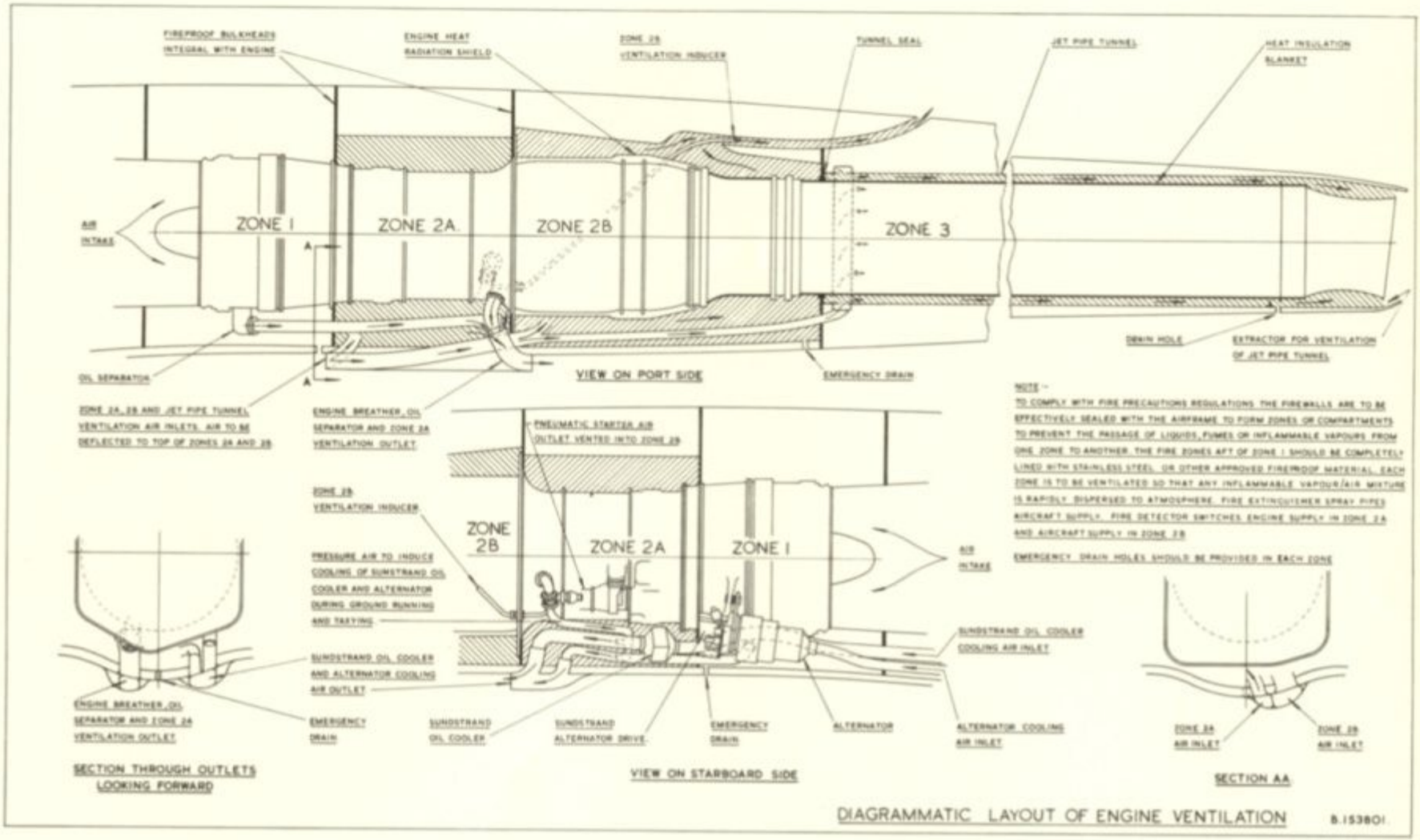
6.2 ENGINE BAY VENTILATION

Zone 1, forward of the front bulkhead, contains the intake casing and l.p. compressor casing. The cooling air inlet ducts of the alternator and constant speed drive unit oil cooler pass through the bottom of this zone.

Zone 2A is the compartment between the two bulkheads which contains the fuel system; this zone is ventilated by ram air, ducted from intakes fitted beneath the exterior of zone 2A engine bay doors being directed to the top of the zone and discharged to atmosphere by the induced action of the main engine breather. The oil separator is also vented from this zone; air from the separator flows through No.4 vane of the intake casing and is ducted rearward to be discharged to atmosphere through zone 2A and the main engine breather outlet duct.

Aft of the rear engine bulkhead is zone 2B; this compartment contains the combustion chambers, turbines and exhaust annulus. Ventilation of this zone is by ram air (ducted from intakes fitted beneath the exterior of zone 2A engine bay doors), entering the compartment and directed to the top where it is discharged to atmosphere through an outlet duct. To ensure efficient ventilation of zone 2B during ground running and taxying induced pressure air, bled from No.3 vane of the delivery casing, is piped to the zone ventilation outlet duct.

Zone 3 is the zone containing the jet pipe tunnel; it is ventilated by ram air, ducted from intakes fitted beneath the exterior of zone 2A engine bay doors, directed around the circumference of the jet pipe and exhausted at its rear end. To ensure a flow of air during ground running or taxying the outlet end of the jet pipe tunnel is shaped to give extractor action.

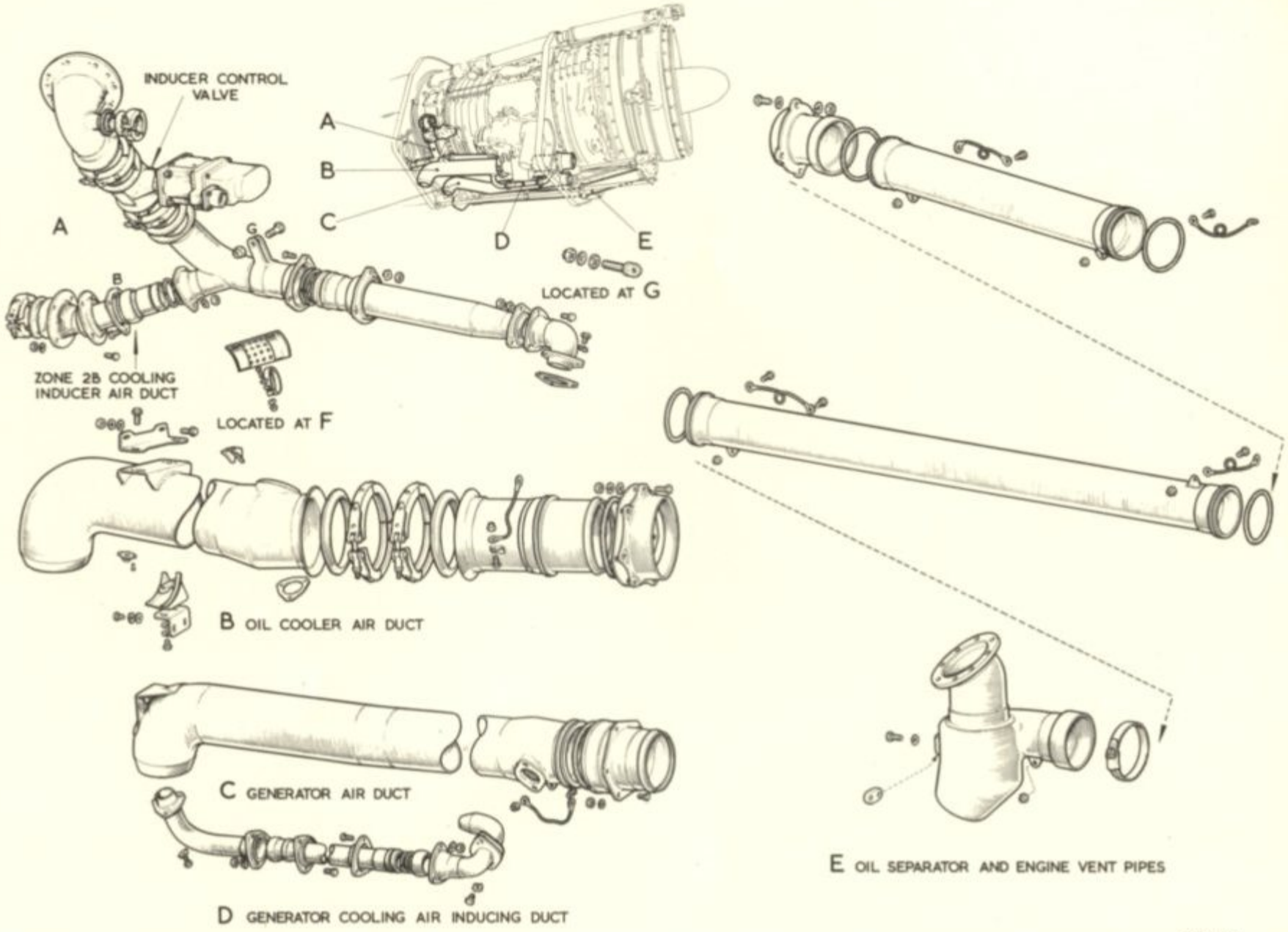


DIAGRAMMATIC LAYOUT OF ENGINE VENTILATION 8.153801.

6.3 ENGINE ANTI-ICING

H.P. compressor delivery air is used to protect the air intake nose bullet and its integral oil tank, the intake guide vanes, pitot and entry guide blades from icing. The hot air passes through No.6 vane of the delivery casing and is then ducted externally to a hot air valve mounted on the l.p. compressor casing This valve is operated by an electrical actuator controlled from the aircraft cockpit; when it is in the open position, hot air passes into the anti-icing collector manifold and through the entry guide blades to the annulus at the rear of the inner casing. The air then flows through the internal passages of the casing to the nose bullet then forward between the bullet and the oil tank and through an aperture at the leading edge of the bullet inner skin to heat the outer skin on its rearward journey to the bullet rear face. Ports in the air intake inner casing front face receive the hot air which then flows into the intake guide vanes from which it is exhausted into the engine air intake.

The pitot head, situated in front of the leading edge of No.4 intake guide vane is heated by air tapped from the air pipe between the valve and front bulkhead; this flexible pipe carries air to the pitot head base through the pitot head to vent, through holes into the air intake.



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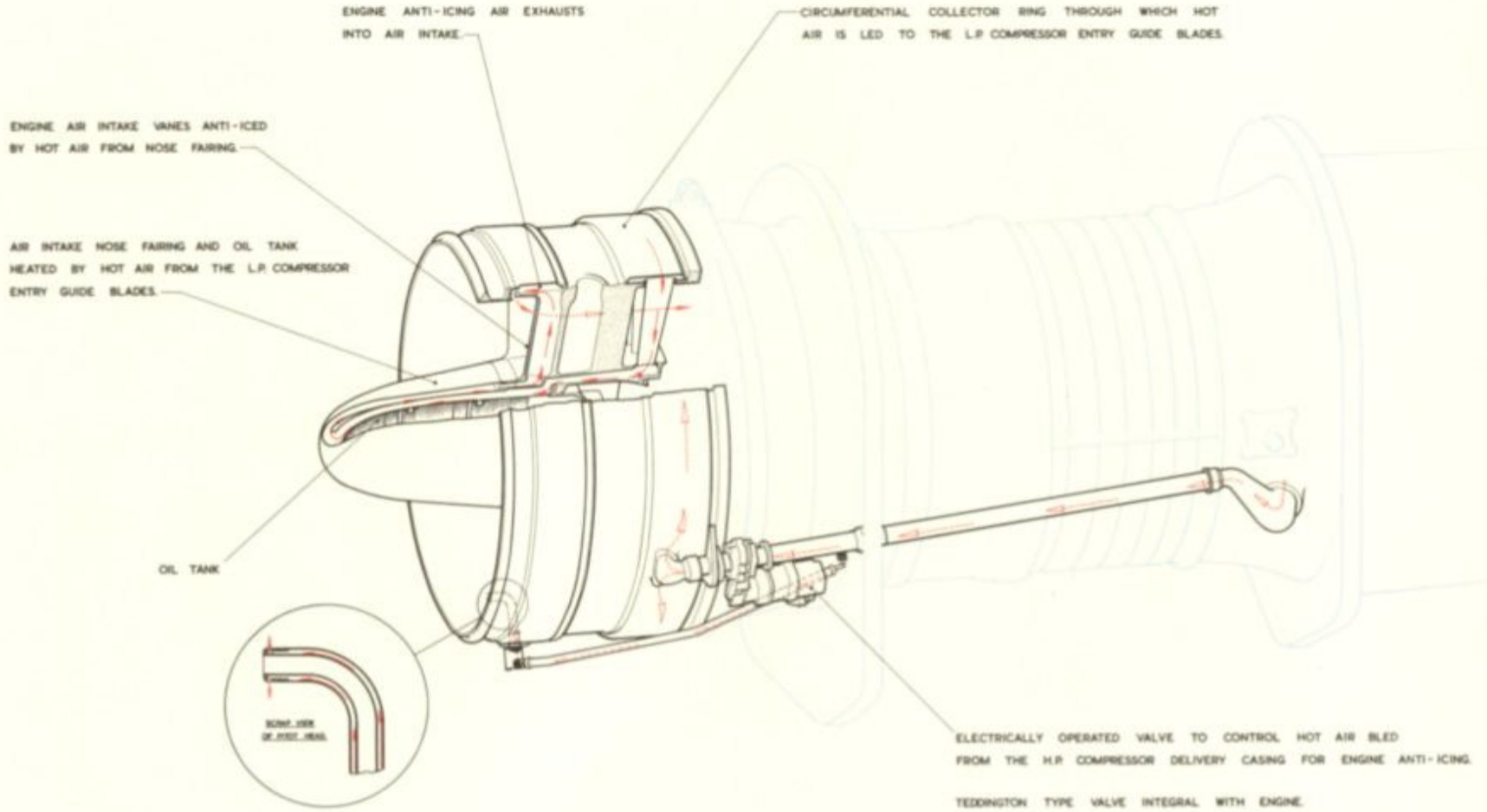
COOLING AIR SYSTEM



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ENGINE ANTI-ICING SYSTEM

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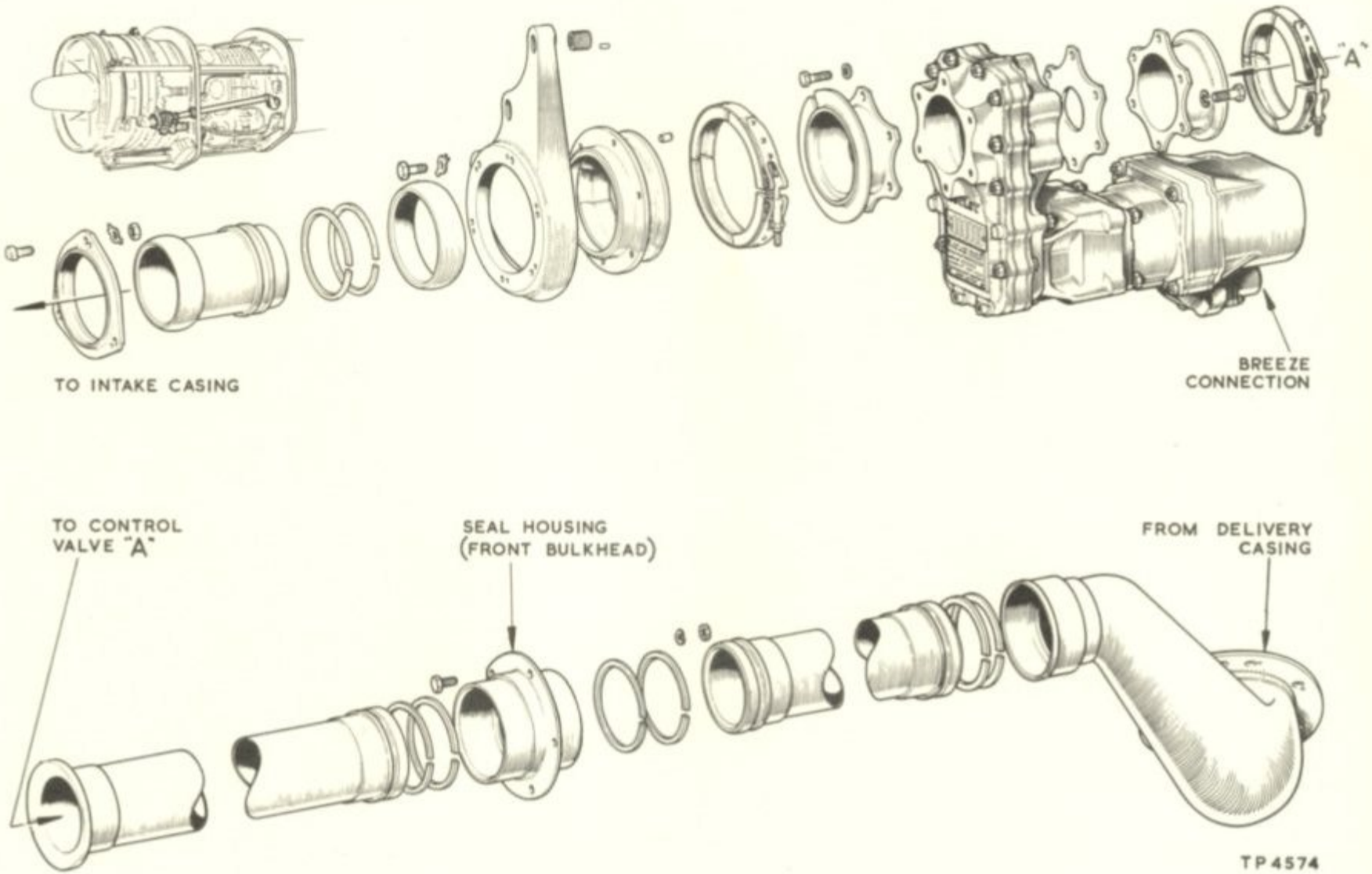
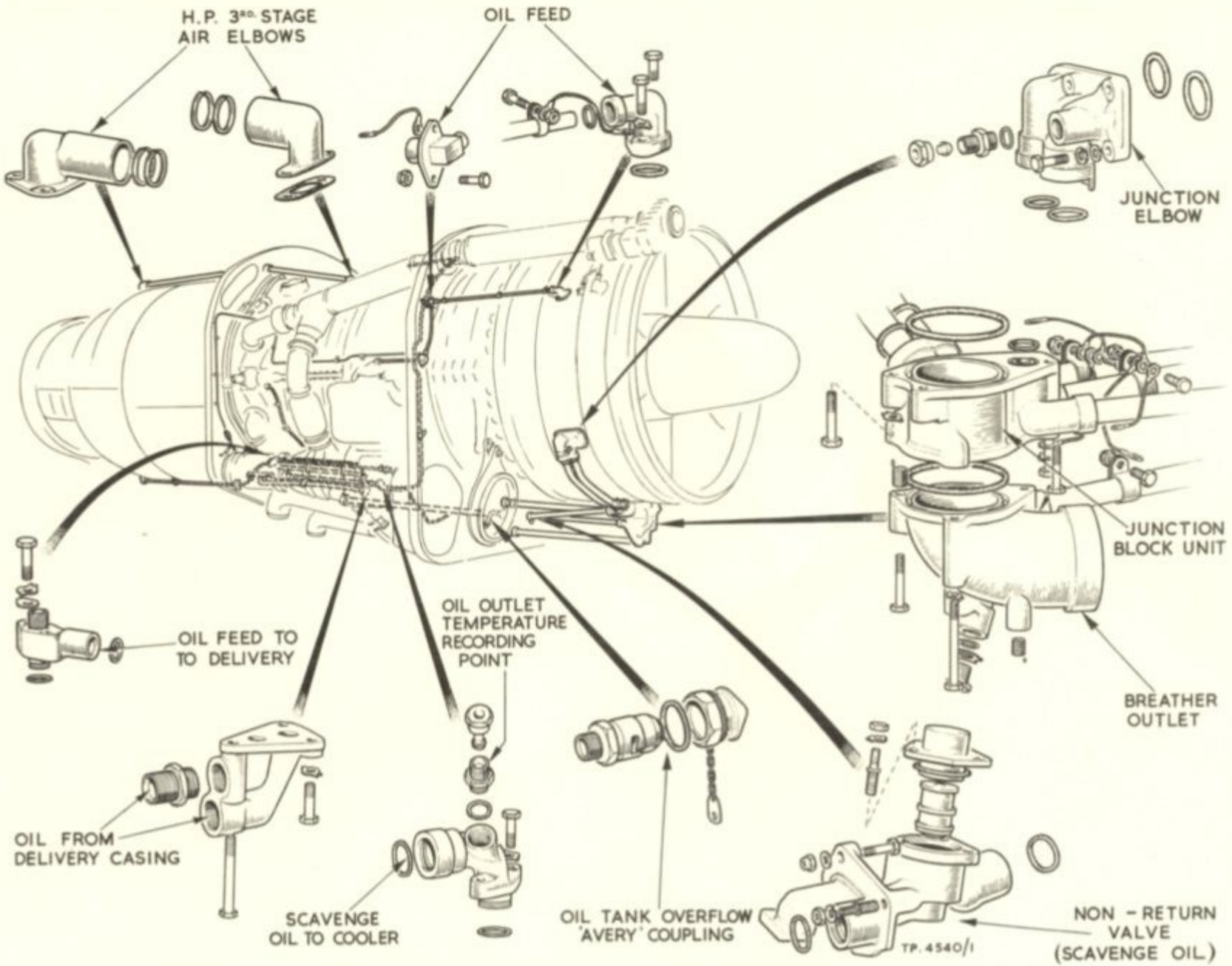


ANTI-ICING EQUIPMENT



COOLING AND LUBRICATION