

TYPICAL AIR BLEED GAS TURBINE

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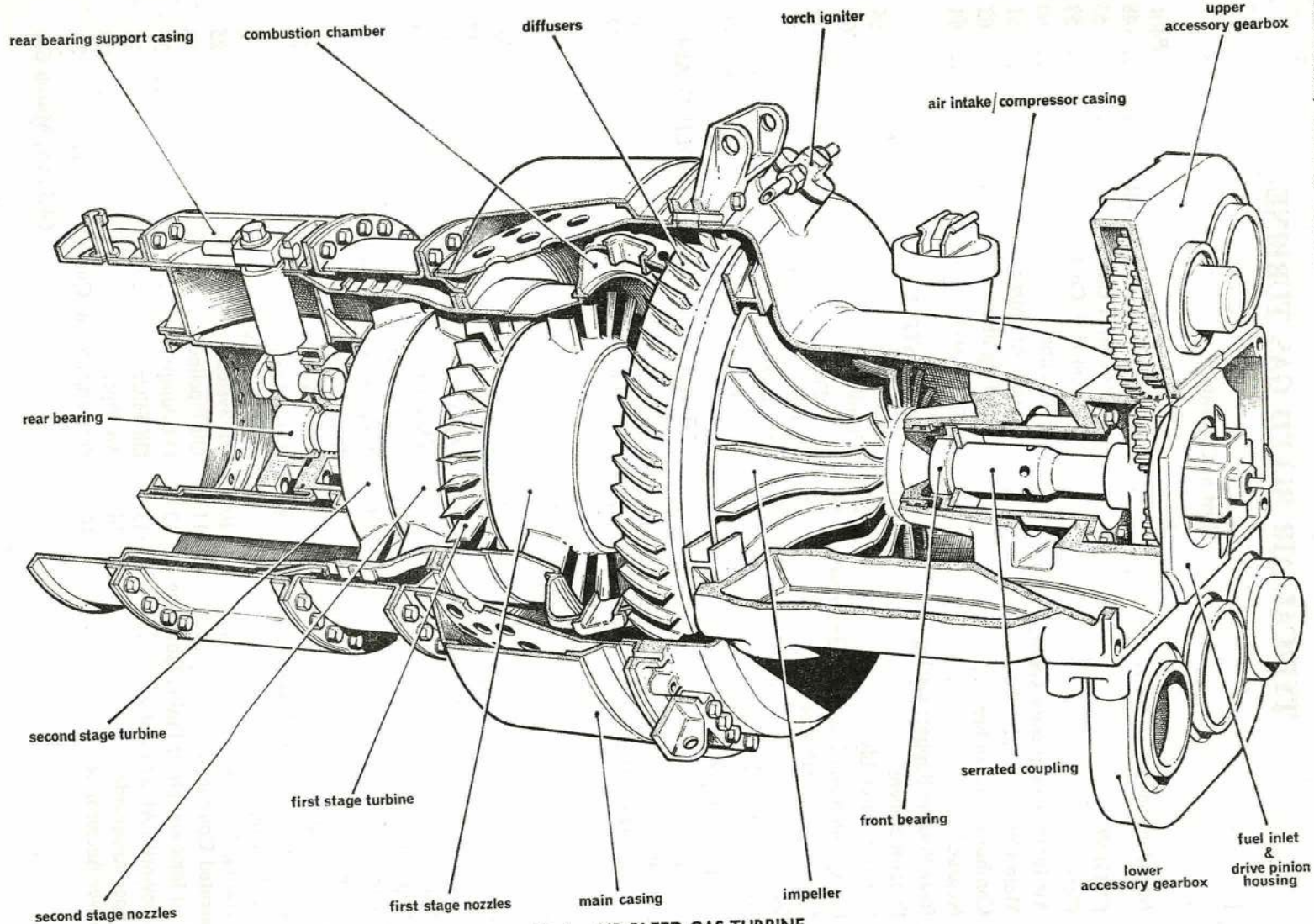


Fig. 1. AIR BLEED GAS TURBINE

Introduction

1. The following information concerns an air bleed gas turbine that is designed to supply air at a low pressure (2 lb/sec at 38.5 lb/sq in) for starting the main propulsion engines of aircraft. The unit is mounted on a trolley and thus can be positioned where required.
2. After the air bleed gas turbine is started and the unit connected to an aircraft, its further operation is semi-automatic. A valve positioned on the main casing controls the air delivery. On connection to the aircraft of the air hose and the electrical lead, the pilot assumes control through the operation of the aircraft engine starter button. Depression of this button completes the circuit, causing the trolley engine to accelerate and the air delivery valve to open. Thus, air at compressor delivery pressure passes via the delivery hose to the aircraft starting system and so provides the low pressure air supply for driving the engine turbo-starter unit selected for operation. Air delivery is indicated by the illumination of a lamp.
3. When the aircraft engine reaches the required revolutions per minute, centrifugal force opens the overspeed switch that is fitted on the turbo-starter; this switch is normally closed. This breaks the circuit and causes the trolley engine to revert to idling conditions and the air delivery valve to close.
4. A sonic venturi is located between the air

delivery hose and the trolley engine. This is incorporated as a precaution to prevent overheating of the engine in the event of hose failure or inadvertent starting of more than one engine.

ENGINE

General

5. This air bleed gas turbine engine (Fig. 1) has a single-stage centrifugal compressor driven by a two-stage axial flow turbine and an annular combustion chamber interposed between these two main assemblies. All the engine driven accessories are attached to two gearboxes, the drive being transmitted from the front of the main rotor shaft through a train of spur gears. Pipe connections are of a non-threaded type which rely on rubber rings for their sealing.

6. Air at compressor delivery pressure is tapped off before reaching the combustion zone. Delivery of this air is controlled by an electro-pneumatically operated valve situated on the main casing.

Air Intake/Compressor Casing

7. This aluminium alloy casting (Fig. 2) forms the forked air intake, and at the rear the casing becomes the compressor housing. The convergent passages allow space which is used for twin oil tanks, and the passages finally form a circular entry to the rotating guide vanes. The front ball bearing flexible mounting is housed between the air intake passages. This bearing takes the main thrust.

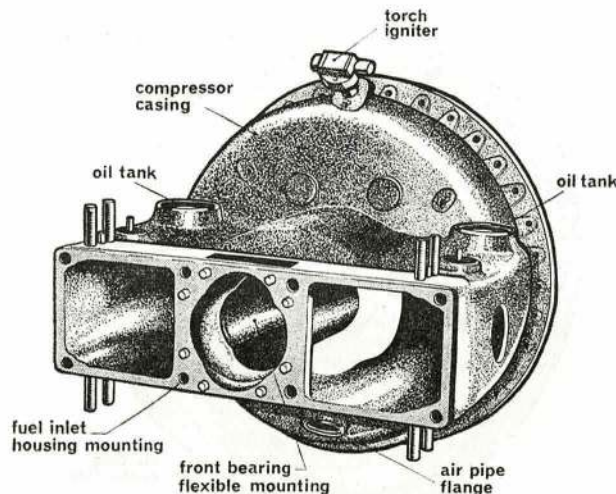


Fig. 2. AIR INTAKE/COMPRESSOR CASING

8. The upper and lower accessories gear-boxes are mounted on faces above and below the air intake entry which abuts the intake silencer when the engine is mounted in the trolley. Inside the casing at the rear is fitted the diffuser assembly (Fig. 3) and a labyrinth air seal is secured to the centre of the axial diffusers. The main casing attachment holes on the horizontal and vertical centre lines are reamed to receive fitting studs. This provides

for the longitudinal alignment of the engine assemblies.

Main Casing

9. The cylindrical main casing (Fig. 4) is located between the air intake/compressor and turbine casings. It is made of double-skinned stainless steel, the inner skin being perforated, and has an internal flange for the attachment of the combustion equipment.

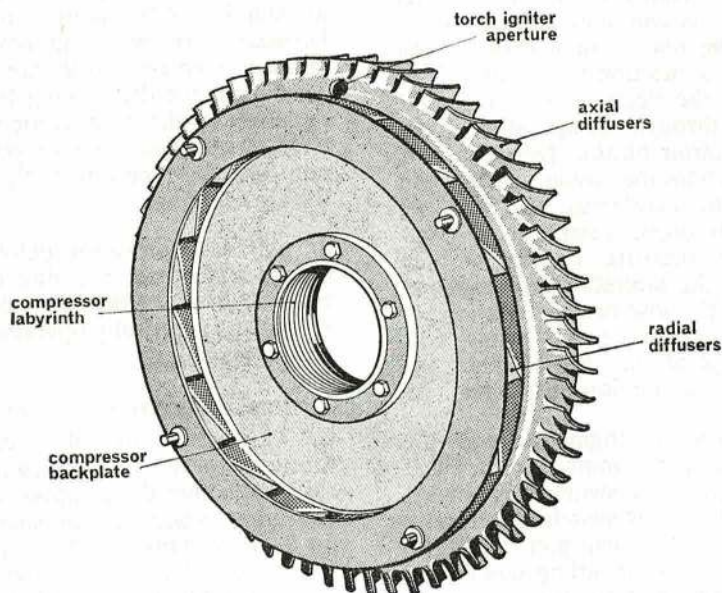


Fig. 3. DIFFUSERS

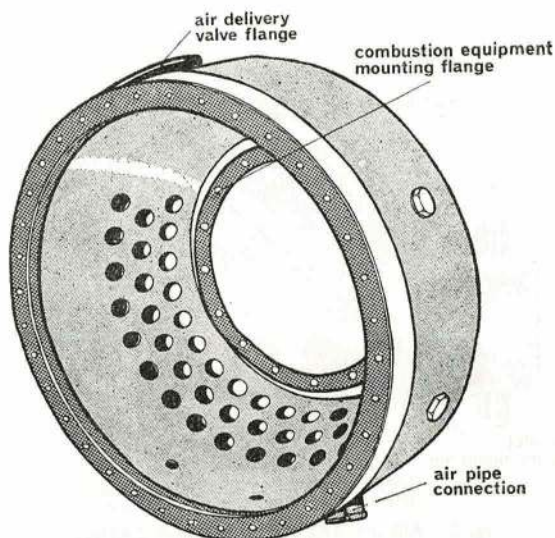


Fig. 4. MAIN CASING

10. Drilled flanges provide attachment for the air intake casing at the front and the second-stage turbine casing at the rear. Reamed holes, eight alternately spaced at 50° and 40° intervals in the front flange and three pairs equally spaced in the rear flange, provide for longitudinal location and permit rotation for alternative location of the air delivery valve flange.

11. In addition to the combustion chamber, the main casing houses the first stage nozzles which in turn form the first stage turbine shroud.

Combustion Chamber

12. The annular combustion chamber (Fig. 5) consists of two main components, inner and outer members, both of which are shaped, louvred and perforated to obtain efficient combustion. A perforated four-piece strap, dimpled to ensure correct location, is bolted around the outer member, the nuts and bolts being wire-locked in pairs.

13. Welded to the outer member rear support ring are five equally spaced tapped lugs. These mate with five similar lugs on the front of the first stage nozzles, tabwashers setscrews being used to secure the nozzles to the outer member. The inner member rear support ring and labyrinth are secured to an internal flange on the first stage nozzles by setscrews locked by double tabwashers.

Nozzles

14. **First Stage.** This fabrication (Figs. 6 and 7) consists of inner and outer shrouds between which are the hollow nozzle blades. The outer shroud extends rearwards to form the first stage turbine shroud, and terminates in a drilled and tapped outward flange. A drilled internal flange is welded to the inner shroud. The nozzles are attached to the main casing internal flange with wire-locked Allen screws which also secure the second stage nozzles.

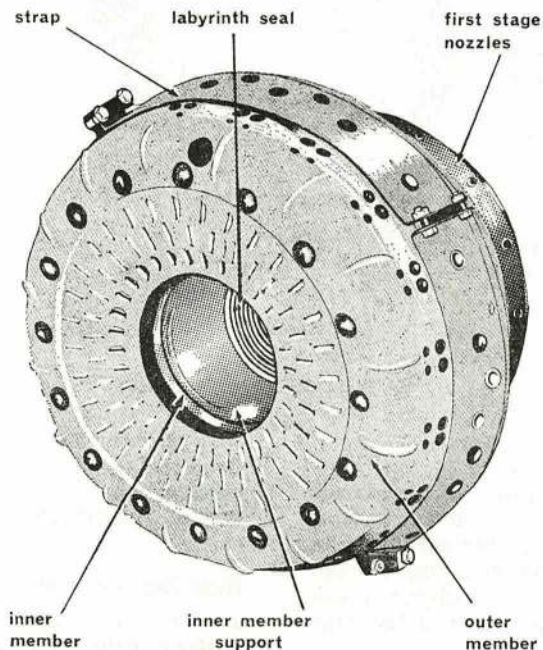


Fig. 5. COMBUSTION CHAMBER

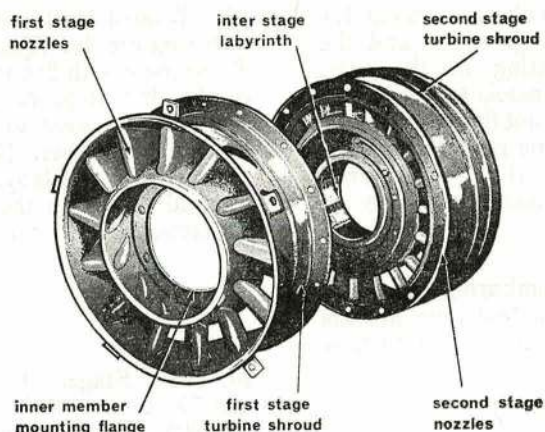


Fig. 6. NOZZLES

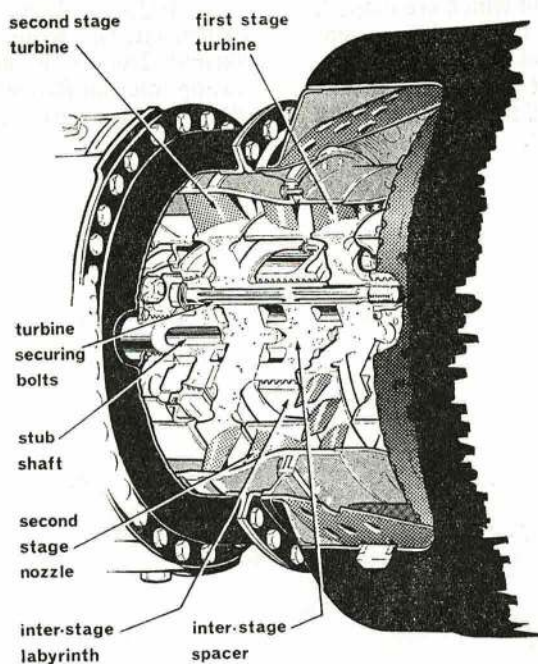


Fig. 7. NOZZLES AND TURBINES

15. **Second Stage.** These nozzles (Figs. 6 and 7) are similar to the first stage. The outer shroud is flanged at the front for attachment to the main casing, and a rearward extension forms the second stage turbine shroud. The inner shroud has an internal flange for the attachment of an inter-stage labyrinth gas seal which is secured to the nozzles with tabwashers and setscrews.

16. **Second Stage Turbine Casing.** This is a shallow cylinder (Fig. 8) having a flange at

each end for attachment at the front to the main casing and at the rear to the rear bearing support casing. Each flange has three pairs of equally spaced reamed location holes.

Rear Bearing Support Casing

17. This structure (Fig. 8) has a cylindrical centre portion surrounded by three concentric passages, the centre one for the exhaust gas and the inner and outer ones for the rear bearing cooling air. The purpose of the three

streamlined vanes situated in the exhaust gas passage is to give a smooth flow to the gas passing around the cooling air inlet tubes (Fig. 9).

18. The three hollow support arms are attached at their outer ends to support webs on the outer casing. They are situated inside

the cooling air inlet tubes, their inner ends being of banjo form. Oil passes to the rear main bearing through one of the hollow support arms, and the remaining two provide passage for the bearing scavenge oil. Special hollow bolts pass through the banjo ends and secure the rear bearing support hub and compound labyrinth.

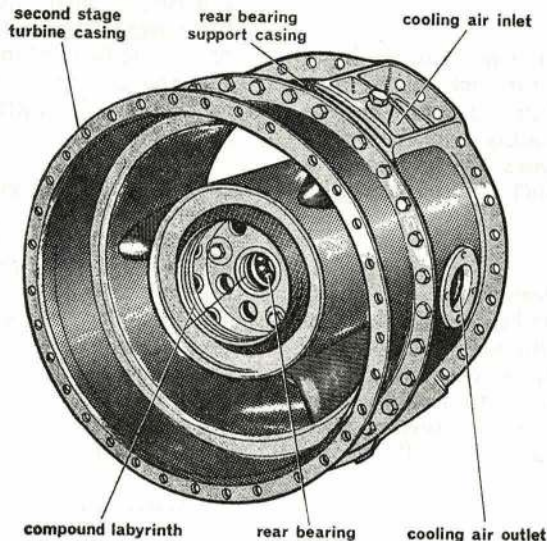


Fig. 8. REAR BEARING SUPPORT CASING

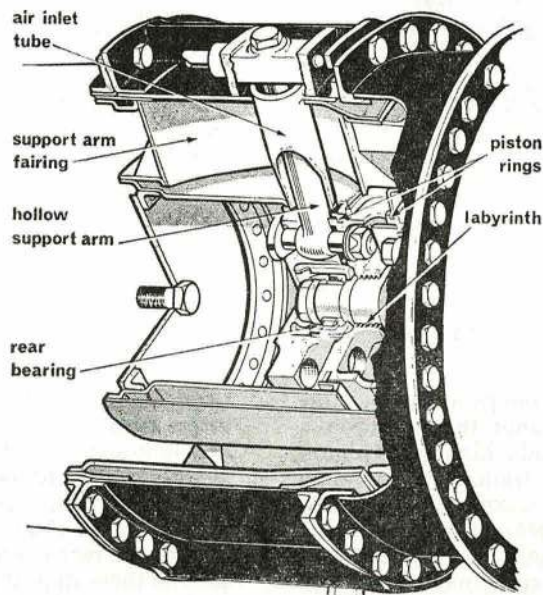


Fig. 9. REAR BEARING

19. Two piston type rings are located in grooves in the labyrinth outer circumference to seal the assembly within the central cylinder. The rear bearing outer race fits in a separate housing located within the bore of the support hub. A blanking plate encloses the rear of the central cylinder, and it has a central stud which is used to secure the exhaust cone.

Exhaust System

20. The exhaust system consists of the inner cone and a tubular exhaust duct. The exhaust duct is flanged at the front to mate with the rear bearing support casing and is slightly flared at the rear. Bosses are provided at intervals around the duct for the fitting of thermocouple probes.

Rotating Assembly

21. The rotating assembly (Fig. 10) is mounted in a ball thrust bearing at the front and a roller bearing at the rear. It consists of the hollow main shaft, the steel rotating guide vanes which are dowelled to a light alloy impeller, a two-stage axial flow turbine unit, an interstage spacer and a stubshaft.

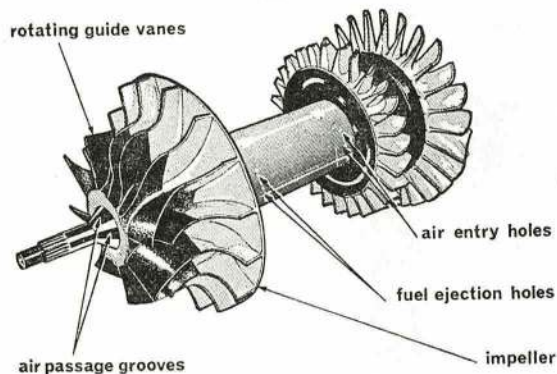


Fig. 10. ROTATING ASSEMBLY

22. The serrations on the front of the rotor shaft are used to transmit the drive via a hollow shaft (Fig. 11) and a high speed pinion to the accessories gear train. The adjoining plain part of the shaft accommodates a distance piece, the front bearing and a packing member which internally is conical and externally tubular. This component is grooved circumferentially and drilled axially to transmit pressurized air to the front bearing labyrinth.

23. A chamfer leads to the next plain part of the shaft which is grooved longitudinally to provide an air passage. The rest of the shaft is of increased diameter and continues plain to the rear end. At the front end of the latter part of the shaft, axial holes and smaller diameter radial holes connecting with them permit pressurized air to pass into and along the shaft. Interposed between the axial holes is a ring of small radial holes which serve as fuel passages, and a blank fitted slightly to the rear of the fuel drillings prevents mixing of the fuel and air. At the rear of the shaft further radial holes facilitate the circulation of pressurized air.

24. The rotating guide vanes are machined from a forged disc, and the single-sided impeller is also machined from a forging. Both items are an interference fit on the shaft, location in relation to each other being by two dowels. The turbine discs are machined from forgings, the blades being integral; location is by a central spigot at the front and rear of each disc.

25. The inter-stage spacer is fitted between

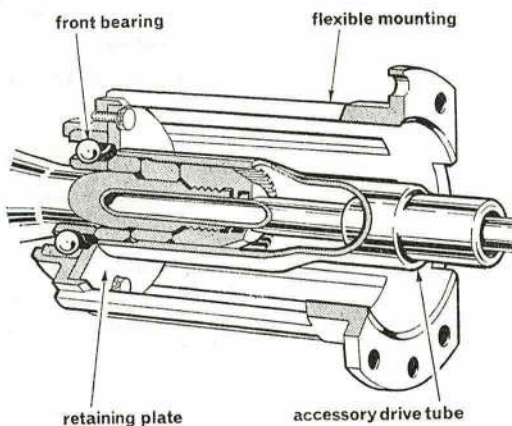


Fig. 11. SERRATED COUPLING

the first and second-stage turbines. It is recessed at the front and rear and is drilled axially to accommodate the turbine bolts. The stubshaft is secured to the second-stage turbine by the four turbine securing bolts. The stepped portion of this shaft rotates within the stepped part of the rear bearing compound labyrinth. Behind these steps the shaft has integral vanes at the rear of which the diameter is reduced to accommodate the compound labyrinth and rear bearing.

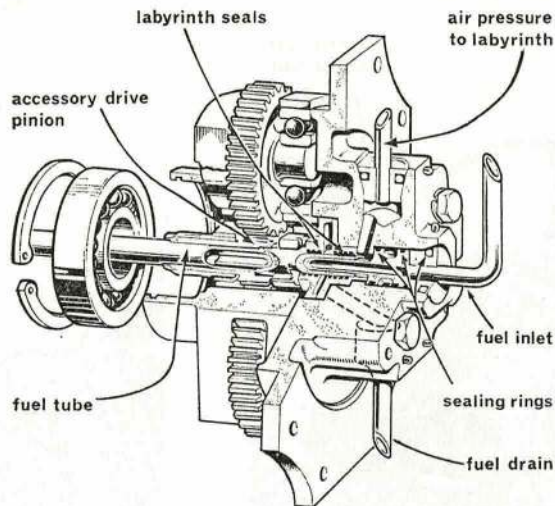


Fig. 12. FUEL INLET AND DRIVE PINION HOUSINGS

Drive Pinion and Fuel Inlet Housings

26. The fuel inlet housing is bolted to the front face of the drive pinion housing, the complete assembly (Fig. 12) being secured to the air intake casing between the entries. The drive pinion housing accommodates the accessories drive shaft ball bearing at the rear and, above and below the engine centre line, each accessories gearbox idler gear and its two bearings. These bearings are pressed into the housing from the front and are retained by the fuel inlet housing, but the

accessories driven shaft bearing is fitted from the rear and retained by a circlip.

27. The fuel inlet housing receives:

- (a) The main fuel supply pipe.
- (b) The oil supply pipe for the front bearing and the high speed pinion.
- (c) The air supply pipe used to pressurize the fuel tube sealing labyrinth. The labyrinth is in two detachable parts, the front one being located in the housing by a dowel.

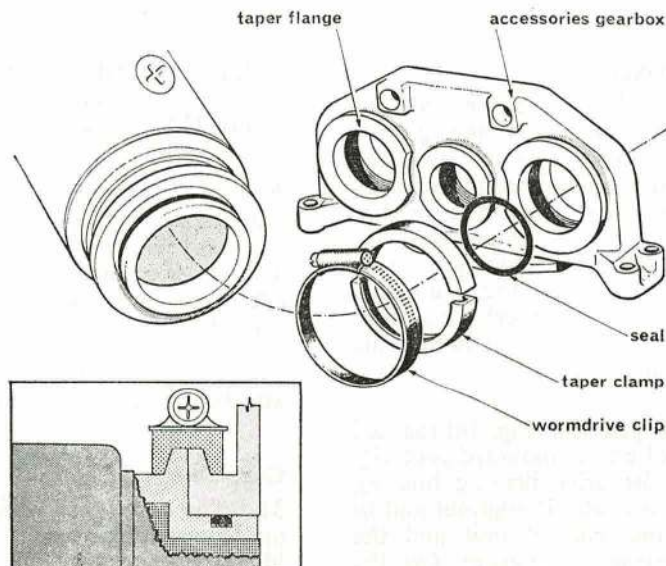


Fig. 13. ACCESSORIES ATTACHMENT

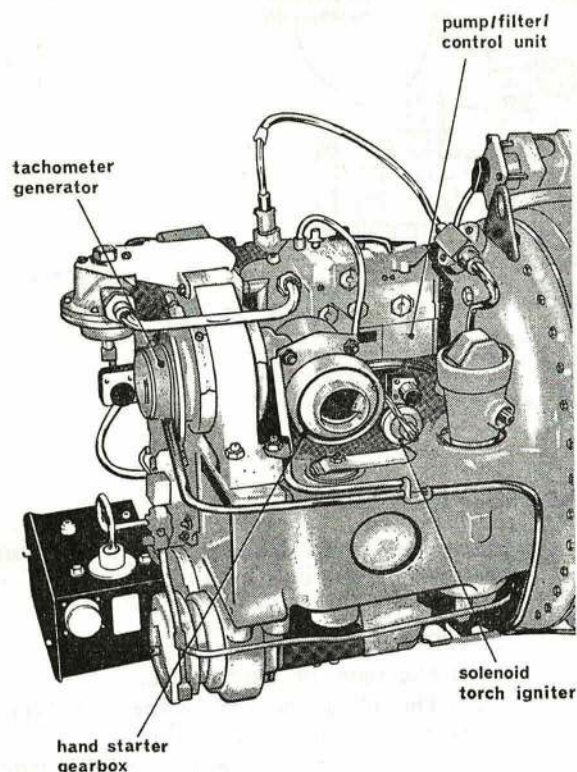


Fig. 14. UPPER ACCESSORIES

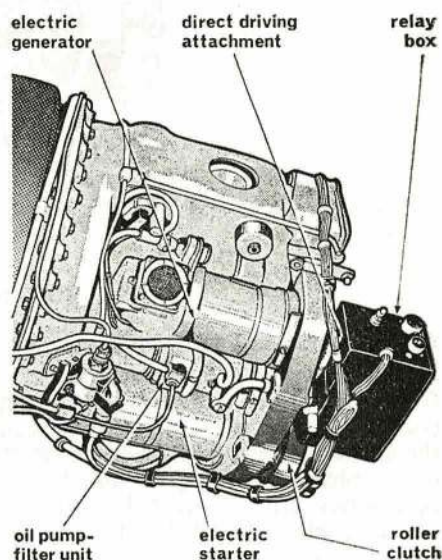


Fig. 15. LOWER ACCESSORIES

Accessories Gearboxes

28. Each gearbox has three forward and three rearward facing mountings having taper flanges (Fig.13). Each accessory mounted directly on the gearboxes is attached by means of two taper clamps and a worm drive clip. A similar flange to that on the gearbox, but having a spigot and an external groove to house an oil sealing ring, is formed on each accessory. The central (smaller) mountings are used solely for the fuel and oil pump units and their bearing housings.

29. On the upper gearbox (Fig. 14) the fuel pump/filter/control unit is mounted centrally at the rear with its drive bearing housing opposite. The hand starter is adjacent and to the left of the fuel control unit and the tachometer generator is opposite. On the other side of the gearbox the front and rear mountings are blanked, but the rear blank is adapted to provide a mounting for the

ignition unit and likewise the front blank provides a mounting for the manually controlled H.P. fuel cock.

30. On the lower gearbox (Fig. 15) the oil pump/filter unit is mounted centrally at the rear with its drive bearing housing opposite. The electric starter is adjacent and to the left of the pump and the electric generator is on the right. The starter motor roller clutch is mounted on the front face opposite the starter motor, and a single direct driving attachment is opposite the generator.

Gear Train

31. The high speed pinion drives the upper and lower idler gears (Fig. 16). The upper idler gear drives the fuel control unit gear, and a smaller gear bolted to it is in engagement with the hand starting gearbox gear which drives the tachometer generator.

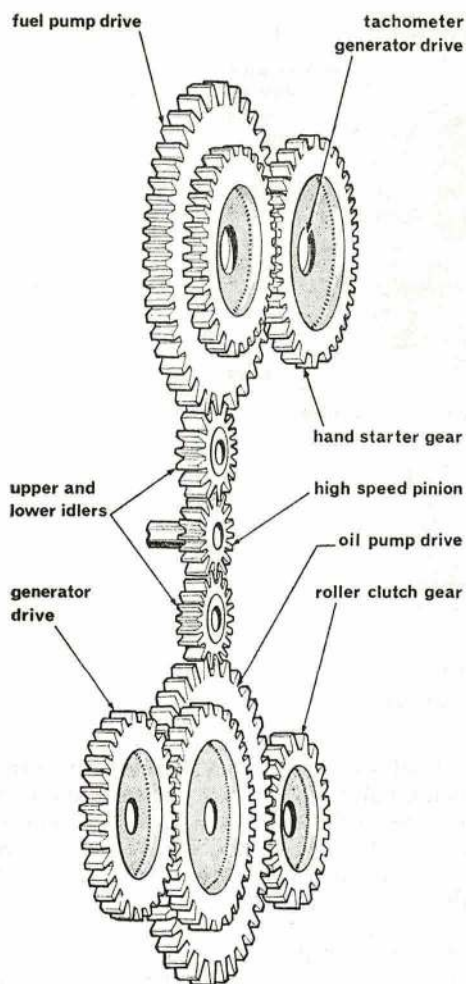


Fig. 16. GEAR TRAIN

32. The lower idler gear drives the oil pump gear which has a smaller gear bolted to it to drive the generator gear. The electric starter roller clutch pinion is also in engagement with the oil pump drive gear.

Air Delivery Valve

33. This valve (Fig. 17) controls the delivery of the air that is tapped off for the purpose of starting the main propulsion units of an aircraft. The main passage flanges are secured by taper clamps at one end to the main casing and to the sonic venturi at the other end.

34. **Construction.** The working parts consist of a rack with a piston at each end operating in steel cylinders retained by a blanking

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cap at one end and a return spring body at the other. The air delivery solenoid valve is connected by a pipe to the blanking cap. The return spring body incorporates two coil springs which load the air delivery valve in the closed position; provision is made for adjustment. A stop plate is situated under the return piston and this sets the clearance between the main passage and the butterfly. Adjustment is by means of shims and the clearance in the closed position must be set to 0.005 in.

35. The rack spindle has internal drillings which connect the backs of the pistons with the front of the opposing pistons and, through two adjustable bleed screws in the housing, to atmosphere. These drillings and bleed screws control the back pressure built up through movement of the pistons and thus act as dampers. The rack spindle is restrained from radial movement by a guide bolt which locates in a channel in the rack spindle.

36. The main and bleed butterfly shafts are interconnected to ensure that when the main passage is closed, the bleed passage is open and vice versa. At the outlet end of the bleed passage is a disc valve which is opened, against the loading of two light springs, by bleed air. This assembly is enclosed by the expansion chamber to which is attached a fishtail shaped duct which directs the bleed air to the exhaust duct.

37. **Operation.** With the engine stopped, the return piston is held on its seat, the main butterfly is closed and the bleed butterfly open; the disc valve is closed.

38. When the engine is started, the compressor delivery pressure increases and, at a predetermined pressure, the disc valve opens allowing the bleed air to escape to exhaust. This condition continues whilst the engine is running at idling speed because the return spring pressure is the only force acting on the pistons.

39. When the engine speed increases to maximum, the air delivery solenoid valve is opened electrically and this allows compressor air to act on the pressure piston. Because the air pressure is greater than the spring pressure the pistons move and, through the rack and pinion open the main butterfly and close the bleed butterfly, allowing the compressor air

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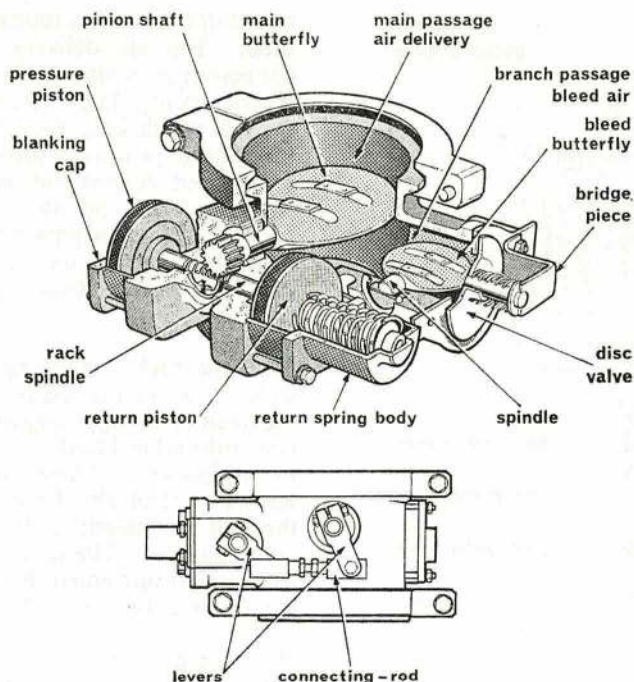


Fig. 17. AIR DELIVERY VALVE

to pass to the starting device of the main propulsion unit. With the closure of the branch passage the disc valve is closed by its springs, and air trapped behind the pressure piston and at the front of the return piston escapes via the drillings and bleed screw to atmosphere (para. 35).

40. With the selection of engine idling speed, the air delivery solenoid valve closes and stops the flow of air to the pressure piston which allows the spring pressure to return the pistons. This closes the main butterfly and opens the bleed butterfly. The bleed air acts against the disc valve which opens and allows bleed air to pass to exhaust. Air trapped behind the return piston acts as a damper before escaping to atmosphere via the rack drillings and bleed screw.

FUEL SYSTEM

General

41. The engine section of the fuel system (Fig. 18) consists of all the components necessary to operate the engine at its two conditions, namely idling and maximum. The fuel supply tankage is mounted on the trolley and incorporates an electrically operated booster pump.

42. Fuel is supplied via a flexible pipe to the reducing valve from which it passes along a rigid pipe to the combined fuel filter/pump/control unit (Figs. 18 and 19). It then passes via external rigid pipes to the torch igniter and to the spill control unit. Fuel from the spill control unit passes to the fuel inlet housing from whence it passes through a jet and a tube to a rotary atomizer in the hollow rotor shaft. The combined control unit and the spill control unit together control engine starting, acceleration and deceleration.

43. There are three solenoid valves in the system; two are of the "energized open" type and the other is "energized closed". One of the former controls the fuel supply to the torch igniter and this is open only during starting.

44. The other two are mounted on the spill control unit, the second "energized open" valve being used as a high pressure shut-off cock which is open whenever the engine is running. The "energized closed" acceleration solenoid valve returns excess fuel from the spill control unit to a T-piece in the main fuel supply line during starting and initial acceleration, and is closed when maximum engine speed is required.

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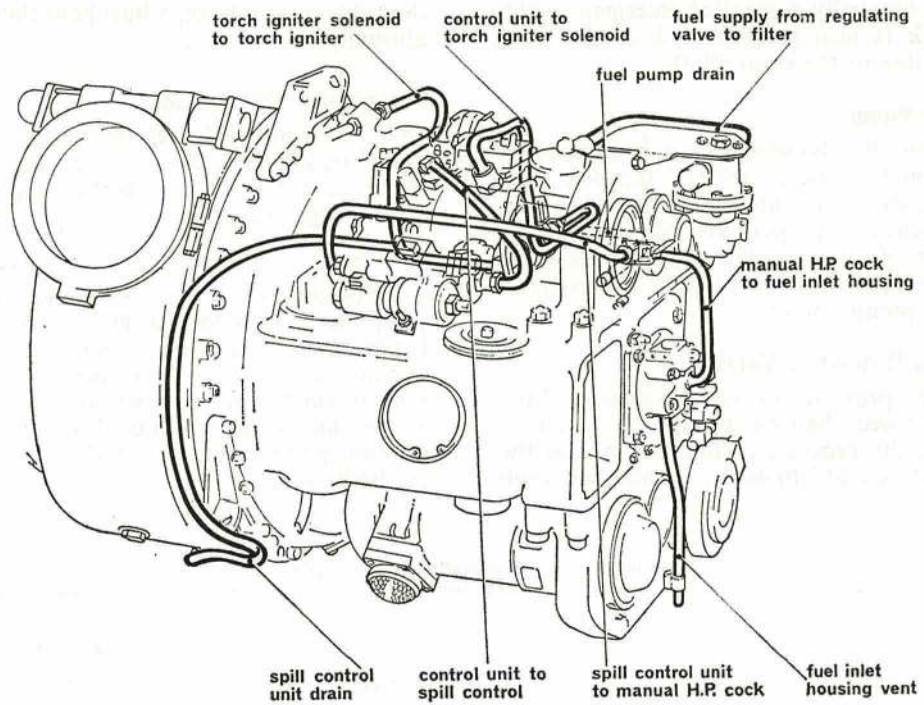


Fig. 18. FUEL SYSTEM PIPES

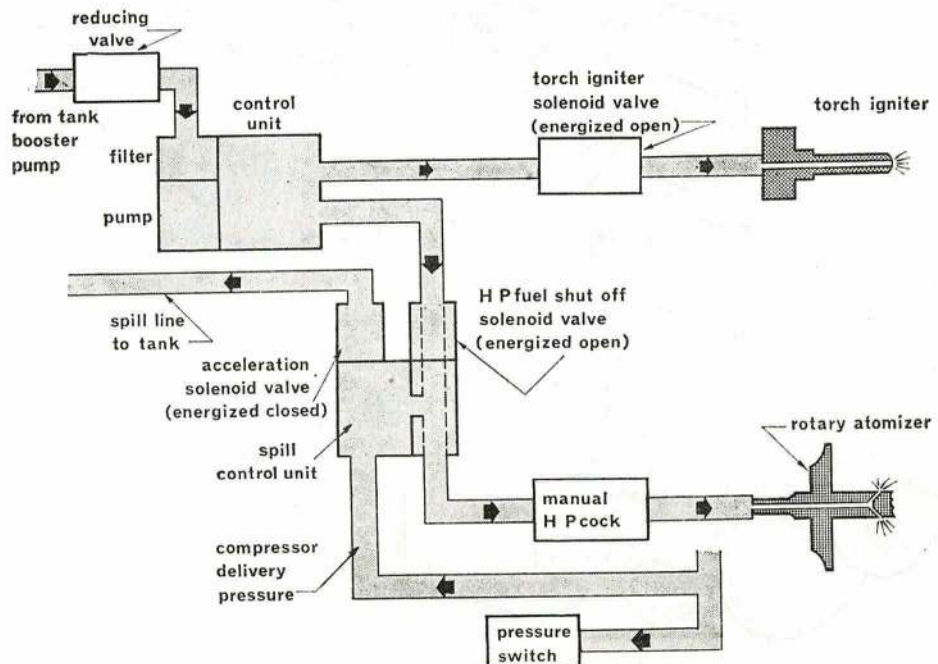


Fig. 19. FUEL SYSTEM

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45. A manually controlled emergency shut-off cock is also incorporated in the main supply line to the rotor shaft.

Booster Pump

46. The fuel booster pump is electrically driven and of the centrifugal impeller type. It is capable of maintaining the fuel requirements under all operating conditions. The purpose of the incorporated by-pass valve is to prevent pressure drop in the event of booster pump failure.

Pressure Regulating Valve

47. The pressure regulating valve is of the spring-loaded diaphragm type. It is set to regulate the pressure at the entrance to the engine system at 2 lb per sq. in. and, although

the valve is adjustable, adjustment should not normally be required.

Filter/Pump/Control Unit

48. The combined fuel filter/pump/control unit (Fig. 20) consists of a gauze disc filter, a gear type pump and a control unit which has a centrifugal governor.

49. **Filter.** The filter element is mounted on a perforated tube which fits around a waisted stud. The tube is located at its base by two L-section washers, fitted so that they form an annulus which contains a spring. The filter element stack is retained within the dome by a base plate secured by a circlip. Filtered fuel reaches the fuel pump inlet via a passage in the body of the unit.

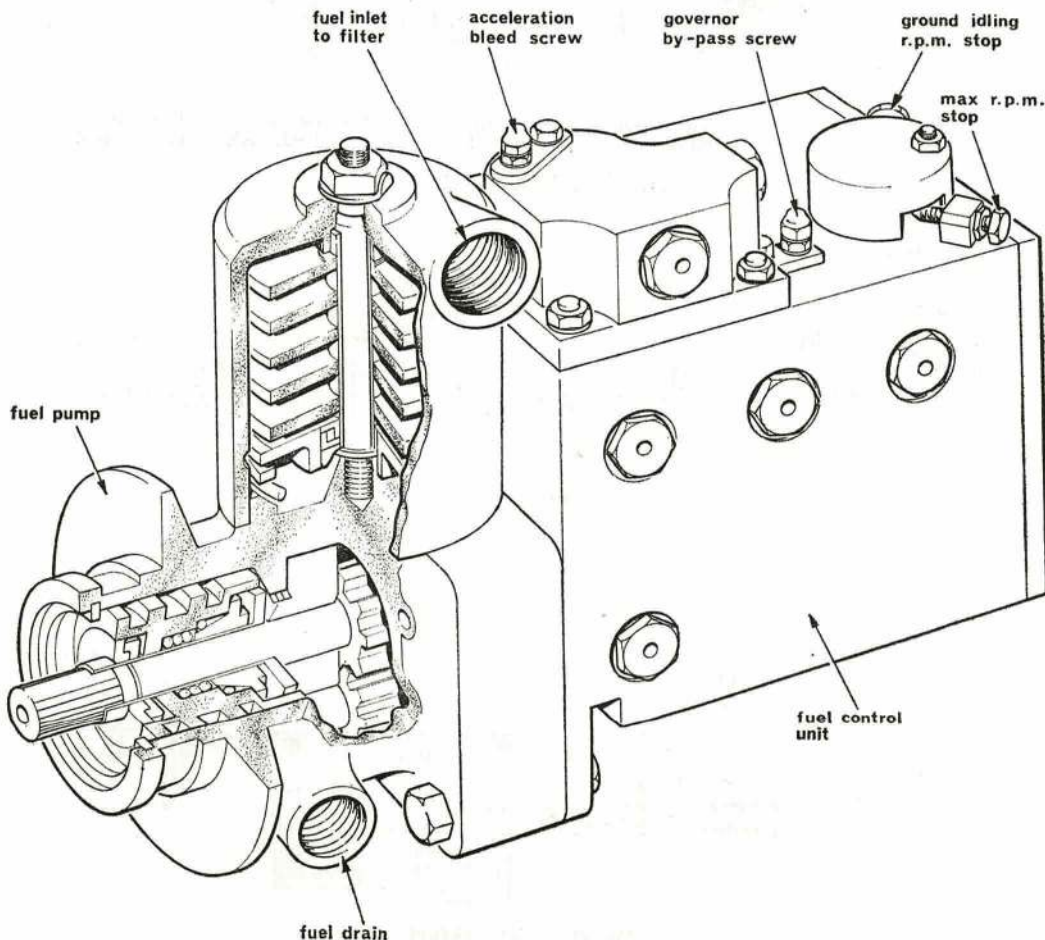


Fig. 20. FILTER/PUMP/CONTROL UNIT

50. **Pump.** The rear face of the pump body mates with the control unit and the pump drive extends through the body to connect with the control unit governor. The pump supplies fuel under pressure to the control unit via an internal passage. A rubber ring sealing joint is used between the pump and the control unit, the pump being self-lubricating. The compound seal prevents fuel leakage into the accessories gearbox and oil leakage into the pump. The space between the respective seals is vented to atmosphere.

51. **Control Unit.** This unit controls the fuel flow to the engine under all operating conditions by means of variable orifices and valves. Maximum engine speed is controlled by a flyweight type governor linked to a piston valve. Acceleration fuel bleed and governor by-pass adjusting screws provide the basic adjustments controlling starting, acceleration and deceleration.

52. A pressurizing valve prevents fuel passing to the main delivery line until sufficient pressure to ensure atomization at the main burner is attained. This same valve, whilst withholding the main delivery, ensures that sufficient pressure is available at the torch igniter. A relief valve, fitted as a safety precaution, is adjusted to open a return line to the inlet side of the pump in the event of the pressure in the line before the governor piston valve becoming excessive. Also included in this line is a non-return valve which prevents fuel from reaching the rotary atomizer before the pressurizing valve opens, and thus eliminates the possibility of over-fuelling by the booster pump during starting.

Spill Control Unit

53. This unit (Fig. 21) comprises two spring-loaded diaphragm valves and two solenoid valves. The two diaphragm valves, **surplus** and **backing**, are complementary to each other and,

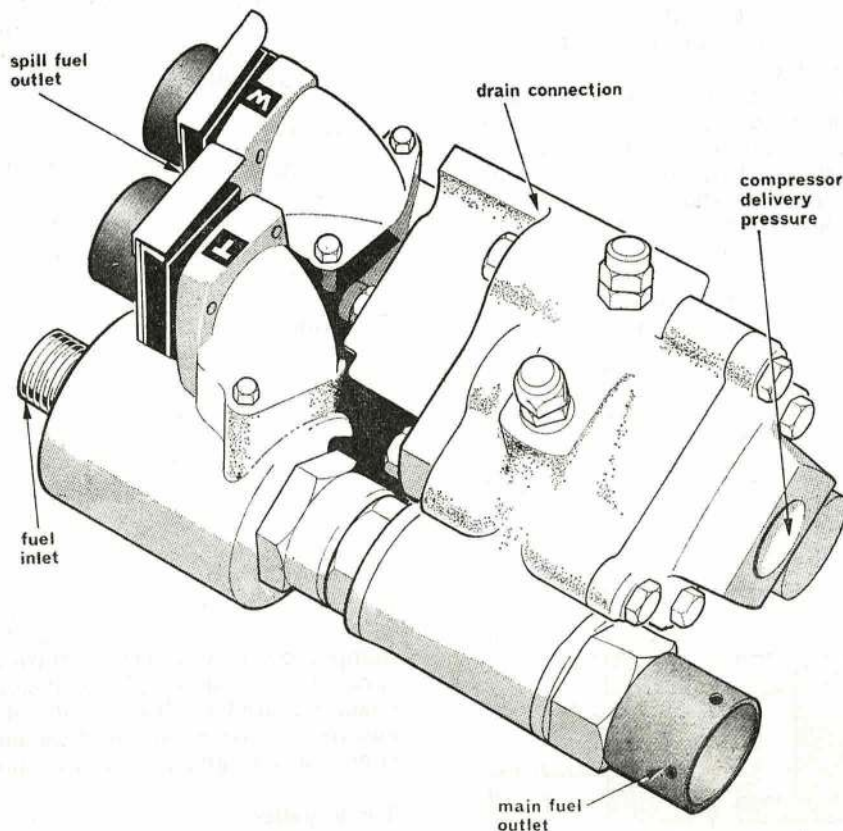


Fig. 21. SPILL CONTROL UNIT

in conjunction with the acceleration solenoid valve, control the engine between idling and maximum speed.

54. The main fuel supply is delivered via the high pressure shut-off solenoid valve into the spill control unit and thence into the main burner. The acceleration solenoid, the surplus and backing valves are incorporated in a return line between main delivery and tank. These three valves permit fuel in excess of idling requirements to spill back to the tank until the acceleration solenoid valve closes, at which time the entire output of the combined control unit passes directly to the engine, thereby causing it to accelerate.

55. Three adjusting screws are provided:

- (a) Two adjacent to each other of which the vertical one adjusts the starting flow and the inclined one the top deceleration flow.
- (b) The third one, near the solenoids, alters the lower deceleration flow.

56. The starting flow adjustment provides for a limited spill during the starting cycle when the surplus valve is closed, thereby limiting the temperatures by reducing the flow to the rotary atomizer. The lower deceleration flow adjustment limits the movement of the surplus valve diaphragm and thus controls the main deceleration flow, whereas the top deceleration flow adjustment controls only the high speed end.

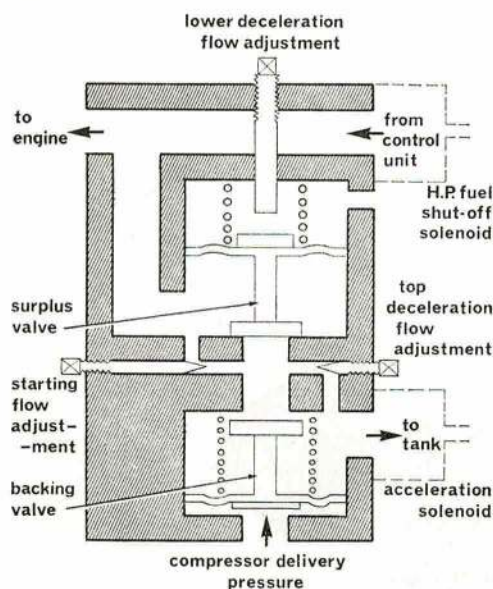


Fig. 22. SPILL CONTROL

57. **Operation (Fig. 22).** With the acceleration solenoid valve closed (engine at maximum speed), the backing valve is held closed by compressor delivery pressure and the surplus valve is held open by fuel pressure. When the solenoid valve opens the engine decelerates, controlled by the fuel, and the top deceleration flow adjustment permits the fuel to spill back to the tank. As the engine speed decreases so does the compressor delivery pressure, and the consequent reduction in the pressure felt on the backing valve diaphragm allows the combined fuel and spring pressures to open the valve. At this point the surplus valve takes control of the spill.

58. During deceleration the surplus valve is fully open until the spring pressure and the fuel pressure on opposite sides of the diaphragm balance, when the valve will have moved towards the closed position. This position where the pressures are balanced determines the idling speed. Switching off the engine causes the high pressure shut-off solenoid valve to close, thereby stopping the supply of fuel to the spill control unit and thus to the engine.

Manual H.P. Cock

59. A manual ON/OFF cock is fitted in the high pressure line between the spill control unit and the fuel inlet housing. Its purpose is to enable the engine to be shut down in case of emergency.

Fuel Tube

60. The main fuel supply connects with the fuel inlet housing whence fuel is transferred to the fuel tube which is housed within the accessories drive shaft. Leakage into the gear-boxes is prevented by a pressurized labyrinth seal. Fuel then passes from the tube to the hollow rotor shaft.

Rotary Atomizer

61. This consists of a ring of small holes drilled radially in the rotor shaft. Fuel at pump pressure is boosted centrifugally and sprayed, finely atomized into the combustion chamber. Radial distribution of the fuel ensures uniform mixing with the air from the compressor to give even combustion.

Torch Igniter

62. Torch igniters are used solely to initiate combustion; thus they only function for a brief period when starting; during normal

operation they are completely cut off. The body (Fig. 23) has three bores which receive the fuel and electrical connections and the hollow central electrode. A passage from the fuel connection bore aligns with a hole in the central electrode. The igniter receives high

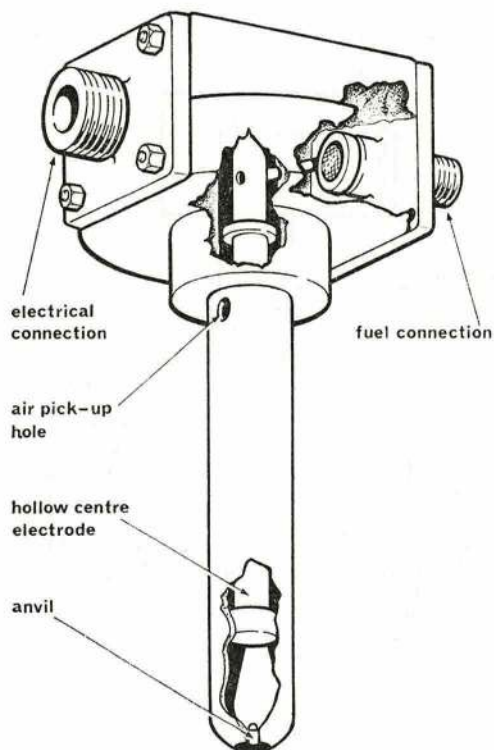


Fig. 23. TORCH IGNITER

tension current from a booster coil type ignition unit which is supplied with low tension current from batteries.

63. Operation. Fuel from the torch igniter solenoid valve enters at the fuel connection and passes through a filter disc before entering the hollow central electrode. At the end of the central electrode is a fine hole through which the fuel is sprayed against an anvil set in the base of the barrel. The spark across the gap between the central electrode and the barrel ignites the fuel spray, the torch igniter being controlled through the starting circuit to cut out at a predetermined speed above which combustion is continuous.

Drain Valve

64. A lightly loaded fuel drain valve (Fig. 24)

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is fitted at the lowest point on the main casing. A piston valve, coil spring and valve seat are located within the body and retained in position by a union adapter which screws into the body and is sealed by an aluminium washer.

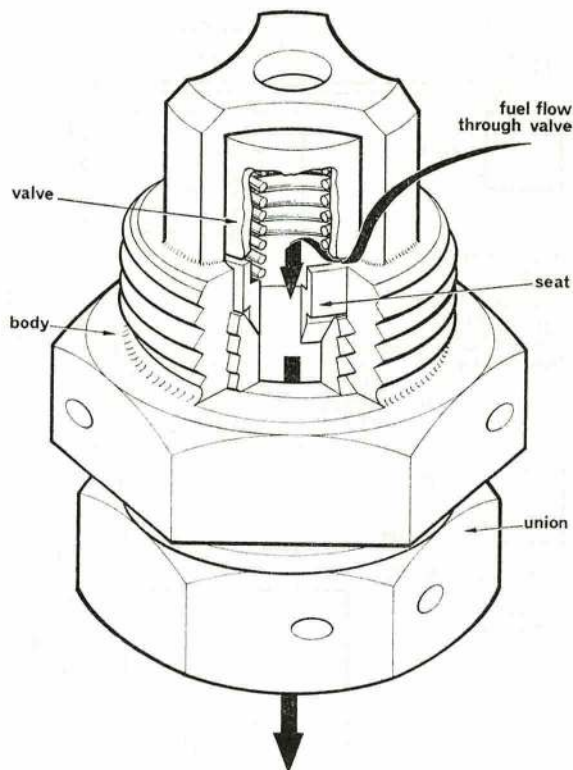


Fig. 24. FUEL DRAIN VALVE

65. Operation. When the engine starts, the air pressure in the main casing overcomes the spring pressure and so the valve closes and remains on its seat whilst the engine is running. On "run down" of the engine the spring will lift the valve and allow any unburnt fuel to drain off.

OIL SYSTEM

Introduction

66. The oil system (Figs. 25 and 26) is completely self contained on the engine. Strainers and restrictors are used to ensure a clean and regulated supply of oil to the front and rear main bearings, the high-speed pinion and the roller clutch mechanism.

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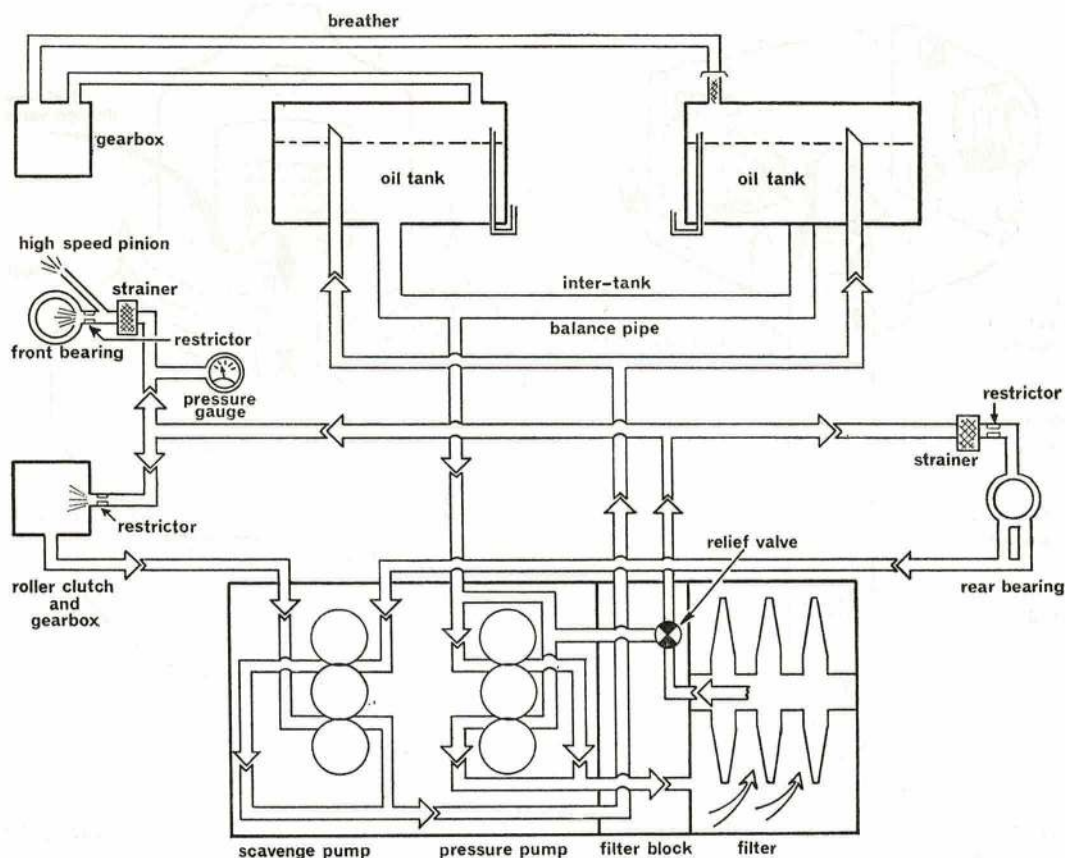


Fig. 25. OIL SYSTEM

Tanks

67. The twin oil tanks are cast integral with the air intake casing, the left-hand tank having a filter fitted in the extended filler neck. The tanks are interconnected by a large bore balance pipe from which a smaller pipe passes oil to the pressure pump inlet. Both tanks are vented to atmosphere and have pressure balance pipes which connect with the upper accessories gearbox.

Pumps

68. The pressure and scavenge pumps (Fig. 27) are housed in a common casing that is mounted on the lower accessories gearbox. The pumps are of the spur gear type and each acts as a double pump. Although the pumps are separate they have a common driving spindle that carries the two driving gears which each mesh with two diametrically opposed driven gears.

TYPICAL AIR BLEED GAS TURBINE

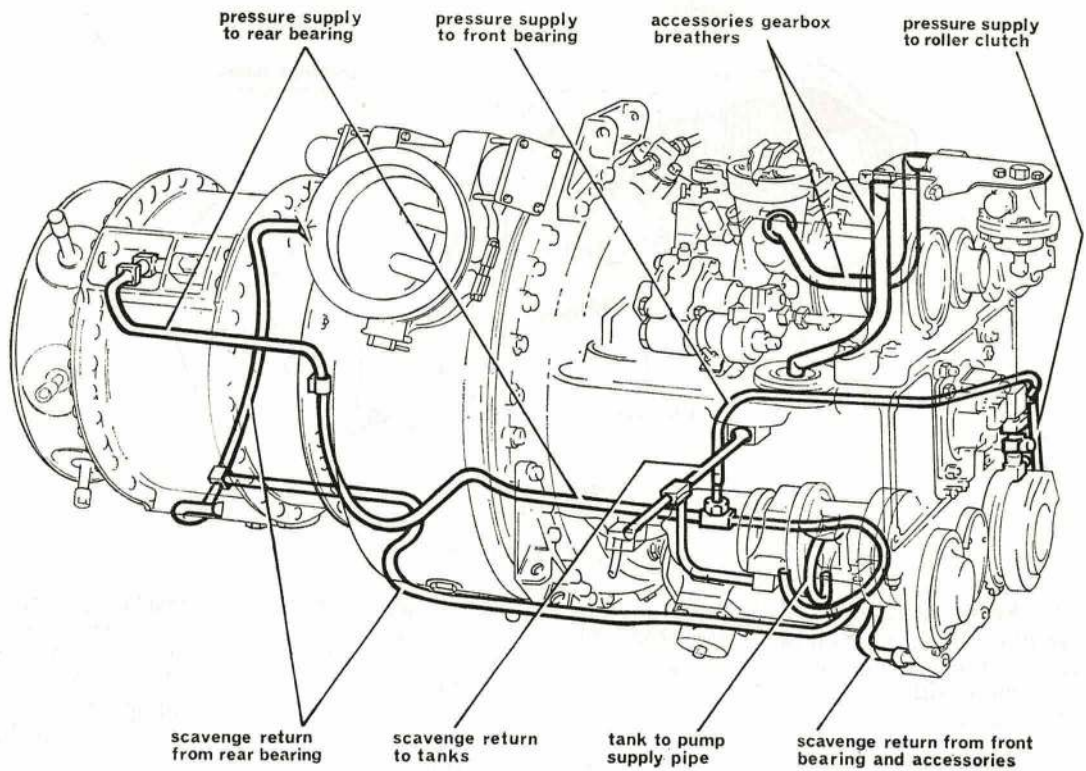


Fig. 26. OIL PIPELINES

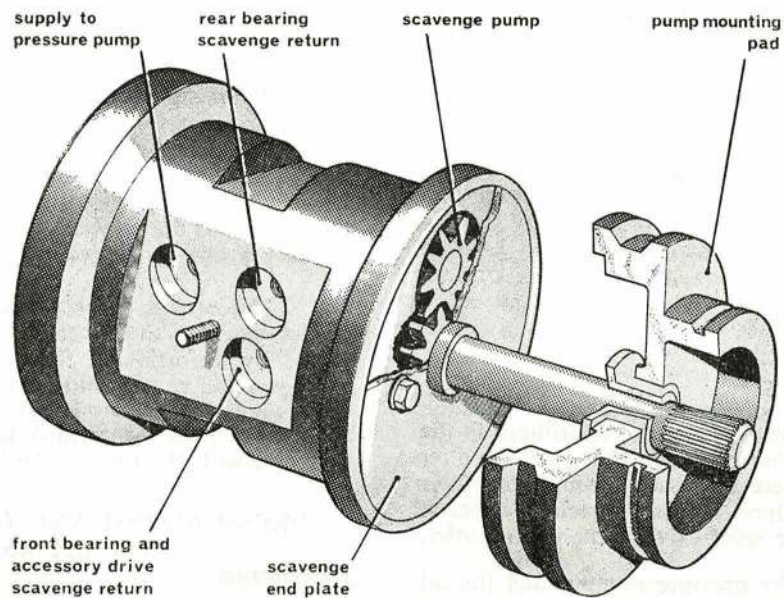


Fig. 27. OIL PUMPS

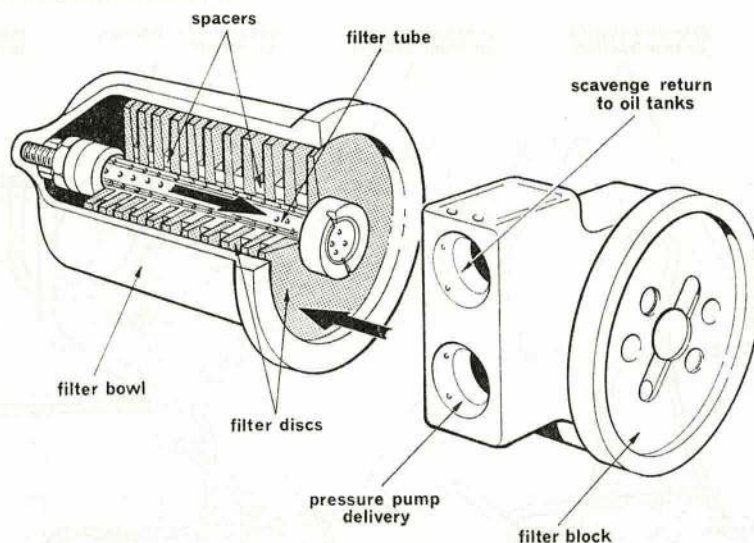


Fig. 28. OIL FILTER

69. **Filter.** Assembled with the pumps in the filter block is an airmaze filter (Fig. 28), the hollow central stem of which communicates with an outlet connection in the filter block.

70. **Relief Valve.** A spring-loaded relief valve is housed in the filter block and is connected to the inlet side of the pressure pump. Its main purpose is to set an operating pressure and in so doing it prevents excessive pressure in the filter chamber, thus safeguarding the filter element.

Strainers and Restrictors

71. Strainers and restrictors are fitted in the oil supply lines to the front and rear main bearings. The supply to the roller clutch and the high-speed pinion is restricted by the size of the oilway drilling. The rear bearing restrictor is incorporated within the strainer but the one for the front bearing is attached to the bearing flexible mounting.

Pressure

72. The pressure pump receives oil through an inlet in the casing and, via drillings in the casing and filter block, delivers it to the filter chamber where it passes through the filter discs and enters the hollow stem. Thence it passes via the relief valve to the pump outlet.

73. From the pressure pump outlet the oil passes along branch pipes to the pressure gauge, the rear main bearing, the front main bearing and the high-speed pinion, and the

starter motor clutch. Oil reaches the rear bearing through one of the hollow support arms, and the front bearing receives oil that is transferred from the fuel inlet housing through a tube. A small drilling within the fuel inlet housing diverts some of the front bearing oil supply to the high-speed pinion. The starter motor roller clutch is lubricated by oil fed to the stub spindle whence holes allow passage of the oil to the bearing surfaces.

Scavenge

74. Scavenge oil from the rear bearing is drawn by the pump through the other two bearing housing support arms and pipes which unite before reaching the pump. Oil from the roller clutch passes into the accessories gearbox where it combines with oil from the front bearing and is drawn via a pipe from the base of the gearbox by the scavenge pump.

75. The scavenge pump receives oil through two connections in the casing. The oil carried round by the gears of the double pump is delivered and routed into a common passage from which it returns through drillings in the filter block to a T-shaped return pipe which connects with the twin oil tanks.

PRESSURIZING AND COOLING AIR SYSTEMS

Introduction

76. Air is used for pressurizing and also for cooling purposes. Pressurized air is tapped from the compressor casing and passes along

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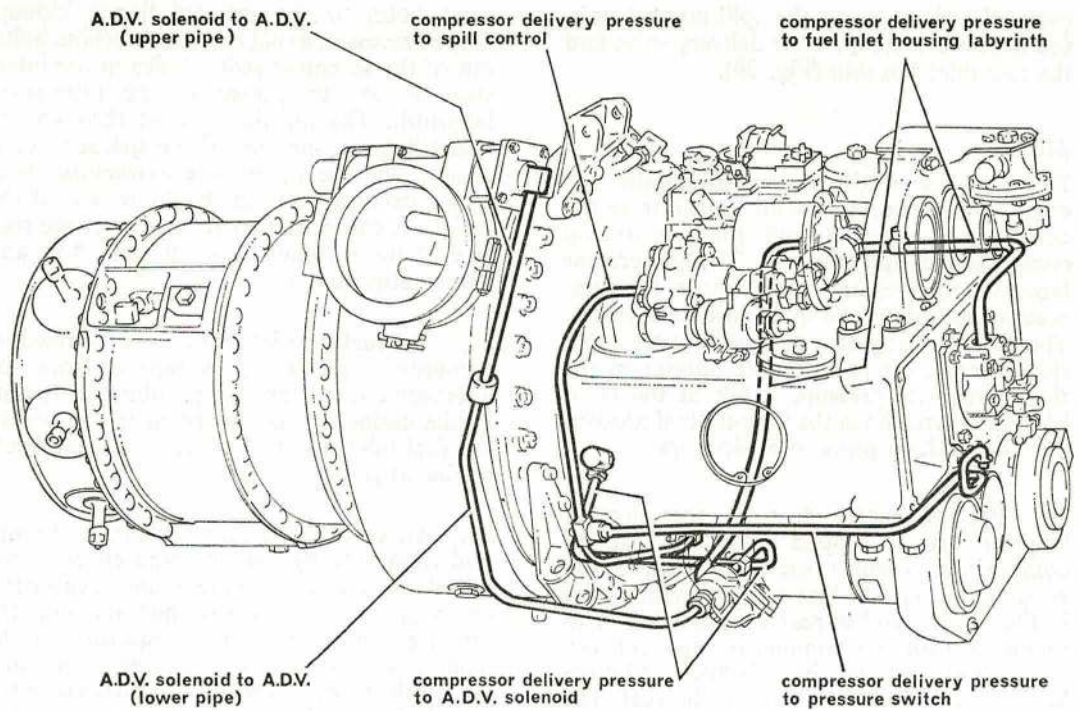


Fig. 29. AIR PIPES

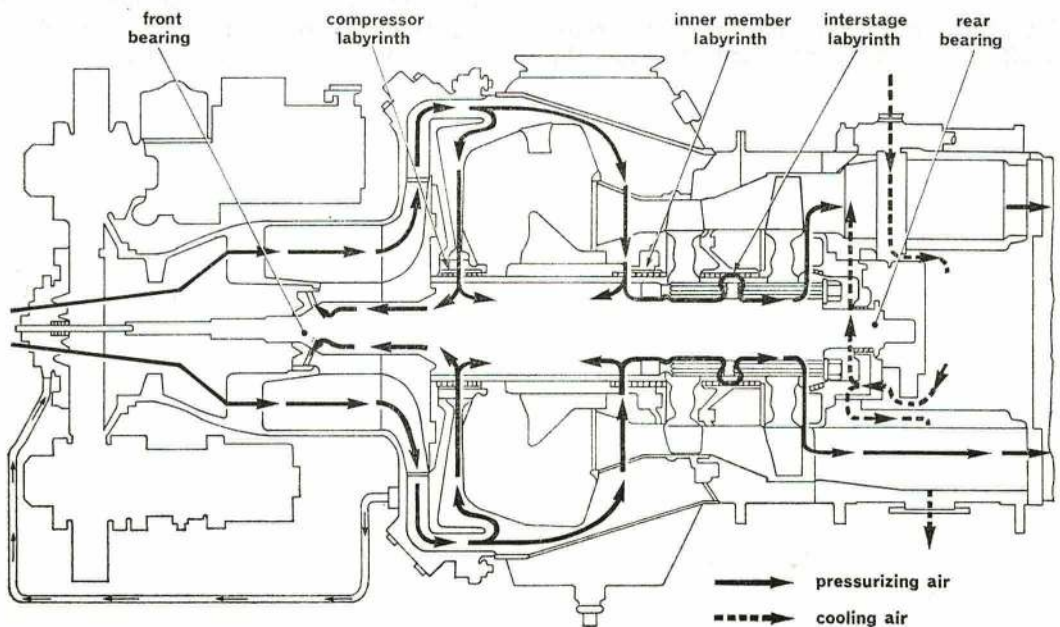


Fig. 30. PRESSURIZING AND COOLING

(A.L. 29, March 68)

external rigid pipes to the spill control unit, the pressure switch, the air delivery valve and the fuel inlet housing (Fig. 29).

Air Flow

77. The labyrinth seals throughout the engine are pressurized by air tapped from the combustion chamber and the air intake/compressor casing (Fig. 30). The compressor labyrinth receives its air via slots in the compressor backplate and holes in the labyrinth. The foremost ring of radial holes in the rotor shaft permits air to reach the interior of the shaft where its pressure is felt at the front bearing labyrinth via the longitudinal grooves and the packing piece axial drillings.

78. The combustion chamber inner member labyrinth air is tapped from the primary combustion air which reaches the combustion zone via the hollow first stage nozzles. Holes in the inner member rear support ring communicate with the annulus formed between the member and the labyrinth body and holes in the body allow air to reach the seal. The rearmost radial holes in the rotor shaft coincide with the labyrinth, thus allowing more air to pass to the shaft interior.

79. From the hollow portion of the rotor shaft the air flows rearwards through the

axial holes to the internal flange kidney-shaped recesses, along the fluted turbine bolts, out of the foremost radial holes in the inter-stage spacer to pressurize the inter-stage labyrinth. The air then passes through the radial holes at the rear of the spacer to continue along the flutes. The extraction effect of the exhaust gases at the front face of the stubshaft causes the air to pass over the rear face of the turbine to join the gas flow and pass to atmosphere.

80. The fuel tube labyrinth is pressurized by compressed air which is tapped from the alternative torch igniter mounting on the air intake casing. From this point it is piped to the fuel inlet housing where a passage leads to the labyrinth.

81. Air to cool the rear bearing is induced and exhausted by the pumping effect of the stubshaft vanes. It enters the cylindrical centre portion via the tubes which surround the bearing support arms and passes through the axial holes in the body of the compound labyrinth. This pressurizes the two parts of the labyrinth and the air exhausts through the radial holes into the annulus between the central cylinder and the exhaust gas passage. The three stream-lined vanes provide a passage between the inner and outer annuli and the air is finally released through the flanged orifice on the rear bearing casing.

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